Clinical Rehabilitation

Effectiveness of aquatic exercises compared to patient-education on health status in individuals with knee osteoarthritis: A randomized controlled trial.

Journal:	*Clinical Rehabilitation*
Manuscript ID	CRE-2017-6315.R1
Manuscript Type:	Original Article
Keywords:	Self-Care, Hydrotherapy, Knee Osteoarthritis, pain, Depression

Abstract:

Objective: To compare the effectiveness of aquatic exercises with patient-education in individuals with knee osteoarthritis.
Design: Randomized controlled clinical trial with blinded assessor and intention-to-treat analysis.
Setting: Aquatic Physiotherapy Centre and Primary Health Care Unit.
Subjects: 60 patients, aged 68.3 (SD=4.8) with clinical symptoms and radiographic grading (Kellgren-Lawrence 1–4) of knee osteoarthritis were included.
Interventions: an eight-week treatment protocol of aquatic exercise (n=31) (16 individual sessions, twice a week) and an educational program (group sessions, once a week) (n=29).
Main measures: Before, after eight-week intervention, and a three-month follow-up with results for the following outcome measures: pain, function, quality of life, functional mobility, and depression.
Results: At the end of treatment, the WOMAC functional capacity values reduced in favour of the aquatic exercise group for both the total score MD (mean difference) = -14.2 CI (confidence interval) 95% [-18; -10.5], P = 0.04 and the pain domain MD = -3.8 points; CI 95% [-8.71; -1], P = 0.021. The total score also reduced in the follow-up: MD = -12.3; CI 95% [-24.7; -6.1], P = 0.017. No differences were found for the outcomes functional mobility or depression.
Conclusion: Aquatic exercise improved pain and function after eight weeks, and function at the three-month follow-up compared to the patient-education program.

SCHOLARONE™
Manuscripts

Effectiveness of aquatic exercises compared to patient-education on health status in individuals with knee osteoarthritis: A randomized controlled trial.

Introduction

Osteoarthritis is known as a degenerative disorder of the joint cartilage associated with hypertrophic bone changes and is the most common form of arthritis, affecting more than 27 million people in the United States.[1] A variety of factors, including demographic, clinical, and biomechanical aspects have been studied and associated with functional and pain status.[2] In addition, growing evidence suggests that psychological factors such as anxiety, fear, and depression may also relate to physical function in patients with knee osteoarthritis.[3]

There is broad agreement on recommendations from the various organizations for non-pharmacologic modalities of treatment for knee osteoarthritis such as aerobic, aquatic, and/or resistance exercises, education/self-management, walking, as well as weight loss in overweight patients.[4] Results of systematic reviews/guidelines have pointed out that physical exercise is the most recommended non-pharmacological intervention for osteoarthritis patients and can reduce pain and enhance physical function of joints affected by osteoarthritis.[5,6] Evidence with low to moderate quality has demonstrated no important differences in self-management, pain, symptoms, function or quality of life for these patients when compared to self-management

For Peer Review

programs and other interventions such as exercise, social support or acupuncture.[7] It has not been compared to an aquatic exercise program.

The most recent review about the use of aquatic exercise for the management of knee and hip osteoarthritis showed it can be effective at the end of treatment with a small effect on pain, function, and quality of life. For only knee osteoarthritis, no positive results were found. Moreover, the authors recommended that future studies should be joint-specific and set exercise programs with clearly described type and dose (intensity, frequency, and duration)[8], besides the comparison among several modalities used by physiotherapy.

Considering the rationale above, the role of self-management programs compared to aquatic exercise still has not been investigated, including a well described joint-specific exercise program and its results in long-term follow-up. Moreover, the aspects of psychosocial outcomes should also be compared for these modalities. Then the aim of this study was to investigate the effectiveness of an aquatic exercise program compared to patient-education for individuals with knee osteoarthritis on pain, function, quality of life, and depression.

Method

Study Design and Selection Criteria

A randomized controlled trial lasting 8-weeks, with a three-month follow-up, according to the Consort-Statement[9], was conducted at an Aquatic Physiotherapy Centre and in a Primary Health Care Unit between January 2015

For Peer Review

and April 2016. This study was registered at ClinicalTrials.gov (NCT02247882). All procedures were approved by the University Ethics Committee (#27913514.8.0000.5231).

Participants were recruited from the local Primary Health Care Unit, after being evaluated by a rheumatologist, who confirmed the diagnosis of knee OA according to the American College of Rheumatology[10] – including the Kellgren-Lawrence radiographic criteria[11], aged from 60 to 85 years and presented adequate clinical and cognitive conditions for carrying out activities in the pool, confirmed by the Mini-Mental State Examination (24-30 points).[12] The Kellgren-Lawrence radiographic criteria indicated that most patients (58%) had a mild degree (grades 1 and 2); while others (42%) had a severe stage of radiographic abnormalities (grades 3 and 4).

The exclusion criteria were: patients undergoing orthopaedic and neurological surgical procedures, those with coronary diseases, cancer, or uncontrolled hypertension, patients unable to walk without aid equipment, patients with contraindications to practice exercises or enter the pool, those participating in nutrition or physical activity programs in the previous two months, individuals with morbid obesity (body mass index > 40 kg/m^2), and those unable to continue the study due to change of address or scheduled hospitalization.

Procedures

In relation to random allocation process, numbers were generated from the site www.random.org using a random sequence from 1 to 100, with two

For Peer Review

columns. For allocation concealment, the numbers generated were placed in sealed, opaque envelopes containing the previously decided group names Aquatic Exercise or Education Program. The envelopes were numbered and placed in sequence. One individual, not involved with the study, was responsible for the randomization and opening the envelope. After the baseline assessment, this individual informed the participants to which he/she was allocated, either the aquatic exercise or the educational program group.

The participants who met the eligibility criteria were assessed on three different occasions: at baseline, at the end of the treatment (8-weeks), and after a three-month follow-up. Participants were evaluated by two individuals in the morning period at the Laboratory of Biomechanics and Clinical Epidemiology. At the baseline assessment, the participants were informed about all the procedures and possible risks, signed the approved consent form, and anthropometric data (mass and height) were collected. Following these initial procedures, the questionnaires were completed, and the functions test performed.

Study Interventions

The patient-education group program (five individuals per group) was designed and delivered by a multidisciplinary team: physician, pharmacist, nurse, nutritionist, psychologist, physiotherapist, and physical educator. The classes were weekly (total of eight), lasting two hours and were given at the Primary Health Care Unit. Following the suggestions by Coleman et al.,[13] the guidance on the disease and its complications were included; strategies for pain control (cognitive and pharmacological), physical exercise, nutrition, and weight

For Peer Review

control, medications (type, interactions, side effects and updates), balance, proprioception, preventing falls, and how to deal with chronic pain. This group also received home knee osteoarthritis exercise guidelines for practice two to three times a week, which included: warm-up, self-stretching, isometric and dynamic exercises, proprioceptive and functional exercises of the lower limbs, and cool down.

The aquatic program was performed individually twice a week, for 8-weeks, each session lasting 60 minutes, totalling 16 sessions, provided by certified physiotherapists in the Aquatic Physiotherapy Centre. The water temperature was maintained at approximately 32 °C (89 °F), with a depth of 1.2 m. The exercise protocol consisted of specific exercises: five minutes of warm-up with walking, patellar mobilization; stretching the leg muscles (quadriceps, gluteus, adductors and abductors of hip, triceps surae, and hamstrings); 15 minutes of knee and hip isometric and dynamic exercises with elastic bands (gluteus, adductors and abductors, quadriceps, hamstrings, and triceps surae); 20 minutes of aerobic exercises (stationary running or deep water-running); 10 minutes of step training and proprioceptive exercises; and 10 minutes of cool down with massage and relaxation (Appendix 1). The selected exercises were based on studies for outcomes function,[8,14] pain,[8,14] balance,[15,16] and aerobic capacity.[17]

Study Outcomes

The primary outcome measures were pain, assessed by a visual analogue scale[18] and functional capacity through the Western Ontario &

For Peer Review

McMaster Universities Osteoarthritis Index: WOMAC.[19] The Minimal Clinically Important Difference for knee OA is -7.9 points for WOMAC total score.[20]

As secondary outcomes, quality of life, screen on depression, and functional mobility were recorded. Quality of life was measured using the Medical Outcome Study Short Form 36-item Health Survey (version 2.0) and an improvement of 5 points in the physical component score of the questionnaire is considered to be clinically significant.[21] The presence of depressive symptoms was defined as obtaining six or more points in the short version (15 items) of the Yesavage Geriatric Depression Scale.[22] The Timed Up and GO test is a performance-based measure and the minimal detectable change of the test in individuals with grade 1 – 3 (Kellgren-Lawrence criteria) for knee osteoarthritis is 1.14 seconds.[23] The team involved in the study was blinded to which study group the patient belonged to throughout the measurements. Two researchers were involved in the assessment.

Statistical Analysis

The sample size was calculated for the outcome of pain using the formula proposed by Pocock[24] which considered an alpha = 0.05 and 80% power to detect a reduction of 30% in pain.[8] The estimated sample was 60 patients in the Aquatic Exercise Group and Educational Program groups.

The variables were analysed for normal distribution using the Shapiro-Wilk test and as the normality assumption was accepted, data are presented as mean and standard deviation (SD), mean differences (MD), and 95% confidence intervals (CI). A Generalized Estimating Equation[25] model through a specific syntax was employed for comparison within/between groups. A working

For Peer Review

correlation matrix was specified a priori and defined the hypothesized relationship between repeated observations on a subject. The model type was set up as a linear scale response. The standard error estimates were adjusted according to the hypothesized correlation between different time points of the outcome (primary and secondary). Bonferroni tests for analysis by multiple comparisons were applied when appropriate. The statistical significance adopted for all tests was 5% and performed according to intention-to-treat analyses. All analyses were carried out using SPSS version 22.0 (IBM SPSS®, Armonk, NY, USA).

Results

A total of 154 patients were screened for eligibility and 60 met the eligibility criteria and were randomized between January 2015 and April 2016. Thirty-one were allocated to the Aquatic Exercise group and 29 to the Educational Program group and received the interventions. Two patients were lost due to health problems (pneumonia and panic syndrome) before the follow-up evaluation, and nine dropped out of the sessions, giving a total of 28 patients in the Aquatic Exercise group and 21 patients in the Educational Program group (dropout rate 18.3%) (Fig. 1) for follow-up evaluation. No side effects were reported during the treatment in either group.

Both groups were similar in the assessed characteristics and outcomes at baseline (Tables 1, 2, and 3). A statistically significant difference was found between groups for the Yesavage questionnaire P = 0.013; MD = -1.7 95% CI [-

For Peer Review

3.76; -0.31] at baseline, although the scores did not indicate the presence of depression.

For the primary outcome of pain, no statistical differences were found between or within groups when assessed by the Visual Analog Scale, but when the pain domain of the WOMAC questionnaire was assessed, statistical changes were found within and between groups in favour of the Aquatic Exercise group. In this group, the pain decreased at the end of treatment MD = -3.3 points; 95% CI [-6.56; -0.1] *P* = 0.031; and at the follow-up period MD = -3.1 points; 95% CI [-6.3; -0.03] *P* = 0.046. At the end of treatment, a significant reduction was noted in favour of the Aquatic Exercise group when compared to the Educational Program group, MD = -3.8 points 95% CI [-8.7; -1] *P* = 0.021.

When function was analysed, WOMAC scores reduced after treatment MD = -11 points 95% CI [-14.9; -9.6], *P* = 0.009 and at the end of follow-up MD = -11.8 points; 95% CI [-19.3; -3.6]; *P* = 0.020 compared to baseline in the Aquatic Exercise group. The Minimal Clinically Important Difference was achieved, with 13 (41.9%) individuals overcoming these values at the end of treatment and 14 (45.2%) at the end of the follow-up period. Moreover, the scores statistically reduced in favour of the Aquatic Exercise group both after treatment MD = -14.2 points 95% CI [-18; -10.5], *P* = 0.04, and at follow-up MD = -12.3 points; 95% CI [-24.7; -6.1], *P* = 0.017. When comparing the values of Minimal Clinically Important Difference between the groups, the aquatic group achieved improvement at the end of treatment in 13 (41.9%) versus 7 (24.1%) individuals of the Educational Program group, and at the end of follow-up in 14 (45.2%) individuals versus 8 (27.5%) of the Educational Program group.

For Peer Review

Regarding the secondary outcome quality of life, improvements over time in the Aquatic Exercise group were observed, with statistically significant differences at the end of treatment MD = 9.6 95% CI [2.9; 16.3], *P*<0.001, and at the follow-up period MD = 10.6; 95% CI [3.5; 17.8], *P*<0.001. When comparing the Minimal Clinically Important Difference values between the groups, the Aquatic Exercise group achieved improvement in 19 (61.3%) patients versus 12 (41.4%) individuals in the Educational Program group at the end of treatment, and in 19 (61.3%) versus 16 (55.2%) at the end of follow-up.

Functional mobility assessed by the Timed Up and Go test showed no statistically significant differences within/between groups, but the minimum values of detectable change were reached at the end of treatment (2.3 seconds; 10 subjects, 34.5%) and at the end of follow-up (1.3 seconds; 13 subjects, 44.8%) in the Educational Program group. The depressive symptoms demonstrated no statistically significant differences either within or between, at the end of treatment and follow-up.

Discussion

This study showed that aquatic exercises, when compared to patient-education, were superior in improving function and pain in individuals with knee osteoarthritis, while quality of life and depressive symptoms presented no differences. The results of the group submitted to aquatic exercises were effective in improving pain, function, and quality of life after treatment, and function at the end of the three-month follow-up period.

For Peer Review

The results indicated no differences between the groups or within the groups for pain when assessed by the Visual Analog Scale. However, it should be noted that the mean baseline pain was moderate: 4.1 cm for the aquatic exercises patients and 4.6 cm for the Educational Program group; there was a decrease for the Aquatic Exercise group of 1.2 cm at the end of the 8-weeks and in the follow-up this value was maintained. On the other hand, for the Educational Program group, the reduction was 0.8 and 0.9 cm at the end and follow-up assessments respectively. It is known that the minimal clinically important difference was not established for Visual Analog Scale on osteoarthritis population, however, according to Tubach et al.,[20] the minimal clinically important improvement varies depending on the baseline state: patients who have the most severe symptoms (which represented 48% of individuals according to the Kellgren-Lawrence criteria) must experience a greater change to consider them improved. In this case, improvements in pain in the present study can be considered satisfactory and must not be discarded within the groups.

However, when assessed by the WOMAC questionnaire (pain domain), changes were observed over time for the Aquatic Exercise group and by the end of the treatments between groups, also in favour of the Aquatic Exercise group. It is generally accepted that the WOMAC questionnaire has greater specificity and consequently better responsiveness for people with osteoarthritis when compared to Visual Analog Scale, explaining the improvement just in the WOMAC questionnaire.[26]

Aquatic exercise may have effects on pain because of fluid mechanics. The effect of buoyancy could reduce pain during exercise as the depth of

For Peer Review

immersion is directly related to the percentage weight bearing.[8,27-30] The hydrostatic pressure acts compressing the tissues and, in combination with the circulatory changes that occur with immersion, reduces swelling, permitting greater movement to reduce joint and soft-tissue stiffness and, therefore, improve pain complaints.[29-30]

A meta-analysis of trials investigating water-based, aerobic and strengthening exercises, and spa therapy for osteoarthritis concluded that all have a positive effect on pain.[31] A Cochrane review of aquatic therapy for osteoarthritis of the hip or knee also concluded that pain may be decreased by aquatic exercises.[8] A recent clinical trial investigating aquarobic therapy (several types of exercises including aerobics in water, three times a week in 1-hour sessions, for a total of 36 sessions over 12 weeks) versus patient education (two educational sessions delivered through lectures on osteoarthritis and the necessity of exercising), showed a statistically significant difference in pain.[32]

The present study presented some similar methodological elements when compared to the aforementioned studies, for example, time of the sessions with a duration of 60 minutes, a minimum weekly frequency of two times and a minimum duration of eight weeks of intervention. When confronted with the types of exercises used in the programs, the clear majority (and the present study) was composed of warm-up, flexibility, dynamic and aerobic exercises. The present study differed in the addition of balance exercises, proprioceptive, deep-water running in the aerobic component and relaxation with the addition of massage in the periarticular musculature of the knees.

For Peer Review

Educational programs have been statistically proven to be good in reducing pain, as evaluated by Coleman et al.,[33] with a 6-week knee specific self-management education program, delivered by health professionals. In a recent review including 29 studies (6,753 participants) Kroon et al.,[7] found that educational programs mildly reduced pain when compared with usual care. In the current study, the Aquatic Exercise group improved function over time and presented better results than the Educational Program group. The Aquatic Exercise group values of minimal clinically important difference from the WOMAC questionnaire were achieved at the end of treatment and at the follow-up period.

This positive result was also reported in the systematic reviews published by Barker et al.,[34] and Bartels et al.,[8] aquatic therapy mildly improved physical function both in patients affected by musculoskeletal, and in patients with combined hip and knee osteoarthritis. In another systematic review, aquatic physiotherapy was compared with exercises on land by Batterham et al.,[14] for function, mobility, and health outcomes. No favourable results were found for either group. In conclusion, the authors suggested the option of aquatic exercises for individuals who have difficulty in attending on land.

Functional improvements were reflected by changes in several measured parameters, such as pain and quality of life. It is generally accepted that the WOMAC questionnaire has greater specificity and consequently better responsiveness for people with osteoarthritis;[26] nonetheless, the Medical Outcome Study Short Form 36-item Health Survey also reflected these changes.

For Peer Review

Educational programs have also proved beneficial in improving function in some clinical trials: Bezalel et al.,[35] reported a reduction in the WOMAC total score after four weeks of treatment and at the 8-week follow-up, between education and control groups. Similar findings were listed by Carvalho et al.,[36] after three months of treatment. Coleman et al.,[33,37] reported improvements in WOMAC total score at the end of a 12-month treatment, as well as after an 8-week intervention and a 6-month follow-up period. Contrary to these findings, a recent review did not show differences between self-management programs or any other intervention for the function outcome.[7]

In the present study, positive effects were seen in quality of life in the Aquatic Exercise group and the minimal detectable change values were achieved at the end and at follow-up period. Two systematic reviews showed improvement in quality of life using the aquatic therapy modality. Bartels et al.,[13] at the end of aquatic exercise treatment for combined knee and hip osteoarthritis, showed a small effect on quality of life. Moderate improvements were reached by Barker et al.,[34] when comparing aquatic exercise with no exercise for musculoskeletal conditions.

The reasons that justify the effectiveness of educational programs for health outcomes are still not well understood and can be justified by many different factors. Moreover, the meta-analysis of educational programs has concluded that it is difficult to compare models between different chronic conditions, which is also the case for different types of arthritis.[38]

The present educational program was developed specifically for the population with knee osteoarthritis, aimed at decreasing pain as well as improving function and quality of life, delegated by professionals with

For Peer Review

experience. Information about the disease and the benefits of exercise were incorporated into the constructs of self-knowledge to improve self-efficacy and changes in the behaviour of these individuals. Using the knowledge and skills of health professionals is a major component of the educational program because knowledge is an important part of self-efficacy and no amount of trust will succeed unless the necessary knowledge and skills are present.[39] Understanding the rationale for adopting concepts in the program allows participants to become self-motivated to change behaviour and thus to be more adherent in the long term.[40]

In the present investigation, functional mobility, assessed by the Timed Up and Go test, did not demonstrate significant differences within or between groups, but in the Educational Program the minimal detectable change was achieved at the end of the treatment (2.3 seconds) and at the follow-up period (1.3 seconds). The same test was investigated in a clinical trial which compared an orientation (manual with guidelines on how not to overload the knee in daily activities and instructions for pain and medication) and an exercise group (on land, twice a week, 8 weeks, involving stretching and strengthening of the quadriceps).[41] At the end of the treatment there was no statistically significant difference in the pre-and post-intervention evaluation in the orientation group.

However, in the exercise group, there was a statistically significant difference in Timed Up and Go test scores. Comparing the groups, a higher improvement in the Timed Up and Go test in the exercise group compared to the orientation group was observed. When investigating water based exercise, a recent study compared the effects of two aquatic exercise programs (aqua-fitness program and seated aqua-based exercise program) on physical function

For Peer Review

for 12 weeks in individuals with osteoarthritis (hip, hands, knee or spine) and no significant changes in Timed Up and Go test were observed.[42] Both instruments (WOMAC and Timed Up and Go test) were used to evaluate function, but WOMAC showed better improvement compared to Timed Up and Go test, regarding its greater specificity to people with osteoarthritis and consequently better responsiveness.

With respect to the screen on depression, no differences were found between or within the groups of the present study. At baseline, the individuals showed no signs or symptoms of depression (<6 points from the questionnaire) and both treatments appeared to maintain this status. Scopaz et al.,[3] investigated the association between fear, anxiety, and depression with physical function in individuals with knee osteoarthritis. Depression may influence scores in function under conditions of low anxiety and no results were found when correlating the Timed Up and Go test and depression.

Axford et al.,[43] proposed a clinical trial (educational versus no treatment) consisting of four 1-h group sessions led by a trained registered nurse. The sessions covered information about the disease, medication and other treatments, activities (exercise and relaxation), and skills (strategies for pain management) guided by a special booklet for both groups. A complex interrelationship between depression, pain, disease knowledge, and physical ability in patients with knee osteoarthritis was demonstrated. All patients showed a progressive decrease in mental health over the duration of the study and greater pain scores were associated with reduced coping, increased depression, and reduced physical ability. The authors concluded that the treatment of depression and pain may be paramount to the successful

For Peer Review

treatment of knee osteoarthritis, and these factors should be considered for each patient. Kim et al.,[44] investigated depression symptoms with another questionnaire comparing a non-equivalent control group and 36 sessions of an aquarobic exercise program (60-minute sessions, three times per week). At the end of the protocol, the aquarobic group presented significantly reduced depression values compared to the control group.

Some limitations of this study are listed as follows: a high dropout rate (especially in the Educational Program group) may have jeopardized the results, even using the intention-to-treat analysis. The Education Program Group does not receive an equivalent amount of supervised land-based exercise when compared to the Aquatic Exercise group. The heterogeneity of the groups in relation to the outcome of depressive symptoms in the baseline evaluation should also be taken into consideration.

New clinical trials are needed to confirm the effects of aquatic exercise and educational programs on patients with knee osteoarthritis, including the cost-effectiveness outcome. High quality studies that follow the recommendations of the Consort-Statement[20] are required, as well as standardization of outcomes and interventions to facilitate comparisons.

For Peer Review

Clinical Messages

Aquatic exercise program (16 sessions, twice a week) was superior when compared to the educational program (eight sessions, weekly, lasting two hours) in pain and function, at the end eight weeks and after three-month follow-up, for patients with knee osteoarthritis.

Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

1. Lawrence RC, Felson DT, Helmick CG, et al. Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. *Arthritis Rheum* 2008; 58: 26-35.

2. Fitzgerald GK, Piva SR, Irrgang JJ, Bouzubar F and Starz TW. Quadriceps activation failure as a moderator of the relationship between quadriceps strength and physical function in individuals with knee osteoarthritis. *Arthritis Care Res* 2004; 51: 40-48.

For Peer Review

3. Scopaz KA, Piva SR, Wisniewski S and Fitzgerald GK. Relationships of fear, anxiety, and depression with physical function in patients with knee osteoarthritis. *Arch Phys Med Rehabil* 2009; 90: 1866-1873.

4. Hochberg MC, Altman RD, April KT, et al. American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. *Arthritis Care Res* 2012; 64: 465-474.

5. McAlindon TE, Bannuru RR, Sullivan MC, Arden NK, Berenbaum F and Bierma-Zeinstra SM, et al. OARSI guidelines for the non-surgical management of knee osteoarthritis. *Osteoarthr Cartil* 2014; 22: 363-388.

6. Fransen M, McConnell S, Harmer AR, Van der Esch M, Simic M and Bennell KL. Exercise for osteoarthritis of the knee. *Cochrane Database Syst Rev* 2015; 1: CD004376.

7. Kroon FPB, Van der Burg LRA, Buchbinder R, Osborne RH, Johnston RV and Pitt V. Self-management education programmes for osteoarthritis. *Cochrane Database Syst Rev* 2014; 1: CD008963.

8. Bartels EM, Juhl CB, Christensen R, Hagen KB, Danneskiold-Samsøe B, Dagfinrud H, et al. Aquatic exercise for the treatment of knee and hip osteoarthritis. *Cochrane Database Syst Rev* 2016; 3: CD005523.

For Peer Review

9. Schulz KF, Altman DG, Moher D and CONSORT Group. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *Int J Surg* 2011; 9: 672-677.

10. American College of Rheumatology Subcommittee on Osteoarthritis. Recommendations for the medical management of osteoarthritis of the hip and knee: 2000 update. *Arthritis Rheum* 2000; 43: 1905-1915.

11. Petersson IF, Boegård T, Saxne T, Silman AJ and Svensson B. Radiographic osteoarthritis of the knee classified by the Ahlbäck and Kellgren & Lawrence systems for the tibiofemoral joint in people aged 35-54 years with chronic knee pain. *Ann Rheum Dis* 1997; 56: 493-496.

12. Lancu I and Olmer A. The mini-mental state examination--an up-to-date review. *Harefuah* 2006; 145: 687-690.

13. Coleman S, McQuade J, Rose J, Inderjeeth C, Carroll G and Briffa NK. Self-management for osteoarthritis of the knee: Does mode of delivery influence outcome? *BMC Musculoskelet Disord* 2010; 11: 56.

14. Batterham SI, Heywood S, Keating JL. Systematic review and meta-analysis comparing land and aquatic exercise for people with hip or knee arthritis on function, mobility and other health outcomes. *BMC Musculoskelet Disord* 2011; 12: 123.

For Peer Review

15. Lund H, Weile U, Christensen R, Rostock B, Downey A, Bartels EM, et al. A randomized controlled trial of aquatic and land-based exercise in patients with knee osteoarthritis. *J Rehabil Med* 2008; 40: 137-144.

16. Hale LA, Waters D and Herbison P. A randomized controlled trial to investigate the effects of water-based exercise to improve falls risk and physical function in older adults with lower-extremity osteoarthritis. *Arch Phys Med Rehabil* 2012; 93: 27-34.

17. Escalante Y, García-Hermoso A and Saavedra JM. Effects of exercise on functional aerobic capacity in lower limb osteoarthritis: A systematic review. *J Sci Med Sport* 2011; 11: 190-198.

18. Price DD, Rafii A and Buckingham B. The validation of visual analogue scales ratio scale measures for chronic and experimental pain. *Pain* 1983; 17: 45-56.

19. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J and Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J Rheumatol* 1988; 15: 1833-1840.

For Peer Review

20. Tubach F, Ravaud P, Baron G, Falissard B, Logeart I, Bellamy N, et al. Evaluation of clinically relevant changes in patient reported outcomes in knee and hip osteoarthritis: the minimal clinically important improvement. *Ann Rheum Dis* 2005; 64: 29-33.

21. Ware JE Jr, Kosinski MA. SF-36 Physical & mental health summary Scales: a manual for users of version 1 second edition. Lincoln, Rhode Island: Quality Metric Inc., 2002.

22. Yesavage JA, Brink TL, Rose TL, Lum O, Huang V, Adey M, et al. Development and validation of a geriatric depression screening scale: a preliminary report. *J Psychiat Res* 1983; 17: 37-49.

23. Alghadir A, Anwer S and Brismée JM. The reliability and minimal detectable change of Timed Up and Go test in individuals with grade 1-3 knee osteoarthritis. *BMC Musculoskelet Disord* 2015; 16: 174.

24. Pocock SJ. Clinical Trials: a practical approach. Chichester: John Wiley & Sons, 1983.

25. Hanley JA, Negassa A, Edwardes MDB and Forrester JE. Statistical analysis of correlated data using generalized estimating equations: an orientation. *Am J Epidemiol* 2003; 157: 364-375.

For Peer Review

26. Davies M, Watson DJ and Bellamy N. Comparison of the responsiveness and relative effect size of the Western Ontario and McMaster Universities Osteoarthritis Index and the Short-Form Medical Outcomes Study Survey in a randomized, clinical trial of osteoarthritis patients. *Arthritis Care Res* 1999,12: 172-179.

27. Verhagen AP, Cardoso JR and Bierma-Zeinstra SM. Aquatic exercise & balneotherapy in musculoskeletal conditions. *Best Pract Res Clin Rheumatol* 2012; 26: 335-343.

28. Harrison RA, Hillman M, Bustrode S. Loading of the lower limb when walking partially immersed: implications for clinical practice. *Physiotherapy* 1992; 78: 164-166.

29. Lin S-C, Davey R and Cochrane T. Community rehabilitation for older adults with osteoarthritis of the lower limb: A controlled clinical trial. *Clin Rehabil* 2004; 18: 92-101.

30. Hinman RS, Heywood SE and Day AR. Aquatic physiotherapy for hip and knee osteoarthritis: results of a single-blind randomised controlled trial. *Phys Ther* 2007; 87: 32–43.

For Peer Review

31. Zhang W, Moskowitz RW, Nuki G, Abramson S, Altman RD, Arden N, et al. OARSI recommendations for the management of hip and knee osteoarthritis, part 1: critical appraisal of existing treatment guidelines and systematic review of current research evidence. *Osteoarthr Cartil* 2007; 15: 981-1000.

32. Fisken AL, Waters DL, Hing WA, Steele M and Keogh JW. Comparative effects of 2 aqua exercise programs on physical function, balance, and perceived quality of life in older adults with osteoarthritis. *J Geriatr Phys Ther* 2015; 38:17-27.

33. Coleman S, Briffa K, Conroy H, Prince R, Carroll G and McQuade J. Short and medium-term effects of an education self-management program for individuals with osteoarthritis of the knee, designed and delivered by health professionals: a quality assurance study. *BMC Musculoskelet Disord* 2008; 9: 117.

34. Barker AL, Talevski J, Morello RT, Brand CA, Rahmann AE and Urquhart DM. Effectiveness of aquatic exercise for musculoskeletal conditions: a meta-analysis. *Arch Phys Med Rehabil* 2014; 95: 1776-86.

35. Bezalel T, Carmeli E and Katz-Leurer M. The effect of a group education programme on pain and function through knowledge acquisition and home-based exercise among patients with knee osteoarthritis: A parallel randomised single-blind clinical trial. *Physiotherapy* 2010; 96: 137-143.

For Peer Review

36. Carvalho NA, Bittar ST, Pinto FR, Ferreira M and Sitta RR. Manual for guided home exercises for osteoarthritis of the knee. *Clinics (Sao Paulo)* 2010; 65: 775-780.

37. Coleman S, Briffa NK, Carroll G, Inderjeeth C, Cook N and McQuade J. A randomised controlled trial of a self-management education program for osteoarthritis of the knee delivered by health care professionals. *Arthritis Res Ther* 2012; 14: R21.

38. Warsi A, Wang PS, LaValley MP, Avorn J, Solomon DH. Self-management education programs in chronic disease. A systematic review and methodological critique of the literature. *Arch Intern Med* 2004; 164: 1641-1649.

39. Pajares F: Overview of social cognitive theory and self-efficacy Atlanta: Division of Educational Studies; Emory College of Arts and Sciences: Emory University, USA; 2002.

40. Elder J, Ayala G, Harris S: Theories and intervention approaches to health-behaviour change in primary care. Am J Prev Med 1999, 17: 275-284.

41. Oliveira AMI, Peccin MS, Kelson Silva KNG, Teixeira LEPP and Trevisani VFM. Impacto dos exercícios na capacidade funcional e dor em pacientes com osteoartrite de joelhos: ensaio clínico randomizado. *Rev Bras Reumatol* 2012; 52: 870-882.

For Peer Review

42. Fisken AL, Waters DL, Hing WA, Steele M and Keogh JW. Comparative effects of 2 aqua exercise programs on physical function, balance, and perceived quality of life in older adults with osteoarthritis. *J Geriatr Phys Ther* 2015; 38: 17-27.

43. Axford J, Heron C, Ross F and Victor CR. Management of knee osteoarthritis in primary care: Pain and depression are the major obstacles. *J Psychosom Res* 2008; 64: 461-467.

44. Kim IS, Chung SH, Park YJ and Kang HY. The effectiveness of an aquarobic exercise program for patients with osteoarthritis. *Appl Nurs Res* 2012; 25: 181-189.

For Peer Review

ABSTRACT

Objective: To compare the effectiveness of aquatic exercises with patient-education in individuals with knee osteoarthritis.

Design: Randomized controlled clinical trial with blinded assessor and intention-to-treat analysis.

Setting: Aquatic Physiotherapy Centre and Primary Health Care Unit.

Subjects: 60 patients, aged 68.3 (SD=4.8) with clinical symptoms and radiographic grading (Kellgren-Lawrence 1–4) of knee osteoarthritis were included.

Interventions: an eight-week treatment protocol of aquatic exercise (n=31) (16 individual sessions, twice a week) and an educational program (group sessions, once a week) (n=29).

Main measures: Before, after eight-week intervention, and a three-month follow-up with results for the following outcome measures: pain, function, quality of life, functional mobility, and depression.

Results: At the end of treatment, the WOMAC functional capacity values reduced in favour of the aquatic exercise group for both the total score MD (mean difference) = -14.2 CI (confidence interval) 95% [-18; -10.5], *P* = 0.04 and the pain domain MD = -3.8 points; CI 95% [-8.71; -1], *P* = 0.021. The total score also reduced in the follow-up: MD = -12.3; CI 95% [-24.7; -6.1], *P* = 0.017. No differences were found for the outcomes functional mobility or depression.

Conclusion: Aquatic exercise improved pain and function after eight weeks, and function at the three-month follow-up compared to the patient-education program.

Keywords: self-care, hydrotherapy, knee osteoarthritis, pain, depression,

For Peer Review

Table 1. Baseline characteristics of participants.

	AE (n=31)	EP (n=29)	
Gender			
Male n (%)	8 (25.8)	11 (37.9)	*P*=0,37
Female n (%)	23 (74.2)	18 (62.1)	*P*=0,16
Age (years)	67.3 (5.9)	68.7 (6.7)	*P*=0,21
BMI (kg/m^2)	29.2 (0.8)	30.4 (0.9)	*P*=0,42

AE: Aquatic Exercises Group, EP: Educational Program Group, mean (SD): standard deviation, BMI: body mass index, and cm: centimeters.

For Peer Review

Table 2. Summary of the primary outcome measures.

	AE (n=31)		EP (n=29)		
	Mean (SD)	**MD [95% CI] Within AE Group**	Mean (SD)	**MD [95% CI] Within EP Group**	**MD [95% CI] Between Groups**
VAS (cm)					
Baseline	4.1 (0.5)		4.6 (0.6)		-0.47 [-2.55; 1.61]
Week 8	2.9 (0.5)	-1.2 [-1.92; 3.81]	3.8 (0.6)	-0.8 [-1.24; 2.56]	-0.90 [-2.90; 1.70]
Follow-up	2.9 (0.5)	-1.2 [-1.92; 3.94]	3.7 (0.6)	-0.9 [-1.40; 2.64]	-0.76 [-3.12; 1.88]
WOMAC Total					
Baseline	33.7 (3.7)[a]		38.9 (3.5)		-5.2 [-12.8; 16.8]
Week 8	22.7 (3.6)[b]	-11 [-14.9; -9.6]	36.9 (3.5)	-2 [-4.8; 8.9]	-14.2 [-18; -10.5][A]
Follow-up	21.9 (3.4)[b]	-11.8 [-19.3; -3.6]	34.2 (3.9)	-4.7 [-8.4; 10.1]	-12.3 [-24.6; -6.1][B]
WOMAC Pain					
Baseline	7.6 (0.8)[a]		6.9 (0.8)		-0.7 [-2.5; 3.9]
Week 8	4.2 (0.7)[b]	-3.3 [-6.5; -0.1]	8.1 (1.5)	1.2 [-6.1; 3.6]	-3.8 [-8.7; -1][B]
Follow-up	4.4 (0.7)[b]	-3.1 [-6.3; -0.03]	7.6 (1.5)	0.72 [-5.6; 4.1]	-3.2 [-8; 1.6]

SD: standard deviation, MD: mean difference [95% confidence interval], AE: Aquatic Exercises Group, EP: Educational Program Group, VAS: visual analogue scale, WOMAC: Western Ontario & McMaster Universities Osteoarthritis Index, cm: centimetres, Intention-to-treat analysis; GEE: Generalized Estimating Equation analysis, a, b (lowercase letters): within group differences from baseline, $P< 0.05$, and A, B, C (uppercase letters): between groups differences, $P< 0.05$.

For Peer Review

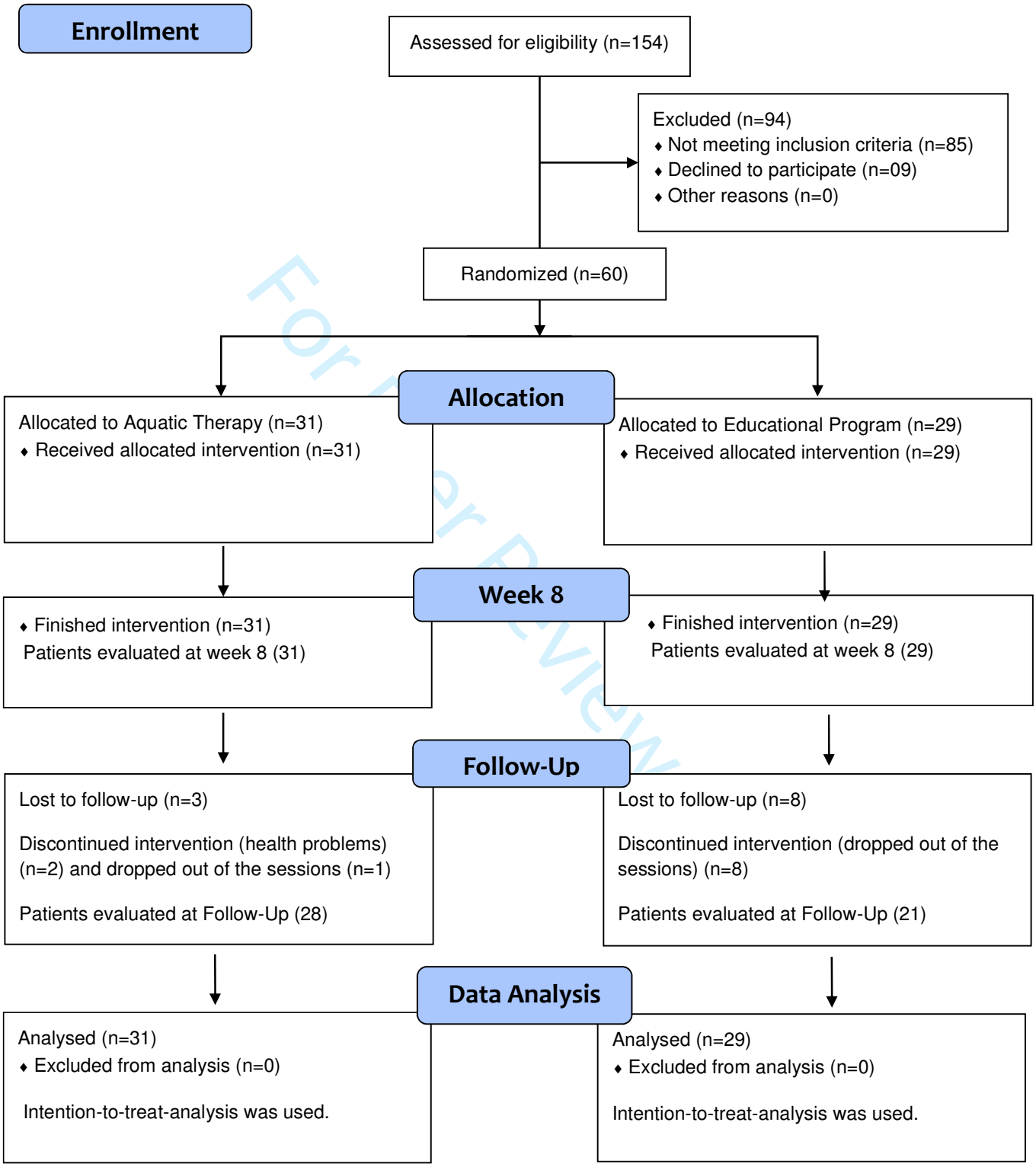
Table 3. Summary of the secondary outcome measures.

	AE (n=31)		EP (n=29)		
	Mean (SD)	MD [95% CI] Within AE Group	Mean (SD)	MD [95% CI] Within EP Group	MD [95% CI] Between Groups
SF-36 (Physical Function)					
Baseline	64.7 (3.1)[a]		57.4 (3.1)		7.3 [-5.5; 20.2]
Week 8	74.3 (2.9)[b]	9.6 [2.9; 16.3]	61.5 (4.1)	4.1 [-13.5; 5.2]	12.8 [-1.7; 27.4]
Follow-up	75.4 (3)[b]	10.6 [3.6; 17.8]	61 (4.1)	3.6 [-12.7; 5.4]	14.3 [-0.3; 29.1]
Yesavage Scale					
Baseline	2.5 (0.4)		4.2 (0.5)		-1.7 [-3.7; -0.3][A]
Week 8	2.4 (0.5)	-0.1 [-3.4; 1.4]	3.5 (0.5)	-0.7 [-0.9; 2]	-1.06 [-3.2; -1.]
Follow-up	2.4 (0.5)	-0.1 [-3.4; 1.4]	3.9 (0.6)	-0.3 [-1; 1.7]	-1.4 [-3.7; 0.9]
TUG (s)					
Baseline	11.2 (0.8)		14.7 (2.5)		-3.5 [-3.7; 2]
Week 8	11.4 (0.7)	0.2 [10.2; 12.5]	12.4 (0.8)	-2.3 [-3.3; 2]	-0.9 [-4.7; 0.5]
Follow-up	11.6 (0.7)	0.4 [10.2; 12.8]	13.4 (1.1)	-1.3 [-4.3; 1.3]	-2 [-5.9; 1.7]

SD: standard deviation, MD: mean difference (95% confidence interval), AE: Aquatic Exercises Group, EP: Educational Program Group, SF-36: Medical Outcome Study Short Form 36-item Health Survey, YESAVAGE: Yesavage Geriatric Depression Scale, TUG: Timed Up and Go Test, s: seconds, Intention-to-treat analysis; GEE: Generalized Estimating Equation analysis, a, b (lowercase letters): within group differences from baseline, $P< 0.05$, and A (uppercase letter): between groups differences, $P< 0.05$.

For Peer Review

Figure 1. Flow Diagram.



For Peer Review

Appendix 1. Aquatic exercises protocol.

1st and 2nd weeks	- Walking forward, side-to-side, and backward (3 min); - Patellar mobilization (2 min); - Passive stretching of the leg muscles: quadriceps, gluteus, adductors, and abductors of the hip, triceps surae, and hamstrings (5 min); - Isometric and dynamic exercises for quadriceps, gluteus, adductors, and abductors of the hip, triceps surae, and hamstrings (5 min); - Balance exercises: step-up, side, and down (5 min); - Proprioceptive exercises with water board (5 min); - Extension exercises with board in supine position (5 min); - Aerobic exercise with stationary running (20 min); - Massage on knee joints (5 min).
3rd and 4th weeks	- Walking forward, side-to-side, and backward with elastic band (3 min); - Patellar mobilization (2 min); - Active stretching of the leg muscles: quadriceps, gluteus, adductors, and abductors of the hip, triceps surae, and hamstrings (5 min); - Isometric and dynamic exercises with elastic band for quadriceps, gluteus, adductors, and abductors of the hip, triceps surae, and hamstrings (5 min); - Balance exercises: step-up, side, and down with elastic band (5 min); - Proprioceptive exercises with water board with eyes closed (5 min); - Extension exercises with board in prone position – swimming leg (5 min); - Aerobic exercise with aquatic bike (20 min); - Relaxation in supine position (5 min).
5th to 8th weeks	- Walking forward, side-to-side, and backward with elastic band (3 min); - Patellar mobilization (2 min); - Active stretching of the leg muscles: quadriceps, gluteus, adductors, and abductors of the hip, triceps surae, and hamstrings (5 min); - Isometric and dynamic exercises with elastic band for quadriceps, gluteus, adductors, and abductors of the hip, triceps surae, and hamstrings (5 min); - Balance exercises with step: kicks and squats (5 min); - Proprioceptive exercises with spaghetti (5 min); - Extension exercises with board in supine and prone position (5 min); - Aerobic exercise with deep-water running (20 min); - Massage on quadriceps and triceps surae (5min).

For Peer Review

Acknowledgements: The authors thank the employees of the Primary Health Care Unit "Vila Brasil" and the assistant pool manager of the Aquatic Physiotherapy Centre "Paulo A. Seibert", Mr. Anselmo Borges, for their careful and valuable help during the study.

Funding: This study was supported by the Araucaria Research Foundation PPSUS/SESA-PR/MS-Decit/CNPq (# 04/2013) and CNPq (National Council for Scientific and Technological Development) grants.

Contributors:

Ligia Facci and Jefferson Cardoso were responsible for conducting the RCT, mentoring the students, and managing the grants. Celita Trelha, Fernanda Melo, and Daniela Silva supervised the Education Program group at the Primary Health Care Unit. Marcelo Taglietti, Geovane Sawczuk, Thamires Ruivo, and Thaisley Souza conducted the physical examination, assessed the outcome measures, and carried out the exercises at the Aquatic Physiotherapy Centre "Paulo A. Seibert". Chiarella Sforza mentored the PhD student Marcelo Taglietti at the Università degli Studi di Milano and, along with Jefferson Cardoso, was responsible for the statistical analysis.

For Peer Review