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Brain Gym exercises versus standard exercises for institutionalised older people with cognitive impairment: a randomised controlled study

ORIGINAL ARTICLE

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ABSTRACT

Background. This study compared the effects of Brain Gym (BG) exercises versus standard exercise (SE) on cognitive function, functional independence, physical fitness, and quality of life among institutionalised older adults with cognitive impairment.

Methods. Institutionalised older adults with cognitive impairment were randomly assigned to either SE group or BG group. Participants performed two 1-hour sessions per week for 10 weeks. Cognitive function, functional independence, fitness level, and quality of life (QoL) of participants were assessed.

Results: A total of 55 participants were assigned to the SE group (n=19) or the BG group (n=36). Of them, 17 in the SE group and 33 in the BG group completed >80% of the sessions. The two groups were comparable in terms of baseline characteristics. Participants in both BG and SE groups had a slight decline in cognitive function, functional independence, and physical-related QoL, as well as minor improvement in fitness level and mental-related QoL. The effects produced by either programme was similar ($F_{1,76}$=0.063-1.986, p=0.163). Both programmes had similar effects on participants, and neither the level of cognitive impairment nor the programme had any significant effect.

Conclusions. BG and SE have similar effects on cognitive function, functional independence, QoL, and fitness levels among institutionalised older adults with cognitive impairment.

Key words: Cognitive dysfunction; Exercise; Institutionalization

INTRODUCTION

Cognitive training and physical exercise have been regarded as useful strategies to improve the cognitive function in older people with cognitive impairment.[1] Physical exercise improves the metabolic activity of the brain, whereas cognitively demanding tasks increase the number of dendritic branches and the level of synaptic plasticity. Therefore, a combination of both therapies may have synergistic effects that positively influence various cognitive domains in different ways.[2]

Brain Gym® (BG) combines mental and physical training and is a movement-based programme to improve learning capabilities through mind-body exercises.[3] BG can be more pleasant for older adults who tend not to participate conventional exercises. In addition, it might have a positive effect on cognitive function.[4] Scientific evidence regarding the effects of BG as physiotherapy/rehabilitation is controversial. One study reported that BG-based exercise resulted in significant cognitive improvements in terms of visual scanning, verbal tracking, and delayed recall,[5] whereas another study reported no significant improvements in cognitive performance and fitness level.[6] Both studies were carried out in healthy active older people.

Results are similar in people with cognitive impairment. In a randomised controlled trial of 27 older adults with dementia, a 6-week training programme based on BG exercises significantly improved the sustained attention and visual memory.[7] In a quasi-experimental study of people with cognitive impairment, cognitive function improved after taking part in a short BG programme.[8] However, a cognitive enhancement gymnastics programme (with exercises similar to those in the BG manual) for octogenarians with dementia found no significant effect on cognitive function or autonomy to perform activities of daily living.[9] None of these studies compared the potential benefits of BG with those of traditional exercises. A comparative study of institutionalised people with cognitive impairment reported that a BG exercise-based programme did not significantly improve the cognitive function or functional independence, and had the same effects as a traditional exercise programme.[10] Nevertheless, the study lacks a control group.

Therefore, we designed a randomised controlled trial to compare BG with traditional exercises, with an aim to identify the potential benefits of BG exercises on the cognitive function, functional independence, physical fitness, and quality of life (QoL) among institutionalised older people with cognitive impairment.

METHODS

This study was carried out in three nursing homes in Spain that provide long-term residential (in-patient) care. Participants were recruited through collaboration between the University of Vigo and a company that manages residential care homes. Inclusion criteria were age >65 years, mean score of ≤24 in the Spanish version of the Mini-Mental State Examination (MMSE),[11] and ability to follow instructions. Those with medical condition that hindered or prevented completion of all evaluation tests were excluded. All participants and their families were informed about the characteristics of the research protocol. The Ethics Committee of the Faculty of Education and Sport Science (Ref: 2-2402-16) approved the study, and all participants gave their informed consent. The full trial protocol of the study is registered and available at ClinicalTrials.gov (Ref: NCT03368482).

Participants were randomly assigned to either standard exercises (SE) group or BG group by an independent researcher blinded to baseline data in a ratio of 1:2 (given that a lower adherence in the BG group was expected). Participants in both groups performed two 1-hour sessions per week for 10 weeks. All sessions were monitored by a specialist in physical exercise with experience in administration of BG. Participants in the SE group took part in a traditional physical exercise programme aimed at increasing the range of mobility and coordination, with focus on the lower limbs. Participants in the BG group performed six of the following BG exercises in every training session: 'cross crawl', 'gravity glider', 'arm activation', 'belly breathing', 'hook-ups', 'think of an X', 'lazy eights', 'elephant', 'space buttons', 'the owl', 'energy yawn', 'balance buttons', and 'the energizer'. All exercises were executed from a sitting position and followed the tenets of the BG work routine (**Table 1**).

The main differences between the BG and SE groups are the aim of these tasks and the approach taken. Coordination work in the SE group was linked to the strength, mobility, and bodily awareness needed to perform the basic lower body movements required by activities of daily living. This was intended to improve performance of independent movements and reduce the risk of falling. Whereas the BG programme consists of a structured intervention of non-aerobic physical exercise that combines specific patterns of crossing movements of the head, eyes, and extremities together with brain and breathing exercises. The creators claim that regular BG exercises lead to stimulation and integration of different parts of the brain, particularly the corpus callosum. This results in a faster and more integrated communication between the two hemispheres, essential for high-level reasoning.[12]

Each participant's age, sex, level of education, pathologies, and medication parameters were obtained from medical records. Cognitive function was assessed using the Spanish version of the

TABLE 1
Standard exercises versus Brain Gym exercises

<table>
<tr><th>Standard exercises</th><th>Brain Gym® exercises</th></tr>
<tr><td colspan="2">Warm-up (15 min)</td></tr>
<tr><td colspan="2">a) Ankle mobility: With heel support and the foot slightly elevated, perform the following:
1. Dorsal and plantar flexion movements.
2. Abduction (eversion) and adduction (inversion) movements.
Sets: 1 complete sequence of the 2 exercises, alternating right and left foot.
Duration: Each exercise lasts 20 s.
Sequence: Follow the established order.
b) Ankle mobility: With toe support and the foot slightly elevated, perform the following:
1. Dorsal and plantar flexion movements.
2. Abduction (eversion) and adduction (inversion) movements.
Sets: 1 complete sequence of the 2 exercises, alternating right and left foot.
Duration: Each exercise lasts 20 s.
Sequence: Follow the established order.
c) Same as exercise a), but using both feet simultaneously.
d) Same as exercise b), but using both feet simultaneously.</td></tr>
<tr><td colspan="2">Main part (35 min)</td></tr>
<tr><td>a) Knee flexion and extension alternating right and left leg. Heel touches the ground at the end of each extension.
Sets: 3 complete sequences.
Repetitions: Each exercise is performed 10 times.
Resting time: 30 s.
b) Hip abduction-adduction.
Sets: 3 complete sequences.
Repetitions: Each exercise is performed 10 times.
Resting time: 30 s.
c) Perform the following kinetic chain sequence of movements using both legs: Extension – Flexion – Abduction – Adduction.
Sets: 3 complete sequences.
Repetitions: Each exercise is performed 10 times.
Resting time: 30 s.
d) Perform the following kinetic chain sequence of movements, first with the right leg, and then with the left leg: Extension – Flexion – Abduction – Adduction.
Sets: 3 complete sequences.
Repetitions: Each exercise is performed 10 times.
Resting time: 30 s.
e) Starting with the right leg, perform an alternating sequence of circular movements (ankle-knee-hip) relying on toe support. Change direction of rotation after the 5th time.
Sets: 2 complete sequences.
Repetitions: Each exercise is performed 10 times.
Resting time: 30 s.
f) Using both legs simultaneously, perform an alternating sequence of circular movements (ankle-knee-hip) relying on toe support. Change direction of rotation after the 5th time.
Sets: 2 complete sequences.
Repetitions: Each exercise is performed 10 times.
Resting time: 30 s.
g) Starting with the right leg, perform an alternating sequence of circular movements (ankle-knee-hip) without toe support. Change direction of rotation after the 5th time.
Sets: 2 complete sequences.
Repetitions: Each exercise is performed 10 times.
Resting time: 30 s.</td><td>a) Knee flexion and extension alternating right and left leg. Heel touches the ground at the end of each extension.
Sets: 3 complete sequences.
Repetitions: Each exercise is performed 10 times.
Resting time: 30 s.
b) Brain Gym® exercise.
Sets: 3 complete sequences.
Repetitions: Each exercise is performed 10 times.
Resting time: 30 s.

• Cross crawl.
• Gravity glider.
• Arm activation.
• Belly breathing.
• Hook-ups.
• Think of an X.
• Lazy 8s.
• Elephant.
• Space buttons.
• The owl.
• Energy yawn.
• Balance buttons.
• The energizer.</td></tr>
<tr><td colspan="2">Cooling-off (10 min)</td></tr>
<tr><td colspan="2">a) Directed breathing.
Duration: 5 minutes.
b) General stretching exercise.
Duration: 10 s per muscular group.
Total duration: 5 minutes.</td></tr>
</table>

MMSE,[11] which has been used to assess the effects of exercise training on cognitive function of people with mild cognitive impairment.[13] In Spain, it is the most widely used test for standardised cognitive assessment in older adults.[14] The Spanish version of the Barthel Index[15] and the 12-Item Short-Form Health Survey (SF-12)[16] were used to assess functional independence and QoL, respectively.

A neurologist and occupational therapists who were blinded to group allocation administered the tests for cognitive function, QoL, and functional independence. The fitness level was assessed using the Five-Chair Stands test[17] by the same person who monitored the intervention.

The Kolmogorov-Smirnov normality test revealed that all the quantitative variables were normally distributed. The two groups were compared using the Student's *t*-test for independent variables or the Chi square test for categorical variables. Analysis of variance was applied to each variable, and outcomes were interpreted according to the main effects and interactions. The within-group factor was the moment and assessed change in outcome between two time points (baseline, post-test). The between-group factor was the type of programme. Analysis of variance was performed to analyse the differential effect of SE versus BG with respect to the moment. A graphical analysis of improvements and involutions was carried out to determine the effect of the level of cognitive impairment on the variables under study. SPSS (Windows version 22; IBM Corp, Armonk [NY], US) was used for data analyses. A p value of <0.05 was considered statistically significant.

RESULTS

Of 176 participants, 55 met the inclusion criteria and were assigned to the SE group (n=19) or the BG group (n=36). Two dropouts were registered in the SE group and three in the BG group. Therefore, 17 participants (mean age, 85.00±7.40 years) in the SE group and 33 participants (mean age, 81.68±8.33 years) in the BG group completed >80% of the sessions (**Figure 1**). The two groups were comparable in terms of baseline characteristics (**Table 2**).

Participants in both BG and SE groups had a slight decline in MMSE score for cognitive function (-7.17% vs -2.88%), Barthel Index for functional independence (-2.31% vs -3.72%), and SF-12 physical component summary score (-11.80% vs -12.69%), as well as minor improvement in fitness level and SF-12 mental component summary score. The moment × programme analysis indicated that the magnitude of the effects produced by either programme was similar ($F_{1,76}$=0.063-1.986, p=0.163, **Table 3**). Both programmes had similar effects on participants, and neither the level of cognitive impairment nor the programme had any significant effect (**Figure 2**).

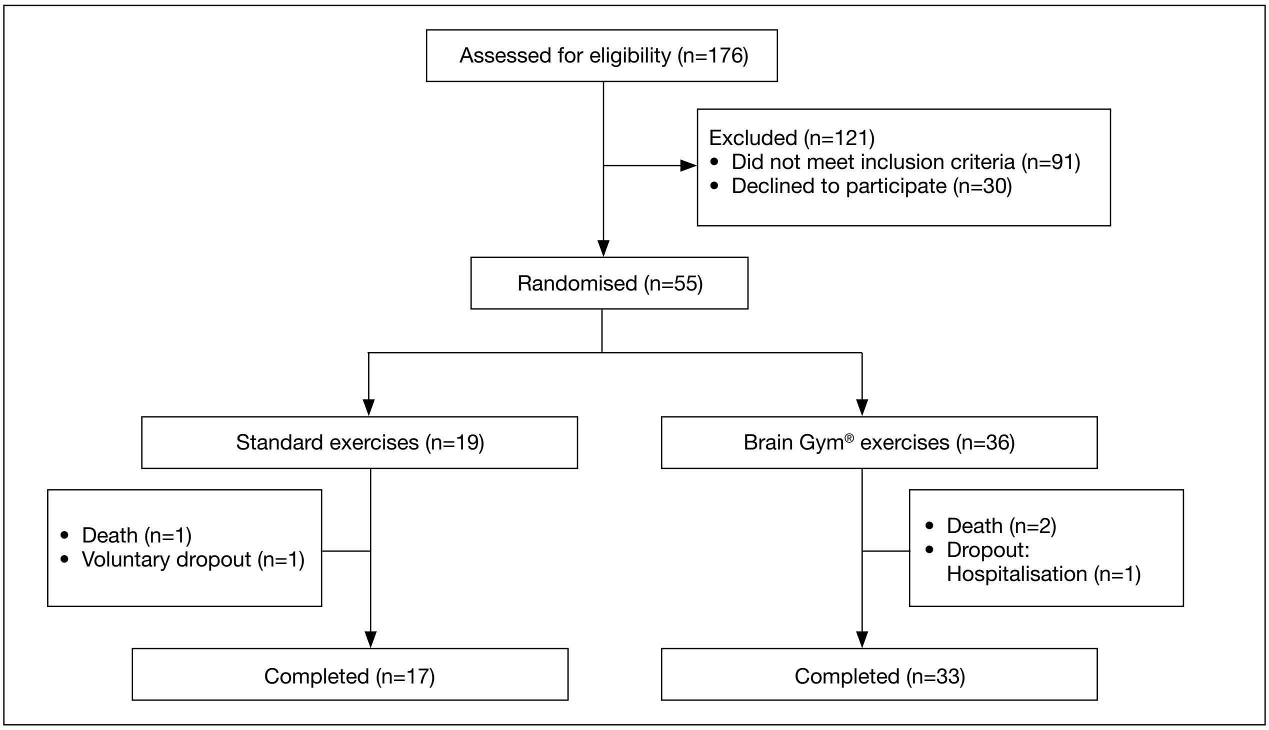

Figure 1. Flowchart of recruitment of participants.

Table 2
Baseline characteristics of participants.

	Brain Gym® exercises (n=33)*	Standard exercises (n=17)*	p Value
Age, y	81.68±8.33	85.00±7.40	0.421
Sex			0.675
Male	33.30	30.80	
Female	66.70	69.20	
Education level			0.187
No studies	92.90	80.0	
Primary	7.10	20.0	
Pathologies			0.061
High blood pressure	30.30	47.05	
Arthrosis	15.15	35.29	
Diabetes types I or II	9.09	11.76	
Cardiopathy	48.48	76.47	
Psychological	39.39	52.94	
No. of medications			0.465
Psychotropic drug	69.69	76.47	
Cardiovascular drug	78.78	88.23	
No. of falls	0.29±0.60	0.50±0.67	0.052
Afraid to fall			0.332
Yes	67.90	48.4	
No	32.10	51.6	

* Data are presented as mean ± standard deviation or % of participants

Table 3
Cognitive function, functional independence, and quality of life of participants before and after standard exercises or Brain Gym exercises

Test	Baseline		Post-test		Factor (moment x programme)	
	Brain Gym® exercises (n=33)*	Standard exercises (n=17)*	Brain Gym® exercises (n=33)*	Standard exercises (n=17)*	F	p Value
Mini-Mental State Examination score	20.50±6.84	19.42±6.36	19.03±6.42	18.86±7.36	$F_{1.76}$=0.063	0.802
Barthel Index	57.86±29.04	60.42±32.85	56.55±34.04	58.25±11.88	$F_{1.76}$=1.619	0.261
Five-repetition sit-to-stand test, s	17.63±6.59	17.83±6.49	16.04±5.43	16.61±5.94	$F_{1.77}$=0.009	0.927
12-item Short Form Health Survey						
Physical Component Summary score	37.27±4.86	36.06±5.41	32.87±20.34	31.43±6.78	$F_{1.79}$=1.986	0.163
Mental Component Summary score	46.06±5.95	42.76±8.44	46.70±8.93	43.71±6.21	$F_{1.79}$=0.096	0.940
Ambulation score	0.37±0.15	0.32±0.14	0.41±0.15	0.33±0.16	$F_{1.73}$=1.940	0.168

* Data are presented as mean ± standard deviation

DISCUSSION

In the present study, BG exercise had similar effect to standard exercise among institutionalised older adults with cognitive impairment, without any significant effect on cognitive levels, functional independence, QoL, or fitness levels. Similar results were reported on a sample of institutionalised octogenarian people with cognitive impairment.[10] However, another study has reported contrasting results.[7] The lack of agreement could be due to several reasons. First, the exercise protocols were

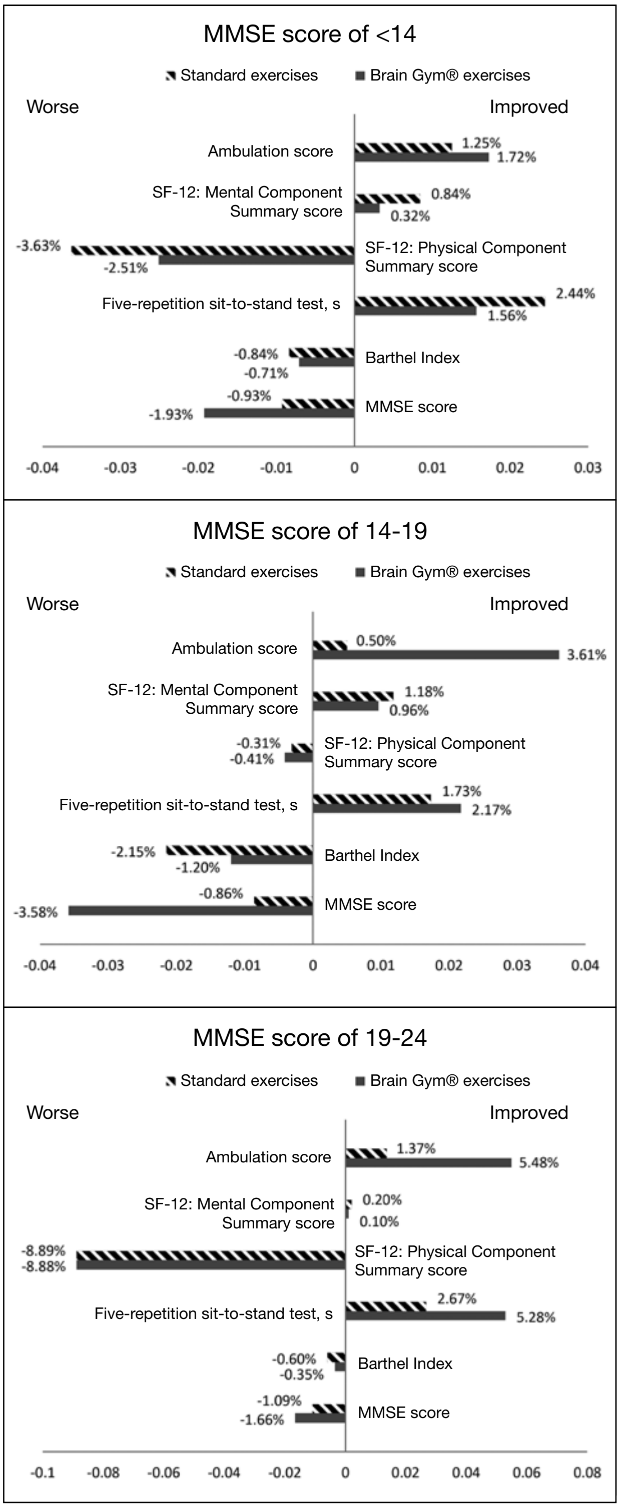

Figure 2. Change of variables according to the degree of cognitive impairment measured by Mini-Mental State Examination (MMSE).

different. The present study did not include drawing activities, whereas the BG protocol in a sample of healthy older adults that featured drawing activities did not have a significant effect on attention or memory functions.[6] In one study the training programme combined sitting and standing exercises,[5] whereas participants of the present study remained in a sitting position. Second, in the present study participants' mean age was higher than that reported in a study,[7] and may have effect on participants' scope for improvement. Third, the time devoted to BG exercise in the present study was 20 minutes, whereas BG sessions were considerably longer (up to 2 hours) in another study.[7]

It was expected that standard exercise did not have significant effects on participants' cognitive level, as the sessions did not include aerobic or muscular exercises. In fact, the positive effects of exercise on the cognitive function of people with cognitive impairment have mainly been observed after aerobic and muscular training.[13,18]

In the present study, both BG and standard exercise resulted in slight decline in functional independence. This in line with a study reporting that the effects of physical rehabilitation on functional independence in long-term care home residents appear quite small and may not be applicable to all residents.[19] Nonetheless, it should be taken into account that most activities in both programmes were performed in a sitting position, with the trunk and the upper limbs barely moved. These body parts are involved in most activities of daily living; therefore, no efficient transference could be expected between the content of the exercise programme and the participants' functional independence. Therefore, other types of physical training programme are required to significantly improve functional independence of institutionalised older adults with cognitive impairment.[9,20]

Both training programmes led to a slight increase in participants' fitness levels (assessed by the Five-Chair Stand test). It is suggested that proprioception may be an influential factor while executing sit-and-stand tests.[21] Therefore, it is hypothesised that mobility and coordination exercises (in both programmes) have positive effect on proprioceptive capacity.

Neither of the programmes produced significant change in participants' QoL. This was a predictable result, as there was also no improvement in cognitive functions or functional independence, and QoL is highly dependent on both factors.[22]

Prescription of physical exercise to older adults should be carefully designed, specific, and individualised to each participant's characteristics.[23] This aspect is frequently disregarded in this type of study.[24] Programme implementation produced similar effects, regardless of the participants' level of cognitive impairment. This finding may be useful in designing and prescribing physical exercise programmes in institutionalised people with diverse cognitive impairments.

Results of the present study could have been sounder if the sample size was larger, if the control group did not involve in any physical activity programme, and if the training programmes were lengthier and a follow-up phase was included. These limitations should be taken into consideration when interpreting the results.

CONCLUSION

BG and SE have similar effects on cognitive function, functional independence, QoL, and fitness levels among institutionalised older adults with cognitive impairment.

DECLARATION

The authors have no conflict of interest to disclose.

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