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Feature Article

Physical and functional implications of aquatic exercise for nursing home residents with dementia

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ABSTRACT

Exercise has reported benefits for those with dementia. In the current study we investigated the feasibility of delivery and the physical and functional benefits of an innovative aquatic exercise program for adults with moderate to severe dementia living in a nursing home aged care facility. Ten adults (88.4 years, inter quartile range 12.3) participated twice weekly for 12 weeks. Anthropometric and grip strength data, and measures of physical function and balance were collected at baseline and post-intervention. Feasibility was assessed by attendance, participation, enjoyment and recruitment. Following exercise, participant's left hand grip strength had improved significantly ($p = .017$). Small to moderate effect sizes were observed for other measures. A number of delivery challenges emerged, but participant enjoyment, benefits and attendance suggest feasibility. Aquatic exercise shows promise as an intervention among those with dementia who live in a nursing home aged care facility. Greater program investigation is warranted.

Introduction

Alzheimer's disease and other dementias are significant precursors to disability, loss of independence and mortality among older adults. In the United States, dementia was the sixth leading cause of death in 2013, with diagnosis prevalence expected to triple by 2050 unless a significant breakthrough to prevent, slow or stop the disease is realized.[1] A body of research is emerging showing exercise and physical activity has potency as a preventative to dementia.[2,3] Specifically, among those who walk greater distance per day or have demonstrated higher physical capacity and muscle strength, the risk of the development of dementia is reduced significantly.[4,5] For those with the disease, evidence is positive that with exercise participation, individuals can improve their physical and functional wellbeing[6] with gains extending even to the very old and institutionalized.[7]

The changes that lead to institutionalization among those with dementia vary, but the loss of physical capacity and the behavioral and psychological management challenges for their carer are significant underlying factors. However, these are symptoms acknowledged as preventable prior to nursing home entry and treatable following entry with exercise participation.[8] Even with the growing body of positive evidence, exercise research for this cohort in end of life care is sparse and prescription guidelines are forthcoming. Complicating things further are a number of issues related to the demented participant's anxiety, depression and behaviors,[8] their motivation to participate and safety during participation, as well as facility resources and the availability for effective and beneficial exercise program delivery.[6,7,9] To this end, the identification of program modes and setting that have participant appeal and benefit, and that warrant facility investment is a primary consideration.

Anecdotal evidence suggests that for those with dementia, water based exercise has significant behavioral and psychological benefit, with reports suggesting reduced wandering and improved social interactions and sleeping patterns.[10,11] For adults without

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dementia, there is good evidence that with water based exercise individuals can reduced the symptoms of lower limb osteoarthritis,[12] as well as benefits extending to those with cardiovascular disease and to improved strength and balance.[13–15] For many older adults swimming activity holds significant familiarity, which for those with dementia may be an important key to the positive behavioral outcomes that follow, as well as playing an important role in the motivation to participate.[16,17] However, the question still remains what, if any, physical benefits are available through water based exercise for individuals with dementia, and importantly is this mode of exercise feasible for delivery to nursing home residents. Here we present the results of a small investigation that assessed the feasibility of a dementia-specific aquatic exercise program for nursing home residents with a particular focus on the physical and functional benefits.

Methods

Design and sample

A purposeful non-randomized sample of nursing home residents was recruited from two facilities in Queensland, Australia. Potential participants were identified by the facility Service Manager and assessed against the study's inclusion criteria. These were: >65 years of age; residing in a nursing home; with a diagnosed dementia and a past history of swimming. Residents were excluded if they were: wheelchair bound; had unpredictable or dangerous behaviors; or exercise contraindications; or were unable to stand or walk without assistance of another for a minimum of 6 m. Prior to the baseline assessment, informed consent was supplied by the participant's substitute decision maker and individuals deemed physically capable of participation by their medical practitioner. Of the 45 facility residents with dementia, 25 (men = 2, women = 23) were found eligible for recruitment, and 24 were consented into the study. Ethical approval was obtained from the University of Queensland Medical Research Ethics Committee, and the research discussed in detail prior to recruitment with the facilities administrating organization. Participants had to assent to all aspects of the research process. The project flow is presented in Fig. 1.

Intervention

The Watermemories Swimming Club intervention is a dementia specific, aquatic exercise program designed by an accredited exercise physiologist in consultation with dementia experts. The program incorporates a short walking warm-up and flexibility cool-down, between which participants undertake targeted exercises to improve aerobic, balance, and strength capacity. Specifically, for aerobic exercise participants did high knee marching and butt kicks, for balance a combination of dynamic (tightrope walking backwards and forwards) and static (front and side foot tapping) exercises, and for strength squats, chest and back fly's and calf raises using the water as a resistance. Initially, the program was delivered at a reduced intensity to allow a conditioning phase, but progressed to a moderated intensity after a couple of weeks and as participants demonstrated increased competency. Participants were guided from the pool side by a trained and qualified swimming instructor educated in the program, and assisted in the pool by program volunteers (facility staff or carer). In addition to in-pool volunteer assistance where needed, participants used the pool lane rope, pool side and pool floatation devices to maintain their balance. While encouraged to follow the guidance of the instructor, due to the nature of the cohort sets completed and repetition undertaken were not policed or recorded. Participants were encouraged to do the best they could manage, but monitored for fatigue and told to rest if and when needed.

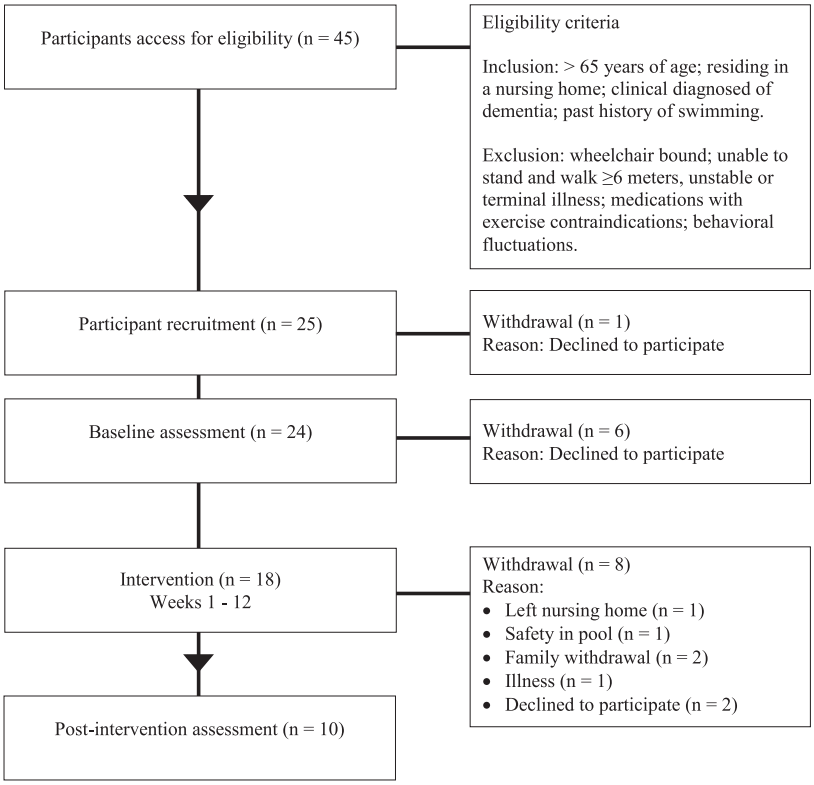

Fig. 1. The Watermemories Swimming Club project flow.

Training took place twice weekly for 12 weeks at a municipal, indoor, temperature controlled swimming pool. Sessions were delivered outside of busy pool times, school holidays and to allow participants to attend facility meal times. Accompanied by staff, participants were bused to the pool, changed before and after training at the pool and then bussed back to their facility. Sessions lasted approximately 45 min and were capped at 12 participants.

Measures

Data were collected for anthropometry, muscle strength, functional performance and balance at baseline (week 0) and after the intervention (week 12) at the participant's facility by a qualified exercise physiologist with experience working with older adults with advance dementia. Testing order and administrators were kept the same at both data collection points. All measures have been demonstrated valid for use among very old institutionalized adults.[18,19] However, to ensure measure appropriateness a seven day test-retest reliability process was undertaken. Participants were familiarized with the assessment protocol and offered verbal encouragement and support to ensure safety.

Height and weight were measured by stadiometer and electronic scale respectively. Percent body fat, lean mass (kg) and body mass index (BMI) (kg/m^2) were measured by Bioelectrical Impedance Analysis (BIA) (Maltron 906, Maltron International Ltd., Rayleigh, UK). Participants lay supine with their hands and legs slightly apart and electrodes were placed at standardized locations on the right hand and wrist and foot and ankle.[20] Hand grip muscle strength was measured using a Jamar dynamometer (Sammons Preston Roylan, Bolingbrook, USA). While seated and using their dominant hand, participants were instructed to keep their elbow at their side and flexed at 90° at all times, and, when given a 'GO' signal, to squeeze the dynamometer as hard as they could.[21]

To measure performance related balance and functional capacity participants undertook two standardized performance batteries. The Balance Outcome Measure for Elder Rehabilitation (BOOMER) is a composite balance measure that consists of the step test, timed up and go (TUG), functional reach and static standing test, and has been described in detail elsewhere.[18] In brief, the step test measures the number of times a participant can move their foot from the floor onto of a 7.5 cm block in 15 s. The TUG measures the time taken for the participant to rise from a standardized chair without assistance, walk 3 m at their normal walking pace, turn 180°, return to the chair and sit down. The functional reach measures the participant's ability to reach out and forward from an upright standing position without letting their feet leave the ground. The static timed standing test measures the participant's ability to maintain balance in an upright standing position for 30 s with their eyes closed. The Short Physical Performance Battery (SPPB) was used to measure functional wellbeing and mobility and consists of a standing balance, 2.4-m walk and repeated chair rise test. Measures can be analysed separately or provide an overall summary score. Summary scores range from 0 to 12 with lower scores indicating poorer performance and an increased risk of negative health outcomes.[22] Briefly, the standing balance measures the ability of participants to maintain a feet side-by-side, semi-tandem and tandem stance for 10 s each. The 2.4-m walk measures the habitual walking pace of participants and the repeated chair rise measures the time taken for participants to rise from a seated position with their arms folded across their chest, to their full standing height, then return to sitting five times as fast as they could safely manage.

In this study, test-retest Interclass Correlations Coefficients (ICC) for anthropometric measures were $\geq$0.925; for grip strength measures were $\geq$0.956; for the BOOMER were: step test 0.797, TUG 0.940, functional reach 0.586, and static standing 0.905; and for the SPPB were: standing balance 0.394, 2.4-m walk 0.719, and repeated chair rise 0.548.

Facility records were reviewed for the participant's age and the Functional Assessment Staging Tool of Alzheimer's Disease (FAST) was used to determine the stage of dementia.[23] In addition, as a measure of feasibility from an individual and facility perspective, attendance records were kept and reasons for not attending recorded.

Statistical analysis

Data were analyzed using IBM SPSS Statistics Version 21 (IBM Corporation, New York, USA). Due to the small sample size and skewed distribution of variables, repeated measure outcomes were analyzed with the Wilcoxon Signed Rank Test (for pre-post comparisons). Percent change was calculated on individual data, effect size was calculated from the Wilcoxon test statistic and the strength assumption based on Cohen interpretation.[24] All tests were two-tailed and an α of 0.05 was required for significance.

Results

Of the 24 participants consented into the study 10 adults (1 male; 9 females) (88.4 years (IQR = 12.3): FAST − moderate to severe dementia) completed the post-intervention analysis. Of those excluded, six declined to participate in the program and two declined to participant in the post-assessment, two became physically unwell (not due to the intervention), two were removed from the program by family, one left the nursing home and one participant was removed due to safety/behavioral issues. No between group differences for completers and non-completers was observed.

At baseline, participants had low walking speed (0.5 ± 0.2 m/s) and TUG performance (23.9 ± 9.1 s), below normal muscle strength (>14.7 ± 5.6 kg) and an SPPB summary of 5.2 ± 2.3. These scores demonstrated the cohort were a low functioning 'at risk' group.[25,26]

A significant improvement in left hand grip strength was found post-intervention (Effect size (r) = 0.53; p = .017). In addition, positive non-significant trends where observed for percent body fat (r = 0.32; p = .154), lean mass (r = 0.23; p = .314), right hand grip strength (r = 0.36; p = .106), standing balance (r = 0.17; p = .446) and the step test ($r \geq 0.04$; $p < .864$). In contrast, negative trends were observed for walking speed, TUG and the functional reach. In addition, the chair stand showed a negative trend, but only half of the participants could complete the five required stands at both the baseline and follow-up analysis. Data are presented in Table 1.

Of those who completed the program seven attended 12 or greater (12–18) and three attended 7 or fewer sessions (5 − 7). Illness or refusal to participate was the most common reason for not attending. In addition, on five occasions an entire facility missed a session for various reasons and one facility postponed post-intervention data collection by two weeks due to a Gastroenteritis outbreak.

Discussion

The present study is innovative in that it delivered aquatic exercise, a common leisure and sporting activity with known benefits for older non-demented adults, to a group of low functioning older adults with moderate to severe dementia. This work compliments previous evidence that aquatic exercise can have important psychological and behavioral implications for institutionalized adults with dementia.[11,27] While in the present study, grip strength was the only variable to achieve a statistical improvement, a number of other variables did display small to moderate effect sizes.[28] While delivery challenges exist, this work shows that aquatic exercise is

Table 1
Anthropometric, physical and functional performance measures before and after 12 weeks of aquatic exercise in adults with dementia living in nursing home aged care facilities. Wilcoxon Signed Ranked non-parametric data are presented as Median (Interquartile range).

Variable	Number	Pre-	Post-	*Z*	*r*[c]	*p*	% Change[d]
BMI (kg/m^2)	10	30.0 (5.4)	29.3 (4.7)	−0.986	0.22	0.324	−2.7 ± 14.4
Body fat (%)	10	40.4 (8.9)	39.4 (6.9)	−1.424	0.32	0.154	−2.5 ± 14.4
Lean mass (kg)	10	42.9 (5.7)	43.4 (4.1)	−1.008	0.23	0.314	1.4 ± 5.3
Grip strength (kg)							
Right hand	10	14.7 (5.6)	16.4 (6.1)	−1.616	0.36	0.106	8.9 ± 15.7
Left hand	10	9.7 (7.6)	13.3 (6.2)	−2.384	0.53	0.017	30.0 ± 32.6
Performance measures							
Seniors physical performance battery (SPPB)							
Standing balance[a] (s)	10	18.9 (7.0)	20.0 (6.9)	−0.762	0.17	0.446	8.1 ± 71.7
2.4-m Walk (m/s)	10	0.5 (0.2)	0.4 (0.1)	−1.718	0.22	0.086	−15.0 ± 27.2
Chair rise[a] (s)[b]	5	19.0 (6.3)	20.4 (3.6)	−1.680	0.38	0.093	3.6 ± 25.2
Summary score	10	5.2 (2.3)	4.5 (1.8)	−1.119	0.25	0.263	−19.9 ± 37.4
BOOMER							
Step test (R)	10	6.6 (4.1)	6.4 (3.2)	−0.322	0.07	0.748	−0.53 ± 23.6
Step test (L)	10	6.2 (3.4)	6.1 (2.1)	−0.171	0.04	0.864	−0.8 ± 42.3
Timed up and go (s)	10	23.9 (9.1)	30.9 (18.0)	−1.955	0.44	0.051	14.5 ± 24.6
Functional reach[a] (cm)	10	16.4 (6.4)	14.1 (6.7)	−1.719	0.38	0.086	−30.4 ± 63.1
Static timed standing (s)	10	75.5 (23.5)	72.5 (29.4)	−0.314	0.03	0.753	−37.9 ± 98.8

kg – kilograms, m – meters, *N* – number, *s* – seconds.
[a] Data for measures will low-moderate Interclass Correlation Coefficients are reported but should be interpreted with caution.
[b] Chair stand – Only 5 participants were able to the required number of chair stands (5) at both baseline and post analysis.
[c] r – Effect Size calculated from the Wilcoxon analysis $r = Z/\sqrt{N}$.
[d] Percent change on individual data (final-baseline)/baseline × 100.

feasible and can be delivered safely to the target population of nursing home adults with advanced physical and cognitive disability. These outcomes are positive and support the need for a more detailed investigation of the program.

Working with those with dementia residing in end of life care is by no means easy. Similar to previous research, our study experienced large dropout rates, poor attendance numbers and sickness among the cohort.[7,9] Complicating things further, for our group to attend sessions they needed to be bussed to and from, and changed at the pool. For many nursing homes, participation in an out-of-facility program or activity has many challenges, among these are man-power and resources availability. In the present study, the participating facilities were proactive about involvement and received no funding support from the research team for bussing participants to and from the pool, or the staff commitment for session attendance. Importantly, there was a realization by the facility that resident involvement would have important benefits including to address the common physical activity unmet need among people with dementia.[29] While sufficient staff and resources to facilitate participation are not a luxury commonly afforded to all nursing homes, future work should assess the economic benefit of exercise participation. For those with dementia, there is growing evidence that the cost associated with program delivery could be offset in part or full by savings related to participation benefits such as reduced medication and care needs, and falls related injuries.[30,31]

Our cohort had moderate to severe dementia, which influenced their ability to follow instructions and their day to day enthusiasm to participate in exercise and/or the assessment. The motivation to adherence challenge of working with this group was demonstrated by the undulating participant attendance to sessions, even though facility staff indicated participants were enthusiastic about the program.[32] In the present study, no participants attended all sessions and only seven attended 50%–75% of sessions. Susceptibility to illness and fluctuating psychological symptoms are a key consideration when working with adults with dementia,[33] with attendance complicated further by changes in facility capacity, where on five occasions an entire facility was unable to attend. The challenges mentioned above are not uncommon in any end of life care research.[7,19,30] To overcome these, facility and staff involvement and ownership of the program is encouraged. In turn, staff enthusiasm will transfer to increased participant motivation.[33]

This study supports previous research among institutionalized adults with dementia showing that benefits follow exercise training.[6,7,34] Heyn et al[6] in their meta-analysis of exercise training for older adults with cognitive impairment reported a strong effect for strength, fitness and performance (Effect size $\geq$ 0.59). However, only a small percentage of the studies included were in end of life care and with participants with advanced dementia. Recent work by Bosser et al[33] has also demonstrated significant gains in muscle strength and walking capacity in institutionalized older adults with dementia following a 6-week on-site one-on-one aerobic and strength training program. In support of these, our study showed positive gains in muscle strength, and a trend toward increased muscle mass and balance, and a decreased body fat. Given the implications of sarcopenia for this very old population countermeasures to the losses in muscle strength and muscle mass have benefit in reducing health care burden.[35] In contrast to land based exercise, our aquatic program is more suitable for those with joint and balance issues and who require low impact training.[13] Specifically, by being in water there is a reduced risk of a falls injury and with an added benefit of resistance. In addition, by using in-pool lane rope or the pool edge, participants could move freely at a moderate intensity while still maintaining a higher level of safety than if involved in, for example, a walking program. Importantly, participants always appeared happy and laughing while participating, which supports previous reduced behavioral symptoms evidence.[11,27]

A reliability analysis of measures undertaken as part of the study design indicated that not all measures were appropriate for this population. Observations during the test-retest process show that the limitations in functional capacity were not always the primary factor, but that the cognitive translation of protocols to implementation also plays a part in test reproducibility.[36] This has wide reaching implications for future work and work done to date in this population. In addition to measure reliability, three of the present participants attended less than 33% of all sessions and one facility had post-assessment measures taken two weeks after the intervention due to a facility illness outbreak. These occurrences may have had serious implications for the size of the cohort physical gains with training.

While there is a broad range of issues to address in future program assessments, the feasibility of delivery is supported by facility participation, their understanding of the value of this participation for this cohort and willingness to commit, and that participants enjoyed their involvement and benefited. Of consideration is that the cohort investigated were low functioning with moderate to severe dementia, which influenced their ability to follow instructions and their day to day enthusiasm to participate. In addition, issues such as dropout rates, the challenge of off-site training and the assessment measures chosen need increased attention if the program is going to be thoroughly and accurately investigated.

Conclusion

Our work supports previous anecdotal evidence reporting that swimming exercise can be beneficial for those with dementia,[11] but requires greater rigor as a future research study to address the shortcomings identified and to better establish the program value. Physical activity is a primary unmet need among those with dementia; interventions that can improve capacity in activities of daily living and prolong wellbeing warrant investigation.[27,37] Moreover, even in the presence of small physical changes, programs with psychological and participant enjoyment benefits, and that get nursing home clients out of the facility warrant greater investigation.

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References

1. Alzheimer's Association. Alzheimer's disease facts and figures. *Alzheimers Dement*. 2014;10(2).
2. Ahlskog JE, Geda YE, Graff-Radford NR, Petersen RC. Physical exercise as a preventive or disease-modifying treatment of dementia and brain aging. *Mayo Clin Proc*. 2011;86(9):876–884.
3. Barnes DE, Whitmer RA, Yaffe K. Physical activity and dementia: the need for prevention trials. *Exerc Sport Sci Rev*. 2007;35(1):24–29.
4. Abbott RD, White LR, Ross GW, Masaki KH, Curb JD, Petrovitch H. Walking and dementia in physically capable elderly men. *J Am Med Assoc*. 2004;292(12):1447–1453.
5. Boyle PA, Buchman AS, Wilson RS, Leurgans SE, Bennett DA. Association of muscle strength with the risk of Alzheimer disease and the rate of cognitive decline in community-dwelling older persons. *Arch Neurol*. 2009;66(11):1339–1344.
6. Heyn P, Abreu BC, Ottenbacher KJ. The effects of exercise training on elderly persons with cognitive impairment and dementia: a meta-analysis. *Arch Phys Med Rehabil*. 2004;85(10):1694–1704.
7. Littbrand H, Stenvall M, Rosendahl E. Applicability and effects of physical exercise on physical and cognitive functions and activities of daily living among people with dementia: a systematic review. *Am J Phys Med Rehabil*. 2011;90(6):495–518.
8. Venturelli M, Scarsini R, Schena F. Six-month walking program changes cognitive and ADL performance in patients with Alzheimer. *Am J Alzheimers Dis Other Demen*. 2011;26(5):381–388.
9. Burge E, Kuhne N, Berchtold A, Maupetit C, von GA. Impact of physical activity on activity of daily living in moderate to severe dementia: a critical review. *Eur Rev Aging Phys Act*. 2012;9(1):27–39.
10. Smith P. Coming along swimmingly. *Nurs Times*. 2002;98(32):28–29.
11. Smith P. Waterworks. *Work Older People*. 2003;7(3):39–40.
12. Waller B, Ogonowska-Slodownik A, Vitor M, et al. Effect of therapeutic aquatic exercise on symptoms and function associated with lower limb osteoarthritis: a systematic review with meta-analysis. *Phys Ther*. 2014;94(10):1383–1395. Epub ahead of print June 5.
13. Honda T, Kamioka H. Curative and health enhancement effects of aquatic exercise: evidence based on interventional studies. *Open Access J Sports Med*. 2012;3:27–34.
14. Bergamin M, Ermolao A, Tolomio S, Berton L, Sergi G, Zaccaria M. Water-versus land-based exercise in elderly subjects: effects on physical performance and body composition. *Clin Interv Aging*. 2013;8:1109–1117.
15. Vivas J, Arias P, Cudeiro J. Aquatic therapy versus conventional land-based therapy for Parkinson's disease: an open-label pilot study. *Arch Phys Med Rehabil*. 2011;92(8):1202–1210.
16. Cotelli M, Manenti R, Zanetti O. Reminiscence therapy in dementia: a review. *Maturitas*. 2012;72(3):203–205.
17. Resnick B. A seven step approach to starting an exercise program for older adults. *Patient Educ Couns*. 2000;39(2–3):243–252.
18. Haines T, Kuys SS, Morrison G, Clarke J, Bew P, McPhail S. Development and validation of the balance outcome measure for elder rehabilitation. *Arch Phys Med Rehabil*. 2007;88(12):1614–1621.
19. Henwood TR, Keogh JW, Reid N, Jordan W, Senior HE. Assessing sarcopenic prevalence and risk factors in residential aged care: methodology and feasibility. *J Cachexia Sarcopenia Muscle*. 2014;5(3):229–236.
20. Janssen I, Heymsfield SB, Baumgartner RN, Ross R. Estimation of skeletal muscle mass by bioelectrical impedance analysis. *J Appl Physiol*. 2000;89(2):465–471.
21. Taekema DG, Gussekloo J, Maier AB, Westendorp RG, de Craen AJ. Handgrip strength as a predictor of functional, psychological and social health. A prospective population-based study among the oldest old. *Age Ageing*. 2010;39(3):331–337.
22. Guralnik JM, Simonsick EM, Ferrucci L, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol*. 1994;49(2):M85–M94.
23. Reisberg B. Functional assessment staging (FAST). *Psychopharmacol Bull*. 1988;24(4):653–659.
24. Cohen J. *Statistical power Analysis for the Behavioral Sciences*. 2nd ed. Hillsdale, NJ: L. Erlbaum Associates; 1988.
25. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. Sarcopenia: European consensus on definition and diagnosis: report of the European Working Group on sarcopenia in older people. *Age Ageing*. 2010;39(4):412–423.
26. Chiu AY, Au-Yeung SS, Lo SK. A comparison of four functional tests in discriminating fallers from non-fallers in older people. *Disabil Rehabil*. 2003;25(1):45–50.
27. Neville C, Henwood T, Beattie E, McKenzie M. Exploring the effect of aquatic exercise on behaviour and psychological wellbeing in people with moderate to severe dementia: a pilot study of the watermemories swimming club. *Australas J Ageing*. 2013;33(2):124–127.
28. Chang SH, Chen CY, Shen SH, Chiou JH. The effectiveness of an exercise programme for elders with dementia in a Taiwanese day-care centre. *Int J Nurs Pract*. 2011;17(3):213–220.
29. Hancock GA, Woods B, Challis D, Orrell M. The needs of older people with dementia in residential care. *Int J Geriatr Psychiatry*. 2006;21(1):43–49.
30. Lazowski DA, Ecclestone NA, Myers AM, et al. A randomized outcome evaluation of group exercise programs in long-term care institutions. *J Gerontol A Biol Sci Med Sci*. 1999;54(12):M621–M628.
31. Yamaguchi H, Maki Y, Yamagami T. Overview of non-pharmacological intervention for dementia and principles of brain-activating rehabilitation. *Psychogeriatrics*. 2010;10(4):206–213.
32. Neville C, Henwood T, Clifton K, Beattie E. The watermemories swim club for people with dementia. *J Aging Phys Act*. 2012;20:S8–S9.
33. Bossers WJ, Scherder EJ, Boersma F, Hortobagyi T, van der Woude LH, van Heuvelen MJ. Feasibility of a combined aerobic and strength training program and its effects on cognitive and physical function in institutionalized dementia patients. A pilot study. *PLoS One*. 2014;9(5):e97577.
34. Ries JD, Drake JM, Marino C. A small-group functional balance intervention for individuals with Alzheimer disease: a pilot study. *J Neurol Phys Ther*. 2010;34(1):3–10.
35. Lang T, Streeper T, Cawthon P, Baldwin K, Taaffe DR, Harris TB. Sarcopenia: etiology, clinical consequences, intervention, and assessment. *Osteoporos Int*. 2010;21(4):543–559.
36. Fox B, Henwood T, Neville C, Keogh J. Relative and absolute reliability of functional performance measures for adults with dementia living in residential aged care. *Int Psychogeriatr*. 2014;3:1–9.
37. Miranda-Castillo C, Woods B, Galboda K, Oomman S, Olojugba C, Orrell M. Unmet needs, quality of life and support networks of people with dementia living at home. *Health Qual Life Outcomes*. 2010;8:132.