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Original Article

Effects of resistance training and chess playing on the quality of life and cognitive performance of elderly women: a randomized controlled trial

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Abstract:
Objective: To analyze the effects of resistance training and chess playing on the cognitive performance and perception of quality of life (QoL) in elderly women. Methods: Twenty-seven elderly women were randomly assigned to an experimental group, which performed resistance training (RG; n=14; age: 66.1±5.1 years), or another group that, in addition to these exercises, participated in chess classes (RCG; n=13; age: 66.5±4.3 years). The resistance training was performed three times a week with 60-minute sessions for 16 weeks. Data on cognition were obtained through the Mini-Mental State Examination (MMSE). The QoL was assessed using the WHOQOL-Old. Results: In the cognition analysis pre- and post-test, RCG showed significant improvements in spatial orientation; attention and calculation; recall; language and total scores. The RG presented improvements in spatial orientation and total score. In the post-test intergroup comparison, significant favorable values were obtained for RCG in attention and calculation, recall and total scores. After intervention, RCG presented significant gains in FAC1, FAC2, FAC3, FAC4, FAC5 and overall QoL. The RG showed significant improvements in FAC2, FAC4 and overall QoL. In the intergroup comparison, there were favorable and significant differences of the RCG in relation to the RG in FAC1, FAC2 and overall QoL. Conclusions: Resistance training associated with chess playing can be an efficient strategy to minimize cognitive declines and improve the QoL of elderly women.
Key words*:* aging, chess, cognition, quality of life, resistance training.

Introduction

Biological aging is a process characterized by the progressive decline of sensory, motor and mental functions, which is influenced by both genetic factors and current life habits (Santos, Foroni, & Chaves, 2009). The regular and systematic practice of physical activities has been shown to be efficient in minimizing the impairment of the neuro-cognitive functions of elderly individuals (Gajewski & Falkenstein, 2016). Through the operations of cognition, individuals process the information received by the sense organs, obtaining organization and meanings. Cognition plays a mediating role between people and the world around them, becoming determinant for the management of interpersonal relationships, development of self-awareness and affirmation of an autonomous existence (Kirk-Sanchez & McGough, 2013; Liu-Ambrose & Donaldson, 2008).

Resistance training is an efficient strategy to cope with the cognitive decline caused by the advancing age, since it is capable of causing increases in the biochemical concentration of insulin-like growth factor 1 (IGF-1). This hormone contributes to increase the production of brain derived neural factor 1 (BDNF1) and vascular endothelial growth factor (VEGF), which is a vascular expansion-related molecule (Chang, Pan, Chen, Tsai, & Huang, 2012; Kirk-Sanchez & McGough, 2013; Liu-Ambrose & Donaldson, 2008). In addition, resistance training is also estimated to reduce serum homocysteine levels, which excess can compromise cognitive performance and is associated with lesions in the white substance of the brain (Schafer et al., 2005; Wager et al., 2004).

Combinations of physical training with intellectual activities, where mental actions of comparison, interpretation, memorization, calculation and application of concepts occur, represent an efficient measure of stimulation the formation of additional connections between brain cells and their proliferation (Kraft, 2012; Oswald, Gunzelmann, Rupprecht, & Hagen, 2006). One possible explanation for this is that if physical training mobilizes the brain metabolism and the best use of these gains, it requires that brain cells be submitted to situations of cognitive challenge. In this sense, the integration of physical training with essentially intellectual

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tasks may be more beneficial for elderly individuals than if each activity were applied in isolation (Oswald et al., 2006).

Physical training combinations with intellectual activities are capable of exerting positive effects in elderly individuals regarding the preservation of the capacity to perform arithmetic operations, manage financial resources, verbally express thoughts, perform everyday instrumental activities (walking, carrying loads) and maintain affective relationships (Netz, Wu, Becker, & Tenenbaum, 2005; Oswald et al., 2006). Perform activities of daily living (ADL) with autonomy, efficiency and independence is one of the prerogatives of quality of life (QoL) in the elderly. Hence, intellectual activities associated with physical training may potentiate QoL (Netz et al., 2005).

Although there is still no consensus on the most appropriates intellectual activities to integrate physical training, preventive programs to control and reduce cognitive impairment in the elderly can use GO-game (Chinese chess), backgammon and chess (Dartigues et al., 2013; Lin, Cao, & Gao, 2015). In addition to practicality, such games demand strategies, decision-making, scenario assessments and self-discipline (Gobet & Simon, 1998). These requirements trigger the basic executive functions (cognitive adaptability, self-control, self-regulation, working memory) and complex (problem solving, reasoning, and action design), which are related to attention, manipulation of ideas, and suitability for new environmental stimuli (Léon, Rodrigues, Seabra, 2013).

Therefore, physical exercise articulated to chess playing seems to be a hypothetically effective mechanism for controlling and reducing cognitive deficits related to aging. This may be because QoL is positively associated with the preservation of physical and cognitive skills (Aciego, García, & Betancort, 2012; Forte, Boreham, De Vito, & Pesce, 2015). In this sense, the combination of regular chess practice with physical training may indirectly interfere with the maintenance of QoL in the elderly. Thus, the aim of the present study was to analyze the effects of a resistance training program and chess playing on the cognitive performance and QoL perception in elderly women.

Material & methods

Participants and data collection

Sixty-six elderly women enrolled in a social project in the Estácio de Sá University, Cabo Frio, RJ, Brazil were invited to participate in the present study. Subjects should be 60 years of age or older, be independent in their ADL, be considered fit by medical evaluation and have not been exercising for at least six months. It was excluded from the study subjects who presented any type of uncontrolled pathology, cardiopathies or diabetes; blood pressure ≥ 150 x 90 mmHg; inflammatory processes and/or open wounds; use of antidepressant or sedative drugs; neurological, vestibular, or movement disorders related to cognitive decline; recent surgeries; use of prostheses or those who missed more than 20% of the intervention classes.

After these criteria were applied, 42 women were selected and randomized by simple draw into an experimental group (RG), submitted to a resistance training program, and another group that, besides this resistance training, participated in chess classes (RCG). However, due to personal reasons or missing more than 20% of the classes, 15 subjects dropped out from the study, seven from the RG and eight from the RCG. Therefore, 14 women composed the RG (age: 66.1±5.1 years; BMI: 28.91±5.2 kg/m^2) and 13 participated in the RCG (age: 66.5±4.3 years; BMI: 27.42±3.9 kg/m^2) (Figure 1).

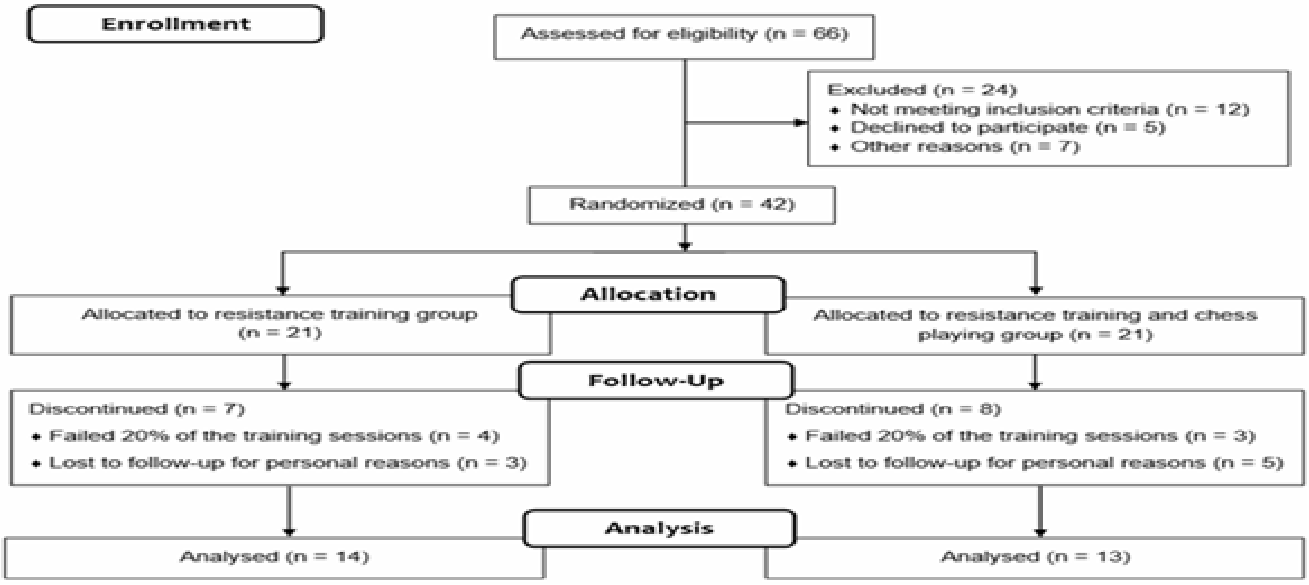

Figure 1. Flow of participants through the trial.

Initially, an anamnesis was performed to obtain socioeconomic and health information from study participants. Anthropometric measures of height and body mass were also performed through a mechanical scale with stadiometer (Filizola, Brazil) to calculate the body mass index (BMI) (Marfell-Jones et al., 2006).

This study was submitted and approved by the Research Ethics Committee of Estácio de Sá University (CAAE: 53771816.3.0000.5284). The participants who agreed to participate in the study signed an informed consent form in accordance with the guidelines regarding human research defined in the Resolution 466/12 of the National Health Council and the Declaration of Helsinki.

Measurements and Procedures

The procedures for data collection are described below.

Cognition evaluation

For the evaluation of cognition, the Mini-Mental State Examination (MMSE) was applied before and after the intervention. The MMSE is a scale composed of several issues grouped into seven categories, each one of which is designed to evaluate the following specific elements of cognition: time and place orientation (10 points); record of three words (3 points); attention and calculation (5 points); remembering the three words (3 points); language (9 points). The MMSE score can range from a minimum of zero to a maximum of 30 points. Thus, it is possible to evaluate the temporal decline of memory and other higher cortical functions, such as language, praxes, ability to recognize and identify objects, abstraction, organization, planning and sequencing (Bertolucci, Brucki, Campacci, & Juliano, 1994; Folstein, Folstein, & McHugh, 1975).

Quality of life (QoL) assessment

To evaluate the QoL, the WHOQOL-Old questionnaire was applied individually for each participant of the sample. The World Health Organization (WHO) developed this specific instrument for elderly people. The WHOQOL-Old questionnaire is composed of 24 questions, which evaluate six facets: FAC1 (Sensory Functioning): evaluates sensorial functioning and loss of sensorial abilities in QoL; FAC2 (Autonomy): refers to independence in old age and describes the extent to which one is able to live autonomously and make their own decisions; FAC3 (Past, Present and Future Activities): describes the satisfaction of the achievements in life and what is desired; FAC4 (Social Participation): participation in everyday activities, especially in the community; FAC5 (Death and Dying): relates to worries, concerns and fears about death and dying; FAC6 (Intimacy): evaluates the ability to have personal and intimate relationships. Each one of these facets has four items – in a Likert scale from 1 to 5 – resulting in a set of facet scores that can vary from 4 to 20. The combination of the scores of these six facets of the 24 WHOQOL-Old items produces an overall Quality of Life (oQoL) in older adults. This questionnaire is based on the assumptions that QoL is a subjective and multidimensional construct, composed of positive and negative dimensions (Fleck, Chachamovich, & Trentini, 2003).

Intervention

The resistance training program consisted of a combination of four dimensions articulated in the following class sessions: communication, warm-up, main activity and recuperative relaxation, with 3 sessions of 60 minutes per week, during 16 weeks.

At the communication session, corresponding to the first 5 minutes of the class, the teacher brought the students together, greeted them personally with handshakes and hugs, and requested that everyone do so with their colleagues. Then, the teacher gave a brief description of what would happen in the class, as well as the names of the exercises, which should be repeated by the study participants. Besides, the teacher asked how the daily life of the participants had been between the last class and the present one.

In the warm-up phase, which lasted 5 minutes, the teacher began by asking the students to walk freely through the class space, asking them to communicate the number of steps taken when they heard a clap of hands. Then, the teacher, with the help of monitors, placed the participants in a circle and asked them, under their demonstration and with the support of sticks, to carry out stretching exercises and adduction, abduction, flexion, extension, circumference and rotation movements of the neck, shoulders, elbows, wrists, hips, ankle and knees joints, always accompanied by a collective count aloud.

After the warm-up, the main activity phase was started immediately, lasting 40 minutes. In it, also under the teacher's demonstration and with repetitions counts aloud, the elderly performed submaximal muscular actions of dynamic contraction using ankle weights, dumbbells, sticks and steps. Technically, the exercises performed were squats, elbow flexion and extension, knee flexion and extension, horizontal flexion and extension of the shoulders, plantar flexion and abdominals, distributed between 2 and 3 sets of 15 to 20 repetitions in the first 4 weeks, and 3 sets of 8 to 12 repetitions in the remaining 12 weeks, totaling 16 weeks.

The final phase, with a total duration of 10 minutes, consisted of stretching exercises for 5 minutes to promote relaxation and muscle release. In the other 5 minutes, the teacher asked the opinions of the elderly about the class session, as well as opened the opportunity for students to make suggestions for the next classes. In addition, the birthday celebrations of the day and the week were part of the group routine. It should be noted that the phases of warm-up, main activity and recuperative relaxation always occurred with musical accompaniment.

The exercise intensity of the proposed resistance exercises was controlled by the OMNI-Resistance Exercise Scale (OMNI-RES) of perceived exertion, maintaining a mild-moderate level of the scale (level 3 to 5) in the first four weeks and moderate-high (level 5 to 7) in the other weeks (Robertson et al., 2003). The RCG, in addition to performing the RG exercises, also participated in chess lessons once a week, lasting 50 minutes per session, during the same period of the experiment.

The elderlies of the RCG did not have previous experiences in chess playing, that is, all began the learning of the game during the period of intervention. The game of chess was started through theoretical lessons, in which the purpose of the game and the rules were explained. The names of the pieces and their movements were also presented. Then, the study participants began playing chess effectively shortly after the resistance training sessions.

Statistical analysis

The data were analyzed using the IBM SPSS Statistics 20 and presented as mean and standard deviation. The normality of the data and the variance homogeneity was verified by the Shapiro-Wilk and Levene tests, respectively. The Kruscal-Wallis test, followed by Dunn's post hoc, was used to analyze the multiple comparisons in the study variables. The Spearman correlation test was used to verify the associations between the variables related to cognition and QoL. The observed power was calculated. The values ≥ 80% represents strong power. In addition, the effect size (*d*) was calculated to analyze the results magnitude of the present study. It was used for the interpretation: < 0.2: weak; 0.2 – 0.79: moderate; > 0.8: strong. The study adopted $p<0.05$ for statistical significance.

Results

All study subjects had a level of education of 4 years or more. The RG presented 5 subjects with 4 years of study, 8 subjects between 5 and 8 years and 1 subject between 9 and 11 years. The RCG presented 5 subjects with 4 years of study, 7 subjects between 5 and 8 years, and 1 subject between 9 and 11 years. The level of family wage income varied between 2 and 6 minimum salaries in both groups. The observed power were strong in all the variables of the MMSE, except in the registration (22%). In the QoL variables, the facets presented strong observed power, with exception of the FAC3 (71%) and FAC5 (64%) – both with moderate power –, and FAC6 (9%) – which presented weak power.

Table 1 presents the comparative analysis of the cognitive responses of the RG and RCG groups observed through the scores for each category and the total score of the MMSE. In the pre- and post-test analysis, the RCG showed significant improvements ($p<0.05$) in the dimensions spatial orientation; attention and calculation; recall; language; and total scores. The RG showed improvements in spatial orientation and total score. In the post-test intergroup comparison, there were favorable values ($p<0.05$) for the RCG in attention and calculation, recall and in total scores. The strong *d* demonstrates the magnitude of the variables after the intervention. The *d* was higher in the RCG when compared with the RG. This enhances the results found in these variables in the current study. In some variables, the *d* was moderate or weak in the RG. However, in the RCG, only the registration had a moderate *d*.

Table 1. Comparative analysis of cognitive responses between RG and RCG.

Variables	Groups	Mean (pre)	SD	Mean (post)	SD	*d*
Spatial orientation	RG	8.29	1.20	9.71*	0.47	1.18
	RCG	8.31	0.95	9.92*	0.28	1.69
Registration	RG	2.79	0.43	2.86	0.36	0.16
	RCG	2.69	0.48	2.92	0.28	0.48
Attention and calculation	RG	3.14	1.88	3.50	1.40	0.19
	RCG	3.15	1.21	4.92*#	0.28	1.46
Recall	RG	1.64	1.15	1.71	0.61	0.06
	RCG	1.69	0.95	2.85*#	0.38	1.22
Language	RG	7.29	1.73	8.36	0.63	0.62
	RCG	6.92	1.66	8.85*	0.38	1.16
Total score	RG	23.14	3.53	26.14*	2.18	0.85
	RCG	22.77	3.77	29.46*#	0.78	1.77

SD: standard deviation; RG: resistance training group; RCG: resistance training, and chess playing group; *d*: effect size; * $p<0.05$, pre-test vs. post-test; # $p<0.05$, RG-post vs. RCG-post

Table 2 shows the results on the QoL levels between RG and RCG observed through the application of the WHOQOL-Old questionnaire. The RCG presented significant increases in FAC1, FAC2, FAC3, FAC4, FAC5 and overall QoL in the pre- and post-test comparison. However, the RG obtained significant improvements in QoL scores and in the FAC2 and FAC4 categories. In the intergroup comparison, there were significant differences favorable to the RCG in relation to the RG in FAC1, FAC2 and overall QoL. With exception of the FAC4, the *d* was higher in the RCG when compared with the RG. This enhances the positive

effect of the combination of resistance training with chess playing in the elderly women of the present study. In some facets, the *d* was moderate or weak in the RG. On the other hand, the *d* was moderate only on the FAC6 in the RCG.

Table 2. Results on the quality of life levels between RG and RCG.

Facets	Groups	Mean (pre)	SD	Mean (post)	SD	*d*
FAC1	RG	13.86	1.96	14.93	2.59	0.55
	RCG	13.92	3.38	17.08*#	2.25	0.93
FAC2	RG	12.50	3.50	15.86*	2.11	0.96
	RCG	13.00	3.67	18.23*#	2.13	1.43
FAC3	RG	14.07	2.23	15.14	2.80	0.48
	RCG	13.15	2.82	16.23*	2.86	1.09
FAC4	RG	13.64	2.37	16.50*	2.41	1.21
	RCG	13.54	2.79	16.46*	1.81	1.05
FAC5	RG	14.07	3.17	14.93	2.16	0.27
	RCG	14.15	2.91	16.85*	2.79	0.93
FAC6	RG	15.93	2.20	15.79	2.08	0.06
	RCG	15.54	2.82	16.31	2.50	0.27
oQoL	RG	14.01	1.20	15.52*	1.04	1.26
	RCG	13.88	1.62	16.86*#	1.44	1.84

SD: standard deviation; FAC1: Sensory abilities; FAC2: Autonomy; FAC3: Past, present and future activities; FAC4: Social participation; FAC5: Death and dying; FAC6: Intimacy; oQoL: overall Quality of Life; RG: resistance training group; RCG: resistance training, and chess playing group; *d*: effect size; * $p<0.05$, pre-test vs. post-test; # $p<0.05$, RG-post vs. RCG-post.

Table 3. Correlation analysis between cognitive responses and quality of life facets.

		FAC1	FAC2	FAC3	FAC4	FAC5	FAC6	oQoL
Spatial orientation	r	0.36	0.39	0.10	0.27	0.25	-0.01	0.41
	p-value	0.007	0.004	0.481	0.046	0.069	0.949	0.002
Registration	r	0.10	0.13	0.10	0.04	0.10	0.04	0.19
	p-value	0.479	0.358	0.485	0.757	0.450	0.799	0.159
Attention and calculation	r	0.50	0.44	0.03	0.04	0.54	0.29	0.54
	p-value	0.001	0.001	0.847	0.757	0.001	0.036	0.001
Recall	r	0.28	0.35	0.07	0.17	0.33	0.01	0.36
	p-value	0.038	0.010	0.630	0.231	0.014	0.979	0.008
Language	r	0.38	0.38	0.15	0.05	0.29	-0.08	0.37
	p-value	0.004	0.004	0.287	0.738	0.036	0.545	0.006
Total score	r	0.54	0.54	0.14	0.17	0.46	0.08	0.58
	p-value	0.001	0.001	0.299	0.231	0.001	0.545	0.001

FAC1: Sensory abilities; FAC2: Autonomy; FAC3: Past, present and future activities; FAC4: Social participation; FAC5: Death and dying; FAC6: Intimacy; oQoL: overall Quality of Life.

Table 3 presents the correlation coefficients obtained between cognitive responses and QoL levels. With the exception of registration, the other dimensions of cognition measured by the MMSE obtained positive correlations ($p<0.05$) with five of the six facets of the QoL of the WHOQOL-Old and the overall QoL. The spatial orientation showed association ($p<0.05$) with FAC1, FAC2, FAC4 and overall QoL; attention and calculation with FAC1, FAC2, FAC5, FAC6 and overall QoL; recall with FAC1, FAC2, FAC5 and overall QoL; and language with FAC1, FAC2, FAC5, and overall QoL.

Discussion

The results of the present study indicate that the RCG showed changes in the facets FAC1, FAC3 and FAC5 of QoL measured by the WHOQOL-Old. The RCG and RG showed positive and joint changes in FAC2, FAC4 and overall QoL. In the cognitive abilities, the RCG presented alterations in the cognitive functions of attention and calculation, recall and language, measured by the MMSE. The RCG and RG improved their results in spatial orientation and total scores of the MMSE.

Cognition can be considered as a set of intellectual processes that an organism uses to acquire, process, and utilize knowledge (Liu-Ambrose & Donaldson, 2008). Cognition is stimulated through the richness of experiences and interactions to which the person is subjected. Thus, insufficient cognitive stimuli result in weak

adaptations. However, the richer and more diversified these stimuli are, the greater and more comprehensive their development will be. Through cognition, individuals equate solutions to problems, modify behaviors, normalize attitudes, and make value judgments. This reflects the refinement of their interpretations of the surrounding environment (Yaffe et al., 2009). The diversity of these stimuli may justify the answers obtained on cognition found in the RCG, which, when compared to the GR, showed significant improvements in more categories of the MMSE.

Although spatial orientation was the only category of GR that had improvement, this result corroborates the hypothesis that resistance training can exert positive effects on cognitive functions (Chang et al., 2012). At the end of a 24-week resistance training program with moderate to high intensities and a frequency of 3 weekly sessions lasting 1 hour, Cassilhas et al. (2007) found that elderly men (n=63) exhibited improvements in working memory and the elaboration of verbal concepts. Byun and Kang (2016) also observed increases in working memory and verbal conceptualization in older women exposed to 12 weeks of resistance training, with frequency of 4 days a week, 50-minute sessions, and moderate to high effort intensities. In addition, positive associations between gains in flexibility and strength and general cognitive ability were also found by Smolarek et al. (2016). The authors evaluated elderly women over 65 years of age who were enrolled three times weekly on alternate days in a 12-week resistance training program in which they performed 12 different exercises for upper and lower limbs in three sets of 10 repetitions with loads fixed between 60% and 75% of the estimated value of 1RM.

On the other hand, Lachman et al. (2006) reported that small increases in working memory were observed in elderly people over 65 years old of both sexes and after 6 months of resistance training. At the end of the study, they reported that the higher the intensity of training, the greater the possibility of increases in memory. Carral and Pérez (2007) reinforce this point of view, emphasizing the importance of high training intensities in minimizing the deficits caused by aging over working memory. Liu-Ambrose et al. (2010) reported significant gains only in selective attention and conflict resolution in elderly women submitted to a resistance program for 12 months with moderate intensity and weekly frequency of 2 days. From the perspective of the authors, long-term training with medium to high intensity can provide cognitive gains such as those observed in the present study.

The studies cited previously (Cancela Carral & Ayán Pérez, 2007; Lachman et al., 2006; Liu-Ambrose et al., 2010) confirm that resistance training is capable of exerting positive impacts on cognition functions. Nevertheless, varying combinations of volume and intensity have impacted different cognitive functions, which shows that the mental responses to the amounts of resistance training are individual. In the RCG, besides the spatial orientation, the attention and calculation, recall and language functions were positively impacted. Improvements in these last three dimensions were not observed in the RG. This denotes the possible interference of the practice of chess. It is noteworthy that significant intergroup differences also occurred in favor of the RCG in attention and calculation, recall and in the total score.

Aciego et al. (2012) identified possible consequences of the continuous practice of chess in cognition through behavioral tests applied to adolescents beginning in the modality. At the end of a year of regular dedication, these young people improved the levels of selective attention, ability to plan and resolution of mathematical activities. In another research, Fattahi et al. (2015) tested as short-term, working and auditory verbal memories (which is linked to word retrieval) in adults who players chess regularly, comparing them to a group of non-chess players with the same age rage. In the three items, the authors found significant improvements in the first group compared to the second, without gender interference. The results obtained by the RCG of the present study corroborate the findings in the studies of Aciego et al. (2012) and Fattahi et al. (2015), insofar as language, recall, and attention and calculation functions showed positive increases at the end of the intervention period.

According to Nichelli et al. (1994), solving complex problems in a match confirms the interference of chess on neurocognition. An example is to build strategies in order to place the enemy king in checkmate via articulation of different pieces in the board, or even defend it from opponents' attacks. The authors (Nichelli et al., 1994) used functional neuroimaging techniques and found that the search for solutions to such game tasks, which others could be summed up, stimulates participants to network in several functionally distinct brain regions. In order to make this integration feasible, the continuous exercise of chess represents a strong factor to promote adaptive changes (Atherton, Zhuang, Bart, Hu, & He, 2003).

Duan et al. (2012) found confirmatory evidence of this association also through the use of functional magnetic resonance imaging (fMRI) techniques. Applying them to beginner and great masters Chinese chess players, they obtained images of their brain activity from which they identified the influence of chess in the mobilization of four brain networks, namely: central executive network, dorsal attention network, salience network, and default mode network, all linked to cognitive performance. In the more complicated moments of the game, it was noticed the inhibition of the default mode network and the intense activation of the central executive, dorsal and salience networks.

Cognitive tasks that require external attention trigger the central executive network, which is also linked to the process of creative problem solving and verbal fluency (Beaty, Benedek, Barry Kaufman, & Silvia, 2015).

The dorsal attention network is mobilized in actions that require visual orientation in space (Ptak & Schnider, 2010), while the salience network participates in the attention and subjective awareness of events (Uddin et al., 2013). Chess requires of its participants continuous attention and visualization of what happens with each move in the geometry of the board, as well as decisions as to the best sequence of pieces to move with the intention of neutralizing the opponent. In the present study, the repeated exposure of RCG to situations such as these contributed to mobilizing these networks. The improvements in spatial orientation, language, recall, and attention and calculation found in this group, when compared to RG in the post-test, may be an effect of this specific exposure, as well as may have influenced the results on QoL.

QoL in the present study was considered as the way in which somebody evaluates their own health, physical, mental and social well-being over time (Cancela Carral & Ayán Pérez, 2007). After the intervention period, both groups, RG and RCG, improved significantly the QOL scores, but the RCG obtained positive results in more facets than the GR. In the intergroup comparison, the RCG presented higher scores when compared to the GR in FAC1, FAC2 and overall QoL.

Table 3 shows that maintenance of most cognitive functions sustains a positive association with QoL (Forte et al., 2015). It is important to preserve QoL as the aging process progresses. Barnes *et al*. (2007) reported, after a 15-year follow-up, that elderly people whose cognitive functions were maintained intact presented fewer difficulties in exercising ADL, following healthy lifestyles and interacting socially. In addition, they were less likely to have diabetes and hypertension. Furthermore, Yaffe et al. (2009) reported that the preservation of cognitive functions in the elderly relates to a better sense of well-being, a lower isolation and voluntary engagement in social causes. This suggests an improvement in the perception of QoL.

In the present study, preservation of attention and ability to calculate was the function with the highest number of positive correlations (four), focusing on FAC1, FAC2, FAC5 and FAC6 domains of QoL. In addition, there were three correlations between spatial orientation and FAC1, FAC2 and FAC4, as well as three correlations between recall and language with, respectively, FAC1, FAC2 and FAC5. In contrast, the registration did not exert any positive interference in any aspect of QoL. In overall QoL, with the exception of registration, all other cognitive functions were positively correlated.

The results of the present study indicate that the effects of resistance training can be perceived in singular domains of QoL in the elderly. Increases in strength may influence the subjective perception of psychosocial well-being, as elderly individuals often relate the awareness of greater effectiveness in performing ADL, such as walking, sitting, lifting, carrying and transporting loads (Vieira, Nogueira, Cunha, Ferreira, & Nogueira, 2012). In physiological terms, Carral and Pérez (2007) point out that the release of endorphin and the increase of functional capacities are direct effects of resistance training. This indicates that the moderate to high effort intensities are the most appropriate to produce these changes.

Another relevant factor refers to the training method adopted in the present study, in which the activities were given in a group and with the stimulation of interpersonal relations among the students, in addition to the presence of motivating elements such as music, which help self-confidence (Byun & Kang, 2016; Oswald et al., 2006). Systematic training programs for adults occurring in the context of a stimulating teaching-learning environment with plural offerings of sensory information stimulate synaptic plasticity and neurogenesis processes (Naylor et al., 2000; Oswald et al., 2006). Therefore, it is noted that not only the practice of resistance training in itself, but the way it is pedagogically structured and administered, can interfere in the subjective perception of well-being and QoL in the elderly.

The positive correlations shown in table 3 between attention, ability to calculate, spatial orientation, recall and language with QoL facets reinforce the pedagogical relevance of chess to repair cognitive deficits in the elderly and their influence on the perception of QoL. Basak et al. (2008) and Kraft (2012) reinforce this point of view by stating that, in addition to chess, games in general that require formulations of strategies focus on the domains of logical problem solving, binary decisions, working memory and spatial orientation. Additionally, the authors admit that socio-affective reasons should not be discarded, as they develop and put into practice chess skills, it is expected that older people tend to broaden their personal expectations of positive performance and, consequently, to maintain involved in the practice.

The limitations of the present study are related to non-performance of strength and mobility tests at the end of the intervention, in order to compare these results with the levels of cognition and the perception of QoL. Such data could generate more accurate information about the relationship between cognition, QoL, and the efficiency of resistance training.

Conclusions

The results of the present study make it possible to conclude that resistance training programs combined with chess playing can minimize cognitive decline and improve the perception of QoL. In the group of women who practiced chess, there were positive changes in attention, calculation, recall and language, as well as in many facets of QoL. This can interfere in the maintenance of social relationships, the sense of well-being, the reasoning ability and the performance of the ADL. Moreover, chess playing may be an additional strategy of cognitive stimulation and improvement of QoL to be implemented in physical activity programs for the elderly.

Future investigations can be developed with other games requesting executive functions (domino, checkers, backgammon, video games). These games can influence cognition and QoL when associated with resistance training, with controlled manipulation of training volume and intensity for each type of game.

Conflicts of interest

The authors have no conflicts of interest to declare.

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