Physical Exercise for Seniors with Dementia: Potential Benefits Perceived by Formal Caregivers

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Abstract

Background: The social and economic impact of dementia urge for calls to develop accessible and sustainable care for seniors with dementia (SwD). Physical exercise has been seen as a beneficial non-pharmacological therapy in the prevention and management of Dementia, and possible benefits may not impact only the participants, but also indirectly their Caregivers. Thus, this study aimed to analyze the effects of an exercise intervention on functional capacity, neuropsychiatry symptoms and quality of life (QoL) of institutionalized older adults with dementia, perceived by their formal caregivers.

Methods: Sixty-four institutionalized older adults (from both genders, aged 65–93 yrs. old), clinically diagnosed with dementia, were divided into two groups: control group (CG, n= 26) and exercise group (EG, 6-month supervised multicomponent exercise intervention n= 38). Nine caregivers (female, aged 28-47 yrs old) from nine different nursing homes, reported about care receiver’s functional capacity (Katz index), quality of life (QoL-AD) and behavioural and psychological symptoms (BPSD) in dementia (NPI) before and after 6 months of an exercise intervention (aerobic, muscular resistance, flexibility and postural exercises).

Results: A two-way ANOVA, with repeated measures, revealed significant group and time interactions on Total Katz index and NPI-score. The CG’s performance functional capacity and total BPSD score worsen over time while in EG maintains these values after the exercise intervention. Moreover, formal caregiver’s distress triggered by apathy, disinhibition and aberrant motor behavior increased in CG while after 6 months of an exercise intervention no alterations were seen regarding these distress causes in EG. No significant main effects were observed for total QoL-AD.

Conclusions: Overall results show that after the exercise intervention, SwD from the EG, was capable of preserving the functional capacity and neuropsychiatric symptoms were attenuate, contributing to a lower load of distress for the caregivers.

Trial registration: clinicaltrials.gov, NCT04095962. Registered 19 September 2019, https://clinicaltrials.gov/ct2/show/NCT04095962

Background

Presently is estimated that 47 million people live with dementia worldwide, and projections show that this number may increase to more than 131 million by 2050, as populations age (1). Due to this significant prevalence, the huge social and economic impact makes Dementia one of the main age-related health problems affecting society (2). Dementia is a progressive degenerative syndrome that compromises cognitive and functional capacity essential to perform activities of daily life (ADL) autonomously (1). Additionally, Behavioral and Psychological Symptoms of Dementia (BPSD), commonly are developed over time and tends to persist throughout the course of the disease (3), having a negative impact on the health of patients and caregivers (4). Cognitive impairment, physical and functional dependence and
mainly BPSD contributes to family caregivers burden and predicts the institutionalization of the Seniors with Dementia (SwD) (5).

Alzheimer's Disease International (1), reported that 33–50% of people with dementia, in high-income countries, lives in nursing homes and more than two-thirds of care home residents have dementia. The high proportions of SwD, lack of appropriate education and training on BPSD management are physically and psychologically challenging (6) and can result in high levels of emotional exhaustion and distress of the formal caregivers (7). Moreover, after institutionalization, formal caregivers are the individuals with whom SwD have the closest relationship, being the ones who have a better knowledge of their cognitive, physical impairments, usual BPSD, Quality of Life (QoL) and are aware of the progress of the disease. This sets not only the SwD but also the formal caregiver in a central position of this worldwide health problem.

Although dementia cannot be reversed, evidence suggests that poorer performance in ADL can be delayed (8). Among others, physical exercise, ie, planned, structured, repetitive, and purposeful physical activity, constitutes a promising intervention for SwD and has received increased attention in the last years (8). Indeed, exercise interventions have a positive impact on several health outcomes in SwD, including the delay in cognitive impairment and enhancement of functional capacity (8, 9). However, little information has been gathered on the impact of exercise on BPSD (10) incidence and the stress that those symptoms can cause to the caregivers.

Developing safe and effective exercise interventions focus on the management of BPSD, aiming at delaying the progression of declines in functional ability, and improving their QoL are urgent for SwD in nursing homes, to enhance the quality of long term care and reduce formal caregiver burden. Despite caregiver’s close relationship with the SwD and the unique observational role in institutional settings, their perception of exercise intervention outcomes is not highlighted, from the authors’ knowledge. Therefore, it seems relevant to determine the hypothetical positive effect of an exercise intervention in caregivers’ perception concerning functional capacity, QoL and BPSD in institutionalized older adults with mild to moderate dementia.

**Methods**

**Study Design**

Nine nursing homes took part in this quasi-experimental non-randomized study. Four nursing homes implemented an exercise intervention for 6 months (Exercise Group- EG); while five have not participated in structured physical activity program and maintained with their normal routine, during the same period (Control Group - CG).

**Participants**
Nine caregivers’ supervisors aged 28–47 years, from nine different nursing homes, accepted to participate in the study, reporting about the effects of an exercise intervention performed by their care receivers.

Sixty-four care receivers from both genders, aged 65–93 years clinically diagnosed with dementia, were included in the study. The eligible subject pool was restricted to older adults with the following characteristics: age $\geq 65$ years, not engaged in any regular exercise training in the last year, institutionalized for more than 6 months, all diagnosed by a physician with an age-related neurocognitive disorder (dementia) at mild or moderate stage according to Clinical Dementia Rating (CDR) (11) and lack of any diagnosed or self-reported musculoskeletal or cardiovascular disorders that contraindicate participation in moderate exercise and testing.

After initial screening, formal caregivers, care receivers and institutions received a complete explanation of the purpose, risks and procedures of the study. Written informed consent was provided. The investigation was in full compliance with the Helsinki declaration(12) and the nine institutions where the intervention took place approved all methods and procedures. The Ethical Commission of the Faculty of Sports of the University of Porto also approved this study.

A 70% minimum attendance rate to the exercise sessions was required for participants in the EG. The attendance rate for the EG was calculated by dividing the number of exercise sessions completed by participants by the full amount of sessions they were expected to perform throughout the study. The attendance levels were 78.3% or over. The reasons for missing exercise sessions were acute diseases, behavioral disorders, unwillingness to participate in an exercise session and other reasons.

(Fig. 1)

Exercise Intervention

The EG completed a 6-month exercise program following the recommendations of the American College of Sports Medicine (ACSM) (13) including aerobic, muscle strengthening, flexibility, balance and postural exercises with 2 sessions per week on non-consecutive days. Sessions contained 5–15 care receivers and took place in specific rooms with peaceful and pleasant music environment. Sessions lasted for 45–55 minutes and were conducted by the same exercise trainer in all settings. The sessions were divided into 3 main parts: Warm-up (5–10´, including postural and stretching exercises for general activation), specific training (30–35´, including 15´ of moderate aerobic exercises + 15–20´ motor and muscular tasks for strength and coordination/balance training) and cool down (5´ with respiratory and flexibility exercises). To make the exercise program more efficient and attractive, we established regular similar routines that prioritized enjoyable and familiar exercises (as simulating walking, running, biking, rowing). Due to the frailty condition of the participants and for safety reasons, sessions were mainly chair-based and routines of functional exercises with low coordination requirements were emphasized so care receivers could achieve the session’s goals.
Sociodemographic and clinical characteristics

Formal caregivers’ supervisors and care receivers’ characteristics are given in Table 1.

Table 1
Characteristics of the participants at baseline

| CAREgIVERS          | Exercise Group (n = 4) | Control Group (n = 5) | p       |
|---------------------|------------------------|-----------------------|---------|
| Age (years)         | 37.75±8.14             | 36.40±7.54            | 0.806   |
| Geriatric working experience (years) | 9.50±3.51 | 8.60±2.51 | 0.683   |
| Care receivers      | Exercise Group (n = 38) | Control Group (n = 26) | p       |
| Age (years)         | 77.29±8.60             | 80.15±2.80            | 0.179   |
| Men, No. (%)        | 14 (36.8%)             | 5 (19.2%)             | 0.169   |
| CDR (Points)        | 1.18±0.90              | 1.13±0.63             | 0.808   |
| Educational level (years) | 2.60±1.72 | 2.27±1.54 | 0.381   |
| Neurocognitive Disorder due to, No. (%) |          |          | 0.259   |
| Alzheimer’s Disease | 16 (42.1%)             | 18 (69.2%)            |         |
| Vascular Disease    | 6 (15.8%)              | 3 (11.5%)             |         |
| Parkinson’s Disease | 1 (2.6%)               | 0 (0%)                |         |
| Lewy Bodies Disease | 1 (2.6%)               | 0 (0%)                |         |
| Unspecified         | 14 (36.8%)             | 5 (19.2%)             |         |
| Diagnosis, No. (%) (Others than NCD) |          |          | 0.045*  |
| Hypertension        | 14 (36.8%)             | 4 (15.4%)             |         |
| Heart Disease       | 9 (23.7%)              | 2 (7.7%)              | 0.141   |
| Diabetes mellitus   | 5 (13.2%)              | 5 (19.2%)             | 0.463   |
| Osteoporosis        | 3 (7.9%)               | 3 (11.5%)             | 0.650   |
| Blood Pressure (mmHg) |                      |                       |         |
| Systolic            | 126.72±22.50           | 128.81±22.10          | 0.718   |
| Diastolic           | 76.47±14.64            | 76.73±17.31           | 0.950   |

* Student’s t-test or Mann Whitney for continuous variables; Chi-squared or Fisher’s exact.
Outcome Measures

All following measures were assessed at baseline and 6 months of exercise intervention. CDR test, Senior Fitness Test (SFT) and Mini-Mental State Examination (MMSE) were performed by the care receivers. The care receivers Katz index, quality of life - Alzheimer disease scale (QoL-AD) and Neuropsychiatric Inventory (NPI) were reported by the caregivers.

Dementia Stage

The CDR test (11) was used only at baseline to allocate the care receivers according to their cognitive stage. CDR is an instrument that assesses the existence and prevalence of the various stages of dementia. It comprises 6 cognitive-behavioral items covering memory, orientation, judgment and problem solving, community activities, home and hobbies, and personal care. The cut-off points were CDR = 1 (mild dementia stage) and CDR = 2 (moderate dementia stage).

Physical Fitness

The SFT (14) battery is considered a reliable instrument for assessing physical fitness in older adults (≥ 60 years old) including older people with cognitive impairment (15). The test items included: chair-stand test - to assess lower-body strength; arm curl test - to measure upper-body strength; 2-min step test - to assess aerobic endurance; chair sit-and-reach test - to assess lower-body flexibility; back scratch test - to assess upper-body flexibility; and 8-foot up-and-go test - to assess agility and dynamic balance.

Cognitive function

The MMSE (16) was used for a global cognitive evaluation. This instrument is clinically used to assess cognitive mental status, detect and follow the course of mental illness and can also be used as a research tool to screen for cognitive disorders and follow cognitive changes in epidemiological studies. It assesses orientation, attention, immediate and short-term recall, language and the ability to follow simple verbal and written instructions. Furthermore, it provides a total score that categorizes the individual on a scale of cognitive function ranging from 0 to 30 (16). MMSE normative values consider the subject educational level. Operational cut-off values for the Portuguese population are 22 (for 0 to 2 years of literacy), 24 (for 3 to 6 years of literacy) and 27 (for more than 6 years of literacy) (17).

Functional Capacity

Katz index (18), one of the most used instruments for measuring the ability to perform ADL, was used to measure caregiver reports of the physical functioning of the care receivers. Katz index includes 6 items: bathing, dressing, transferring, feeding, incontinence, toileting and the sum of all items to calculate the Katz total. Independence levels for the ADL questions are recorded on a scale of 0 to 4, where 0 represents dependence and 5 represents complete independence (19).

Quality of Life
The QoL-AD(20) was used to measure the care receivers QoL. The questionnaire included 13 items: physical health, energy, mood, living situation, memory, family, marriage, friends, self as a whole, ability to do chores, ability to do things for fun, financial situation, and QoL as a whole. The QoL-AD provides the participant and caregiver reports of the participant’s QoL and is scored on a 4-point Likert scale ranging from 1 to 4 (excellent), with total scores ranging between 13 and 52 points.

Behavioral and Psychological Symptoms of Dementia

The Neuropsychiatric Inventory (NPI) (21) is an instrument administrated to caregivers of dementia patients to measure changes in BPSD during the time. The NPI originally assessed 10 behavioral domains (Delusions, Hallucinations, Agitation, Dysphoria, Anxiety, Apathy, Irritability, Euphoria, Disinhibition, and Aberrant motor behavior). Two more domains have been added since its development: night-time behavioral disturbances and appetite and eating abnormalities (21). For each of the 12 behavioral symptoms on the NPI, caregivers rated the level of distress they experienced on a scale from 1 (low) to 5 (extreme). The NPI Distress score (NPI-D) (22) is the sum of these 12 ratings (range 0–60). In the present study, we used the Portuguese version published in the Book of Scales of the Study Group on Brain Aging and Dementia (23).

Statistical Analysis

Results were expressed as either means (standard deviations) or proportions (Table 1). Differences between groups at baseline were tested using unpaired sample t-tests, Mann-Whitney and chi-square tests. The intervention effects results were expressed as a percentage of the baseline values of the CG and were examined by repeated-measures analysis of variance (ANOVA). The Bonferroni test for multiple comparisons was used. Significance level was set at 0.05 throughout the analyses. Statistical analyses were performed using SPSS 24.0.

Results

Characteristics of the Participants

Sociodemographic and clinical characteristics of the participants are summarized in Table 1. The sample included 9 caregivers’ supervisors, all female and with geriatric nursing assistant certification. The care receivers that participated in the study were 70.3% females and all presented a neurocognitive disorder (NCD). Hypertension, minor heart condition, diabetes mellitus and osteoporosis were the other main diagnoses besides the NCD. The CDR showed that the average of the care receivers was in the moderate stage of dementia for both groups.

No significant differences at baseline between groups were observed in physical fitness and cognition variables.
Table 2
Physical Fitness and cognition. results of the care receivers at baseline.

| CARE RECEIVERS          | Exercise Group (n = 38) | Control Group (n = 26) | p<sup>a</sup> |
|-------------------------|-------------------------|------------------------|---------------|
| **Physical Fitness**    |                         |                        |               |
| Lower Strength (reps)   | 8.95±4.31               | 9.96±4.16              | 0.352         |
| Upper-Strength (reps)   | 9.71±5.18               | 11.77±4.11             | 0.096         |
| Lower Flexibility (cm)  | 20.86±10.43             | 19.69±12.82            | 0.691         |
| Agility/ Dynamic balance (sec) | 19.33±10.86       | 20.36±12.52            | 0.726         |
| Upper Flexibility (cm)  | 43.53±16.44             | 42.88±10.34            | 0.861         |
| Aerobic Endurance (steps) | 58.61±32.82              | 69.46±34.72            | 0.209         |
| **Cognition (MMSE)**    | 18.11±4.81              | 17.77±5.07             | 0.789         |

<sup><sup>a</sup> Student’s t-test; * p ≤ 0.05.</sup>

The baseline results showed significant differences in mobility and continence (functional capacity components) between EG and CG, reported by caregivers.

Caregivers did not perceive other significant differences between groups at baseline, including Behavioral and Psychological Symptoms of Dementia Score (BPSD-score), Behavioral and Psychological Symptoms of Dementia Distress (BPSD-distress), functional capacity components and QoL.

(Table 3)
Table 3
BPSD-score, BPSD-distress, functional capacity and QoL results of the caregivers’ perception at baseline.

| CAREGIVERS | Exercise Group (n = 4 about 38 care receivers) | Control Group (n = 5 about 40 care receivers) | p<sup>a</sup> |
|------------|-----------------------------------------------|-----------------------------------------------|-------------|
| **BPSD – Score** | | | |
| Delusions | 0.97±1.92 | 1.15±2.75 | 0.759 |
| Hallucinations | 0.61±1.48 | 1.31±3.37 | 0.259 |
| Agitation | 1.79±3.01 | 2.35±3.07 | 0.473 |
| Dysphoria | 1.11±2.04 | 1.54±2.67 | 0.465 |
| Anxiety | 1.89±2.72 | 2.58±3.08 | 0.354 |
| Euphoria | 0.84±2.39 | 1.81±3.64 | 0.205 |
| Apathy | 1.39±2.33 | 1.27±2.55 | 0.839 |
| Disinhibition | 1.37±2.73 | 2.42±4.09 | 0.220 |
| Irritability | 1.82±3.27 | 2.31±3.67 | 0.576 |
| Aberrant motor activity | 1.45±2.71 | 1.04±2.46 | 0.540 |
| Night-time behavioral disturbances | 1.13±2.22 | 1.38±2.77 | 0.687 |
| Appetite and eating abnormalities | 1.55±3.00 | 2.35±3.81 | 0.355 |
| NPI Total | 15.92±18.42 | 21.5±26.66 | 0.325 |
| **BPSD – Distress** | | | |
| Delusions | 0.82±1.31 | 0.77±1.37 | 0.890 |
| Hallucinations | 0.53±1.03 | 0.73±1.37 | 0.499 |
| Agitation | 1.11±1.71 | 1.38±1.58 | 0.510 |
| Dysphoria | 0.82±1.41 | 1.12±1.58 | 0.430 |
| Anxiety | 1.11±1.39 | 1.5±1.48 | 0.281 |
| Euphoria | 0.47±1.06 | 0.92±1.44 | 0.155 |
| Apathy | 0.79±1.21 | 0.96±1.46 | 0.609 |
| Disinhibition | 0.79±1.28 | 1.04±1.58 | 0.490 |

<sup>a</sup> Student’s t-test; * p ≤ 0.05.
CAREGIVERS

| Exercise Group (n = 4 about 38 care receivers) | Control Group (n = 5 about 40 care receivers) | p^a |
|-----------------------------------------------|-----------------------------------------------|-----|
| Irritability                   | 0.97±1.46                                      | 1.19±1.47 | 0.560 |
| Aberrant motor activity        | 0.87±1.19                                      | 0.65±1.26 | 0.492 |
| Night-time behavioral disturbances | 0.68±1.30                                      | 0.88±1.48 | 0.568 |
| Appetite and eating abnormalities | 0.89±1.52                                      | 1.23±1.75 | 0.417 |
| NPI Total - Distress            | 8.87±10.01                                     | 11.19±14.13 | 0.444 |

**Functional Capacity**

|                                | Exercise Group | Control Group | p^a |
|--------------------------------|----------------|---------------|-----|
| Bathing                        | 1.74±0.89      | 1.81±0.75     | 0.740 |
| Dressing                       | 2.00±1.09      | 1.88±1.07     | 0.677 |
| Toileting                      | 2.47±0.80      | 2.00±1.20     | 0.062 |
| Transferring                   | 2.53±0.80      | 2.08±1.13     | 0.066 |
| Incontinence                   | 2.61±0.82      | 2.12±0.91     | 0.029* |
| Feeding                        | 2.71±0.87      | 2.19±1.39     | 0.070 |
| Total Katz                     | 14.11±3.90     | 12.00±4.95    | 0.062 |
| **Quality of Life (QoL-AD)**   | 24.13±5.07     | 22.27±5.30    | 0.162 |

^a Student’s t-test; * p ≤ 0.05.

**Physical Fitness and Cognitive Capacity**

As seen in Fig. 2, for all the physical fitness components, a significant group by time interaction was found. 6 months of an exercise intervention improved the EG, physical fitness components whereas no alteration was seen in CG (except for agility-balance and aerobic endurance in which a decrease in performance was observed). No significant changes were observed for the total cognitive function score assessed by MMSE after 6 months in both groups.

(Fig. 2)

**Behavioral and Psychological Symptoms of Dementia Score**

Alterations in BPSD scores following the exercise intervention (EC) and control period (CG) perceived by the caregivers are shown in Fig. 3. The analyses for dysphoria, apathy, aberrant motor activity and NPI
total indicated a significant group by time interaction effect. In CG, caregivers reported a higher presence of dysphoria, apathy, and aberrant motor activity comparing baseline and T1 after 6 months, whereas the perceptions of these neuropsychiatric symptoms score were preserved in EG (except for a significant decreased in apathy score). NPI total interaction revealed that EG decreased significantly their NPI score while no alteration was seen in CG comparing the baseline and following the intervention period.

(Fig. 3)

*Behavioral and Psychological Symptoms of Dementia - Distress*

BPSD distress scores reported by the caregivers at baseline and following exercise intervention are shown in Fig. 4. For the apathy dimension, a significant group by time interaction was observed. Among CG, the caregiver’s distress due to apathy increased whereas among EG decreased at follow-up compared with baseline. A significant interaction for the disinhibition and aberrant motor activity dimensions showed a decreased in CG not seen in EG comparing baseline and T1.

(Fig. 4)

*Functional Capacity and Quality of Life*

Figure 5 shows the functional capacity and QoL perceived by the caregivers at baseline and following an exercise intervention for each group. For the transferring, feeding and total Katz dimensions, a significant interaction between groups and time was observed. Among CG, the values of these variables decreased comparing the baseline and the follow-up while in EG remained unaltered after the exercise intervention. No significant main effects were observed for total QoL-AD.

(Fig. 5)

*Discussion*

Exercise programs may be relevant for SwD living in institutional settings since they spend an extended period in those settings (24) with a high rate of functional decline (25) and they are frequently physically inactive (24, 26). Although exercise interventions are low cost, feasible and can be easily implemented, there is a lack of physical activity opportunities in institutions (27).

The caregivers as the person with more contact with SwD are the most appropriate ones to evaluate the outcomes of an exercise intervention. Therefore, the present study highlighted the caregiver’s perception of exercise intervention as a possible strategy to mitigate symptoms and alleviate disease progression in institutionalized SwD.

The hypothesis that a 6-month exercise program can promote a positive caregivers’ perception concerning its effects on BPSD and functional capacity in institutionalized older adults with mild to moderate dementia was confirmed. This study also tested the hypothesis if a 6-month exercise program
can promote a positive caregivers' perception of the importance of an exercise intervention on QoL, but this hypothesis was not confirmed.

The present study attempted to adapt an exercise program for SwD, living in institutional settings to the physical exercise recommendations of ACSM and American Heart Association for older adults (13). The exercise intervention integrated several important physical abilities to perform the ADLs and involving playful and social group activities. Corroborating other studies that applied for similar training programs in terms of duration, frequency and type of population (9, 26) improvements were seen in all the physical fitness components evaluated in the group that participate in the 6 months’ exercise intervention (Fig. 2). It is possible that these positive results were linked with low scores seen before the intervention. These results also suggested that the exercise intervention was adjusted to the characteristics of our population and enough to induce physical adaptations. This underlines that the adaptation of the physical activity recommendations to this population, allows them to improve their levels of physical fitness.

Although some studies revealed positive outcomes of an exercise intervention on cognitive function, most of these studies were conducted in older adults without dementia (28, 29). In fact, in this special population physical exercise showed controversial results, with studies suggesting no alterations in general cognition in comparison with the control group (8). Our intervention did not significantly alter the general cognition in comparison with the control group. Probably, as suggested by Lautenschlager & Cox (30) to improve brain function and cognition, exercise intervention should be more extended in time.

BPSD are an intrinsic feature of dementia that is often treated with antipsychotics. Current person-centered philosophies of care in dementia, encourage non-pharmacological therapies as an alternative and/or complementary interventions for minimizing BPSD (31), including exercise programs. The literature points out controversial results, while Forbes et al. (8) found no clear evidence of the positive effects of an exercise intervention on BPSD, other authors affirm that exercise interventions can be beneficial to reduce some of the BPSD (32, 33). Besides the controversy, these studies agree that further work is needed to comprehend the potential of exercise as non-pharmacological therapy to manage BPSD (32). Evidence suggests that exercise may affect various BPSD in different ways (33). Indeed, the effects of exercise seem to be more beneficial on depressed mood, agitation and reduce "wandering" (33). The results from our study seem to be in line with this evidence, generally EG maintains their BPSD scores similarly to the scores reported on the baseline, while the CG worsen depression, apathy, aberrant motor behavior scores (Fig. 3). Importantly, in our study, the caregiver’s perceived a decreased of the total BPSD in the EG after the 6 months’ exercise intervention.

From our knowledge, no studies have addressed the caregiver’s perspective about the impact of exercise intervention in their BPSD distress. In our study, formal caregiver’s distress triggered by apathy, disinhibition and aberrant motor behavior increased in CG while after 6 months of an exercise intervention no alterations were seen regarding these distress causes in EG (Fig. 4). Evidence suggests that disruptive behaviors and low ADL levels among residents with dementia expose formal caregivers to demanding physical and emotional distress (7), leading to poorer QoL (34, 35). Thus, our results could
suggest that exercise programs in institutionalized SwD may be useful as a strategy of BPSD-distress management. Strategies to alleviate the burden felt by formal caregivers leads to higher job satisfaction, increase their QoL and consequently improved staff attitudes and caring behaviors and, over time, resident well-being (36).

Functional status is related to institutionalization (37). Among other reasons, in most cases, older adults move to a nursing home when their functional capacity is diminish affecting their independency to perform ADL (38). In institutional settings, assistance in ADL for older adults living are often delivered in a standardized and depersonalized way that undermines independence (39). Particularly in SwD, fewer opportunities to perform ADL and the lack of physical activity opportunities exacerbates the functional decline in the institutional settings (40). Corroborating this evidence, the present study showed a progressive decline in the total functional capacity score and some of their domains including, transferring, feeding, and incontinence outcomes in the group without exercise intervention. Altering this tendency, the EG was capable of preserving their total functional capacity after the 6 months of exercise intervention (Fig. 5). Other studies have verified that exercise programs implemented in institutions can induce positive outcomes concerning the functional capacity of SwD (8, 41, 42).

It has been suggested that in institutional settings the participation in a wide range of activities improves the QoL of SwD (43). fact, activity engagement may contribute to the pleasure and enjoyment, the sense of connection and belonging and retain a sense of autonomy and personal identity (44). Importantly, caregivers also consider aspects such as social relationships, physical movement, attachment and affect, control over life, and contributing to the community as important for SwD QoL (45). A 3 months aerobic exercise randomize control trial (46) and 16 weeks multi center exercise program (4), both for older adults with Alzheimer’s Disease shown some evidence that exercise program can improve QoL. However, we did not found alterations on QoL following 6 months of EG or CG from the perspective of the caregivers (Fig. 5).

BPSD are commonly associated with a reduction in the QoL for the older adult with dementia (47) and increase of caregiver stress (43, 47). Therefore, we would expect an alteration of QoL in CG and possible preservation in EG. Although in the majority of the studies regarding, functional capacity and QoL evaluation of institutionalized SwD have been partially or fully reported by the formal caregivers, the fact that this is the perspective of the caregiver has not been highlighted. In fact, it seems relevant to empathize their perception since dementia care can contribute (due to disruptive behavior and the limited capacity of performing ADL) for the burden of formal caregivers (43). Additionally, from the author's knowledge, no previous studies had explored the effects of 6 months’ exercise intervention on BPSD score and caregivers’ distress in institutional settings. Higher levels of stress and poorer levels of well-being of formal caregiver's impact negatively on the quality of care they provide and consequently have a negative effect on institutionalized SwD well-being (48). Therefore, interventions for residents with dementia perceived as positive by the formal caregiver may increase the well-being both of themselves and, by extension, those they care for. The results of our study showed that formal caregivers perceived some of the benefits of the engagement to exercise program in institutionalized SwD.
The main limitation of this study was the small sample size and the lack of randomization for group assignment. Recruiting voluntary people diagnosed with dementia willing to commit with a 6-month intervention was challenging and several institutions were therefore involved.

**Conclusions**

In sum, this study confirms that 6 months of exercise program can promote positive caregivers' perception concerning its importance on functional capacity and BPSD in institutionalized older adults with mild to moderate dementia. Moreover, this study suggests that an exercise intervention in institutionalized SwD may be useful as a strategy of BPSD-distress management, alleviating the burden felt by formal caregivers. Although no QoL improvement was observed, these results indicate that formal caregivers perceived the engagement in the exercise program in institutionalized SwD as positive. This can be relevant for better well-being of both SwD and formal caregivers in institutional settings.

**Abbreviations**

ACSM  
American College of Sports Medicine  
ADL  
Activities of Daily Life  
ANOVA  
repeated-measures analysis of variance  
BPSD  
Behavioral and Psychological Symptoms of Dementia  
BPSD-distress  
Behavioral and Psychological Symptoms of Dementia Distress  
BPSD-score  
Behavioral and Psychological Symptoms of Dementia Score  
CDR  
Clinical Dementia Rating  
CG  
Control Group  
EG  
Exercise Group  
MMSE  
Mini-Mental State Examination  
NCD  
Neurocognitive Disorder  
NPI  
Neuropsychiatric Inventory
NPI-D
Neuropsychiatric Inventory Distress score
SFT
Senior Fitness Test
SwD
Seniors with Dementia
QoL-AD
Quality of Life - Alzheimer Disease Scale
QOL
Quality of Life

Declarations

Ethical approval and consent to participate: This study was approved by the Ethical Commission of the Faculty of Sports of the University of Porto (Ref CEFADE02.2014). Written informed consent to participate was obtained from all participants and their families/legal representative.

Consent for publication: Not applicable

Availability of data and materials: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Competing interests: Not applicable

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Tables

Table 1: Characteristics of the participants at baseline

|                                      | Exercise Group | Control Group | p^a |
|---------------------------------------|----------------|---------------|-----|
| **CAREgivers**                        |                |               |     |
| Age (years)                           | 37.75±8.14     | 36.40±7.54    | 0.806 |
| Geriatric working experience (years)  | 9.50±3.51      | 8.60±2.51     | 0.683 |
| **Care receivers**                    |                |               |     |
| Age (years)                           | 77.29±8.60     | 80.15±2.80    | 0.179 |
| Men, No. (%)                          | 14 (36.8%)     | 5 (19.2%)     | 0.169 |
| CDR (Points)                          | 1.18±0.90      | 1.13±0.63     | 0.808 |
| Educational level (years)             | 2.60±1.72      | 2.27±1.54     | 0.381 |
| Neurocognitive Disorder due to, No. (%)|                |               | 0.259 |
| Alzheimer’s Disease                   | 16 (42.1%)     | 18 (69.2%)    |     |
| Vascular Disease                      | 6 (15.8%)      | 3 (11.5%)     |     |
| Parkinson’s Disease                   | 1 (2.6%)       | 0 (0%)        |     |
| Lewy Bodies Disease                   | 1 (2.6%)       | 0 (0%)        |     |
| Unspecified                            | 14 (36.8%)     | 5 (19.2%)     |     |
| Diagnosis, No. (%) (Others than NCD)  |                |               |     |
| Hypertension                          | 14 (36.8%)     | 4 (15.4%)     | 0.045* |
| Heart Disease                         | 9 (23.7%)      | 2 (7.7%)      | 0.141 |
| Diabetes mellitus                     | 5 (13.2%)      | 5 (19.2%)     | 0.463 |
| Osteoporosis                          | 3 (7.9%)       | 3 (11.5%)     | 0.650 |
| **Blood Pressure (mmHg)**             |                |               |     |
| Systolic                              | 126.72±22.50   | 128.81±22.10  | 0.718 |
| Diastolic                             | 76.47±14.64    | 76.73±17.31   | 0.950 |
a Student’s t-test or Mann Whitney for continuous variables; Chi-squared or Fisher’s exact.

Table 2: Physical Fitness and cognition. results of the care receivers at baseline.

| CARE RECEIVERS       | Exercise Group (n=38) | Control Group (n=26) | p a  |
|----------------------|-----------------------|-----------------------|------|
| **Physical Fitness** |                       |                       |      |
| Lower Strength (reps)| 8.95±4.31             | 9.96±4.16             | 0.352|
| Upper-Strength (reps)| 9.71±5.18             | 11.77±4.11            | 0.096|
| Lower Flexibility (cm)| 20.86±10.43          | 19.69±12.82           | 0.691|
| Agility/ Dynamic balance (sec)| 19.33±10.86  | 20.36±12.52  | 0.726|
| Upper Flexibility (cm)| 43.53±16.44          | 42.88±10.34           | 0.861|
| Aerobic Endurance (steps)| 58.61±32.82         | 69.46±34.72           | 0.209|
| **Cognition** (MMSE)| 18.11±4.81            | 17.77±5.07            | 0.789|

a Student’s t-test; * p ≤ 0.05.
Table 3: BPSD-score, BPSD-distress, functional capacity and QoL results of the caregivers’ perception at baseline.

| CAREGIVERS | Exercise Group (n=4 about 38 care receivers) | Control Group (n=5 about 40 care receivers) | p^a |
|------------|-----------------------------------------------|---------------------------------------------|-----|
| **BPSD – Score** | | | |
| Delusions | 0.97±1.92 | 1.15±2.75 | 0.759 |
| Hallucinations | 0.61±1.48 | 1.31±3.37 | 0.259 |
| Agitation | 1.79±3.01 | 2.35±3.07 | 0.473 |
| Dysphoria | 1.11±2.04 | 1.54±2.67 | 0.465 |
| Anxiety | 1.89±2.72 | 2.58±3.08 | 0.354 |
| Euphoria | 0.84±2.39 | 1.81±3.64 | 0.205 |
| Apathy | 1.39±2.33 | 1.27±2.55 | 0.839 |
| Disinhibition | 1.37±2.73 | 2.42±4.09 | 0.220 |
| Irritability | 1.82±3.27 | 2.31±3.67 | 0.576 |
| Aberrant motor activity | 1.45±2.71 | 1.04±2.46 | 0.540 |
| Night-time behavioral disturbances | 1.13±2.22 | 1.38±2.77 | 0.687 |
| Appetite and eating abnormalities | 1.55±3.00 | 2.35±3.81 | 0.355 |
| NPI Total | 15.92±18.42 | 21.5±26.66 | 0.325 |
| **BPSD – Distress** | | | |
| Delusions | 0.82±1.31 | 0.77±1.37 | 0.890 |
| Hallucinations | 0.53±1.03 | 0.73±1.37 | 0.499 |
| Agitation | 1.11±1.71 | 1.38±1.58 | 0.510 |
| Dysphoria | 0.82±1.41 | 1.12±1.58 | 0.430 |
| Anxiety | 1.11±1.39 | 1.5±1.48 | 0.281 |
| Euphoria | 0.47±1.06 | 0.92±1.44 | 0.155 |
| Apathy | 0.79±1.21 | 0.96±1.46 | 0.609 |
| Disinhibition | 0.79±1.28 | 1.04±1.58 | 0.490 |
| Irritability | 0.97±1.46 | 1.19±1.47 | 0.560 |
| Measure                                      | Mean ± SD  | Mean ± SD  | p-value |
|----------------------------------------------|------------|------------|---------|
| Aberrant motor activity                      | 0.87 ± 1.19| 0.65 ± 1.26| 0.492   |
| Night-time behavioral disturbances           | 0.68 ± 1.30| 0.88 ± 1.48| 0.568   |
| Appetite and eating abnormalities            | 0.89 ± 1.52| 1.23 ± 1.75| 0.417   |
| NPI Total - Distress                         | 8.87 ± 10.01| 11.19 ± 14.13| 0.444   |

**Functional Capacity**

| Measure | Mean ± SD  | Mean ± SD  | p-value |
|---------|------------|------------|---------|
| Bathing | 1.74 ± 0.89| 1.81 ± 0.75| 0.740   |
| Dressing| 2.00 ± 1.09| 1.88 ± 1.07| 0.677   |
| Toileting| 2.47 ± 0.80| 2.00 ± 1.20| 0.062   |
| Transferring | 2.53 ± 0.80| 2.08 ± 1.13| 0.066   |
| Incontinence | 2.61 ± 0.82| 2.12 ± 0.91| 0.029*  |
| Feeding | 2.71 ± 0.87| 2.19 ± 1.39| 0.070   |
| Total Katz | 14.11 ± 3.90| 12.00 ± 4.95| 0.062   |

**Quality of Life (QoL-AD)**

| Measure       | Mean ± SD  | Mean ± SD  | p-value |
|---------------|------------|------------|---------|
| Feeding       | 24.13 ± 5.07| 22.27 ± 5.30| 0.162   |

*a Student’s t-test; *p ≤ 0.05.*

**Figures**
Figure 1

Subjects flow diagram from initial screening to the end of the study. CG, control group; EG, exercise group.
Figure 2

Effects of a multicomponent training intervention on physical fitness components and cognitive capacity total score of institutionalized older adults with dementia; n= 26 in the CG and n= 38 in the EG. Results were expressed as a percentage of T0. *vs T0; # vs EG (p ≤ 0.05). Significant (p ≤ 0.05) main effects of Group, Time and/or their interaction are indicated. T0 baseline values, before the exercise intervention; T1 after 6 months of exercise intervention.
Figure 3

Effects of an exercise intervention on caregivers’ perception of neuropsychiatric symptoms score (NPI) of institutionalized older adults with dementia. n= 26 in the CG and n= 38 in the EG. Results were expressed as a percentage of T0. *vs T0; # vs CG (p ≤ 0.05). Significant (p ≤ 0.05) main effects of Group, Time and/or their interaction are indicated. T0 baseline values, before the exercise intervention; T1 after 6 months of the exercise intervention.
Figure 4

Effects of an exercise intervention on caregivers' neuropsychiatric symptoms distress of institutionalized older adults with dementia. n= 26 in the CG and n= 38 in the EG. Results were expressed as a percentage of T0. * vs T0; # vs CG (p ≤ 0.05). Significant (p ≤ 0.05) main effects of Group, Time and/or their interaction are indicated. T0 baseline values, before the exercise intervention; T1 after 6 months of the exercise intervention.
Figure 5

Effects of an exercise intervention on caregivers’ perception of functional capacity of and QoL institutionalized older adults with dementia. Data are mean ± standard deviation; n= 26 in the control group (CG) and n= 38 in the exercise group (EG). Results were expressed as a percentage of T0. *vs T0; # vs EG (p ≤ 0.05). Significant (p ≤ 0.05) main effects of Group, Time and/or their interaction are indicated. T0 baseline values, before the exercise intervention; T1 after 6 months of the exercise intervention.