Clinical Trial

Improved function and strength in patients with knee osteoarthritis as a result of adding a two-day educational program to usual care. Prospective randomized trial

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ABSTRACT

Objective: The primary aim was to quantify the improvements on function and pain of patients with knee osteoarthritis (KOA), short education and low income by a two-day self-management program. Secondary aims were verifying if the program improves clinically relevant measures of weight and strength.

Design: A prospective randomized clinical trial was conducted in a tertiary hospital in Brazil with 191 patients with Kellgren & Lawrence grades II and III KOA who were allocated to two groups: control (usual care - CG) and intervention (usual care and two days of an OA self-management program with a multiprofessional team - IG).

Western Ontario and McMaster Universities Index (WOMAC), weight, body mass index (BMI), Timed up and go (TUG) and five Times Sit to Stand Test (FTSST) were assessed at baseline, six, 12 and 24 months.

Results: Groups were similar at baseline (p > 0.05). Both groups exhibited improved WOMAC total and subsets scores throughout the study (p < 0.001). However, only IG improved WOMAC total and subsets in all follow-ups above 20% (minimally clinically important difference), with differences in WOMAC pain, function and total scores (p = 0.001, p < 0.001, and p < 0.001, respectively) and best effect sizes at 1 year (0.355, 0.651 and 0.770, respectively). IG group lost weight (p < 0.001) and BMI (p < 0.01). Both groups exhibited improvements in TUG and FTSST (p < 0.001) that remained in all evaluations. FTSST results favored the IG, p = 0.032.

Conclusions: An educational program to patients with KOA, short schooling and low income improves clinically important measures of pain and function.

1. Introduction

Osteoarthritis (OA) is recognized as a mechanical [1–6], inflammatory [1–6], inflammatory [1–6] and metabolic [7–9] disease. OA is the leading skeletal cause of the number of years that individuals have lived with a disability [10, 11], mainly because it is genetic [12] and related to longevity and obesity [13], both of which are exhibiting worldwide increases [14,15]. Unfortunately, sociodemographic factors, such as low levels of education and low income, are directly related to the risk of OA hospitalization [16].

Latin America (particularly Brazil) is considered a low-income country with both a high population and low levels of education, which places the country at high risks for OA and hospitalization. Currently, Brazil has a population of 210,147,125 and a life expectancy of 76.5 years (men: 73 years; women: 80 years). Men over 40 years of age represent 18% of the population, whereas women over 40 years of age represent 20.65% of the population [17]. In 2018, the income per capita

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was 360.00 USD \cite{18}; in 2016, 51\% of the adult population (66.3 million people) had completed first eight years of education \cite{19}. Both overweight and obese are prevailing conditions among Brazilians. In 2015, 56.9\% of the population was overweight, and 20.8\% of the population was obese \cite{20}.

Physical activity is not a regular habit among Brazilians and is related to the level of education (9\% of people without education practiced some type of physical activity, in comparison to 35.1\% of people with higher education levels). In 2015, 18.4\% of the population between 40 and 59 years practiced some type of physical activity (39.3\% in soccer activities and 24.6\% in walking activities), as did 13.4\% of the Brazilians over 60 years of age \cite{21}.

Education, exercise, diet (if overweight) and the self-management of OA are considered by most guidelines to be some of the core treatment modalities for knee OA (KOA) \cite{22–27}. Despite a relatively small effect size of education, it can influence disease knowledge and self-efficacy when paired with other treatments \cite{26,27}.

In the scenario presented in Brazil (as well as in Asia, Africa and Latin America) involving an aging population with low socioeconomic levels as well as with a poor diet and lifestyle \cite{20,21,28,29}, interventions that are directed at educating patients on OA and its causes, risks and management seem to be necessary because of the lack of common knowledge concerning these factors. A pilot program was performed with 200 patients, and few differences were observed among the interventions \cite{30,31}. Based on this pilot study, we developed this prospective randomized study of a multiprofessional educational program for patients with KOA who had low education levels and income.

The aim of this study was to investigate the effectiveness of a two-day OA educational program in addition to usual care, on physical function and pain in people with KOA in Brazil. Our program targets people with low levels of education and low-income attending care in a public hospital.

2. Patients and methods

2.1. Setting

This study was performed at the Department of Orthopedics and Traumatology–Osteometabolic Group–Hospital das Clínicas–University of São Paulo–Outpatients Clinic.

Ethics Committee for Analysis Certificate - CAAE 37436114.6.0000.0068.

Clinical Trials registration number: NCT 02335034.

2.2. Design

This study was a single-blind, single center, prospective randomized controlled clinical trial that was conducted in a tertiary orthopedic center.

This study followed the guidelines of the CONSORT statements for randomized controlled trials and nondrug treatments \cite{32}.

2.3. Participants

Volunteers were in a waiting list for knee OA clinical treatment. Participants were either patients from the knee group of the institution with OA but without indication for surgery or patients referred by employees of the hospital and by patients of the pilot program \cite{33}.

Patients who met the following criteria were eligible for inclusion in the study: outpatients aged 40 years or older with KOA (according to the American College of Rheumatology clinical and radiological definitions with Kellgren & Lawrence [K&L] stages 1–3) with no rheumatologic diseases (other than OA), with indications for clinical treatments for OA, without any neurological problems or instability that would prevent them from exercising and with the ability to understand and provide informed consent, i.e., if they were not able to read, a family member read to them and they signed. The exclusion criteria included participating in another program with nutritional guidance.

2.4. Randomization

Two hundred and twenty-two sealed, opaque and nontranslucent envelopes containing a card indicating CG or IG were mixed in an urn. After signing the informed consent, the patient chose a card from the urn and opened it in front of an assistant of the project. A second assistant unrelated to the research was responsible for informing and directing patients to the subsequent routine.

2.5. Intervention

Among the care providers were orthopedic surgeons, one nutritionist, psychologists, social workers, physical and occupational therapists and physical educators.

The participants in the intervention group (IG) participated in two days of a structured educational and exercise-based self-management program that were held two months apart. The participants received written and video (DVD) educational material on the first intervention day, with the material describing what was taught in the interventions and including directions for all of the community centers and primary and secondary care centers of the city of São Paulo, where the participants could continue the program near their house (in case they did not want to exercise alone at home). These directions were compiled by the social workers.

This study followed a similar protocol as that described in our pilot study that was based on in programs described in the literature \cite{30,31,33}; however, this study had an increased emphasis on physical fitness \cite{34}. The interventions were conducted over 2 separate days of classes.

The first day of lecture was conducted from 8:00 a.m. to 5:00 p.m. Each of the lectures lasted approximately 40 min to an hour and were provided by a total of seven different teams.

The orthopedic surgeons explained the anatomy, joints, the OA disease, the risk factors and the treatment modalities to the participants.

The psychologists discussed personality characteristics that exist from childhood to adulthood as well as the difference between having a disease and being sick, the importance of their choices (and not their conditions or feelings) and coping skills.

The nutritionist emphasized the importance of a well-balanced diet (reduced quantity of food as well as the importance of colorful whole grains and low-calorie meals). During the intervention, patients were given a break every 3 h and were provided with meals that followed the instructions that were given by the nutritionist; thus, the patients personally experienced a day’s worth of the options of the proposed diet.

The physical therapists re-enforced the importance of the previously mentioned nutritional options as well as the importance of hydration. Additionally, they introduced the benefits of regularly performing physical exercises (at least three times a week as part of a group [if possible] and with comfortable clothing), types of exercises (stretching, isometric and isotonic strengthening), adequate posture when performing exercises and the importance of controlled load (with respect to personal limitations). The therapists clarified to the patients that the benefits of the exercises are in the prevention and control of preexisting diseases. They also explained the difference between physical activity and physical exercise.

The occupational therapists introduced the importance of protecting the joints during daily activities by optimizing ergonomics and by alternating among different levels of energy expenditure.

The physical education professionals (similarly to the physical therapists) also lectured about the health-related benefits of physical exercise and its role in KOA management as well as on the differences between physical activity and exercise and the importance and methods of how to improve physical fitness.

After these lectures, the patients participated in the following 3
workshops that lasted 50 min each:

(1) Physical therapy with stretching, isometric exercises and isotonic exercises (half of the exercises were performed with a chair, either in a seated position or by standing and leaning on the chair, and half of the sessions were performed by lying down on a stretcher). Instructions on how to use weights to progressively increase weight loads at home were discussed and written in a booklet that was given to all of the patients. Physical therapists instructed patients in performing the exercises at least three times a week.

(2) The physical fitness workshop [34] focused on how to perform exercise (resistance and aerobic types) at home by using low-cost alternative tools as well as how to exercise at the appropriate exercise intensity. Patients were instructed to perform 30–60 min/day (in sessions of at least 10 min) of moderate-intensity aerobic exercise (11–15 in the 6–20 rating of perceived exertion scale, or RPE) [35] for 5 days a week. Alternately, when considering the moderate-intensity aerobic exercise recommendation and if physical capacity and disease severity permitted, the participants were instructed to perform 20–30 min/day (in sessions of at least 10 min) of vigorous-intensity aerobic exercise (14–16 at the 6–20 RPE) [35] for 3 days a week. Patients were instructed to perform the type of aerobic exercise that they preferred (for example, walking, stationary cycling, dancing and swimming, among other types). However, if weight-bearing aerobic exercise was not tolerated (for example, due to knee pain that would become increased during or after the exercise), they were instructed to perform stationary cycling or aquatic exercise. In addition to aerobic exercise recommendations, the volunteers were instructed to perform 2–3 sets of 8–12 repetitions (1–2 min of rest intervals between sets) of 10 resistance exercises (bench press, squat, seated row, knee extension, shoulder press, knee curl, triceps pushdown, calf raise, biceps curl and abdominal exercises) for 3 times a week (on nonconsecutive days). The patients were taught that they could perform the resistance exercises by using weight-lifting machines, weight bearing, dumbbells or some adapted materials that were described in the classes (using ankle weights, bars, elastic bands and bottles filled with water or sand) at an intensity between 14 and 17 at the 6–20 RPE scale [35], while simultaneously avoiding the Valsalva maneuver.

(3) The occupational therapy team instructed the patients in a simulated safe house, where they were shown how to protect their joints in daily living activities, such as activities involving organizing, cleaning, squatting, raising items, sitting, sleeping, labor work, ironing clothes, activities in the kitchen and activities in the bathroom.

After a break in the afternoon, patients would attend a final short lecture with the social workers that emphasized the need to perform habits including regular leisure, sports, social gathering and volunteering.

Each team emphasized the importance of the participants in changing their habits.

At the end of the first intervention day, the patients received the educational material with instructions to read or watch the material at least three times. All of the information that was provided to the patients was able to be accessed in the program’s book [36].

Two months later, a second day of interventions was conducted from 8:00–16:00 hs.

The social workers asked if the patients had included new habits and what the new habits were, while also providing options of habits to discuss.

The nutritionist reviewed the slides of her lecture in the first intervention and asked the patients what they remembered and what questions they had about their diets.

The patients then participated in the following 4 workshops:

The physical therapy and physical fitness workshops were very similar to the first intervention, with these workshops solely attempting to increase the weight loads and correct techniques.

The occupational therapy workshop focused on distributing the light and heavy activities of daily living during the day and week, with a specific focus on joint protection and on conserving energy.

The psychology workshop focused on psychological educational and therapeutic group sessions with the patients, with a focus on what the patients had done since the time of the first intervention, in respect to their arthritis [37,38].

The orthopedic team finalized the steps of this intervention by asking questions about the disease and self-management. The final discussion focused on exercising and dieting, according to the program.

2.6. Usual care/Aftercare/follow-up routine

Patients of both groups were seen by the orthopedic surgeons at inclusion, six, 12 and 24 months. The six-month evaluation occurred six months after the inclusion and 3–4 months after the second day of the intervention, whereas the one-year and two-year evaluations were conducted 11 months and 23 months, respectively, after the second intervention. At inclusion patients were already receiving diacerhein and/or analgesics such as paracetamol, codeine and/or dipyrone that were prescribed by the physicians when patients were first seen (either in the knee group or in the osteometabolic group) and sent to the waiting list for OA clinical treatment. At each visit since the inclusion, the medical team explained the disease and its forms of treatment based on international guidelines [22–27] and prescribed whatever services they considered appropriate including the need to diet and exercise, orthotics, and medications to each patient [22–27,39].

2.7. Outcome measures

The primary aim of this study was to evaluate the improvement in physical function of the patients at two years. Secondarily was to evaluate improvements in function in six and 12 months, pain at six, 12 and 24 months. At each follow-up evaluation verify if improvement reaches minimum clinically important differences (MCID), minimum important changes (MIC) and/or minimum detectable change (MDC). Secondary objectives also included to verify if the program leads to clinically relevant improvements in weight, body mass index (BMI), waist/hip ratio (WHR), and objectives measures of strength such as timed up and go (TUG) and five times sit to stand test (FTSST) at six, 12 and 24 months.

At the time of enrollment and at 6, 12 and 24 months (on the same day of the medical consultation in the hospital), the patients were asked to complete the WOMAC questionnaire [40]. The nutrition team measured weight, height, abdominal circumference, hip circumference and seven skin folds to calculate the body mass index (BMI), the waist hip ratio (WHR), and the percentage of body fat (PBF) [41,42]. Patients performed TUG [43] and FTSST [44] with the physical therapy team. VAS and SF-36, DASH (The Disabilities of the Arm, Shoulder and Hand Score) and HAQ (The Health Assessment Questionnaire) were obtained in all time points, but the data were not yet evaluated. PBF results were not shown due to similar measures (BMI, WHR).

To evaluate if improvements in WOMAC total and subsets were clinically important we created a table of the average results of WOMAC total and subset at every follow-up performed in the Brazilian version (0–96) and as a percentage in a reverse format consisting of a range from 0 (worst) to 100 (best) in order to compare our results to those described as significant improvements in rehabilitation trial [45,46], and in total knee arthroplasty (TKA) [47].

2.8. Sample size

The “n” was calculated to obtain a statistical power of 80% and a significance level of 5%. For these calculations, we considered the mean
and standard deviation of the WOMAC questionnaire (our primary outcome) from one of the pilot studies (WOMAC of 48.8 and standard deviation of 15.8) [33]. We sought a sample size that would allow the detection of a 20% variation in the questionnaire. When considering a possible dropout rate of approximately 20%, the result of 76 patients per group was obtained.

2.9. Blinding

When signing the informed consent forms, the patients knew that they would either be selected for a group that would receive the standard care for OA or for a group in which they would also be offered lectures about the disease. The evaluators were blind to the groups that the patients belonged to. Two main assistants scheduled appointments and classes, retrieved material and plotted the questionnaires’ results in Excel sheets.

2.10. Statistical analysis

Patients missing the first or both interventions, missing two follow-up visits, undergoing surgery related or not to OA during the study that would prevent daily regular exercises or that would improve pain and functional performance were not analyzed.

The quantitative personal and clinical characteristics are described (according to the groups) with descriptive statistics (means, standard deviations, medians, minimums and maximums) and were compared between groups by using Mann-Whitney or Student’s t-tests. Qualitative characteristics (race) are described according to groups, and the association was verified with the use of the chi-square test or exact tests. As the comparison involves two factors (group and time), first the interaction between the two factors was evaluated, to know if the behavior of one factor does not differ when the category changes in the other factor (interaction), if this occurred the comparison was carried out in detail, i.e., each group was compared between the moments (p group) and the groups were compared at each moment (p moment). When the interaction did not occur, i.e., groups behaved similarly between the moments, groups were compared without taking into account the moment (p group) and moments were compared without considering the groups (p moment).

WOMAC domains are described according to groups and evaluation times by using summary measures and were compared according to groups and times by using generalized estimation equations with a Poisson marginal distribution and the identity link function. The other evaluated parameters were assumed to have a normal distribution with an identity link function, and a first-order autoregressive correlation matrix was used between the moments of the evaluation for all of the

![Fig. 1. CONSORT 2010 flow diagram.](image-url)
analyses. The analyses were followed by the use of Bonferroni’s multiple comparisons to verify where the differences between the groups and the evaluation times occurred, when the results were observed to be significant. The analyses were performed by using IBM-SPSS for Windows version 20.0 and were tabulated by using Microsoft-Excel 2010; the tests were performed with a significance level of 5%.

3. Results

The flowchart of the study is presented in Fig. 1. Three hundred thirty-one patients were assessed for study eligibility in January 2015. Two hundred twenty-one patients met the inclusion criteria and were allocated into two groups. In the IG, 15 participants missed the first and/or both interventions, and one patient died. In the CG, six patients declined to continue participation at 6 months, and nine patients declined to continue participation at the one-year follow-up. At the 24-month follow-up, there were 96 patients in the control group and 95 patients in the intervention group.

Table 1 shows the personal and clinical characteristics according to group. The groups were similar in all aspects.

3.1. WOMAC

Table 1 shows the difference in average behavior of the groups in WOMAC pain, function and total scores (p < 0.05 in all evaluations between groups in all moments). The IG improvements in WOMAC pain, function and total scores were better than those of the CG in all follow-ups. At six and 12 months, WOMAC pain was better in the IG (p = 0.029, ES 0.238, average difference 1.41, 95% CI 0.07, 2.76 and p < 0.001 ES 0.355, average difference 2.09 95% CI 0.75, 3.42, respectively, Table 3). WOMAC function and total scores of the IG, despite better than those of the CG in all follow-up evaluations (p < 0.001), lost some of the gains obtained in the first 12 months at 24 months, with moderate effect sizes at 12 months follow-ups (p < 0.001, ES 0.651, mean difference 19.5 95% CI 10.1, 28.9, Table 3). Both groups improved WOMAC stiffness with better results at all follow-ups in the IG (p = 0.001, ES = 0.241, mean difference 7.27, 95% CI 4.73, 9.81, and 0.770, mean difference 10.15 95% CI 7.16, 13.15, respectively, Table 3). Both groups improved WOMAC stiffness with better results at all follow-ups in the IG (p = 0.001, ES = 0.241, mean difference 7.27, 95% CI 4.73, 9.81, and 0.770, mean difference 10.15 95% CI 7.16, 13.15, respectively, Table 3). Both groups improved WOMAC stiffness with better results at all follow-ups in the IG (p = 0.001, ES = 0.241, mean difference 7.27, 95% CI 4.73, 9.81, and 0.770, mean difference 10.15 95% CI 7.16, 13.15, respectively, Table 3). Both groups improved WOMAC stiffness with better results at all follow-ups in the IG (p = 0.001, ES = 0.241, mean difference 7.27, 95% CI 4.73, 9.81, and 0.770, mean difference 10.15 95% CI 7.16, 13.15, respectively, Table 3).

3.2. Weight, BMI and HWR

Whereas the CG maintained the same weight during the study, the IG exhibited a nonsignificantly reduced weight (p = 0.132, Table 5), with the differences not reaching a minimally important difference. At 6, 12 and 24 months, the CG and the IG had 2, 7 and 7 patients and 4, 7 and 13 patients, respectively, who lost 5 kg of their weight or more. The WHR exhibited minor changes during the study (Table 5).

3.3. TUG/FTSST

Table 5 shows that both groups exhibited improved TUG and FTSST results in all of the follow-up evaluations. The FTSST results were better in the IG in all of the evaluations since the sixth-month follow-up (p = 0.032, ES = 0.156, mean difference 2.89, 95% CI 0.25, 5.53).

| Variables          | Group               | Control (N = 96) | Intervention (N = 95) |
|--------------------|---------------------|-----------------|-----------------------|
| Age (years)        | mean ± SD           | 63.2 ± 8.7      | 63.8 ± 9.5            |
|                    | median (min.; max.) | 63.5 (43; 83)   | 63 (42; 86)           |
| Years of schooling | mean ± SD           | 5.8 ± 4.6       | 5.9 ± 4.7             |
|                    | median (min.; max.) | 4 (0; 15)       | 4 (0; 16)             |
| Physical Activity  | mean ± SD           | 2.8 ± 1.3       | 3.3 ± 1               |
| (IPAQ)             | median (min.; max.) | 2 (1; 5)        | 3 (1; 5)              |
| Gender n (%)       | Male                | 20 (20.8)       | 16 (16.8)             |
|                    | Female              | 76 (79.2)       | 79 (83.2)             |
| Race n (%)         | White               | 55 (57.3)       | 60 (63.2)             |
|                    | Black               | 16 (16.7)       | 15 (15.8)             |
|                    | Mulatto/Mestizo     | 20 (20.8)       | 16 (16.8)             |
|                    | Asian               | 5 (5.2)         | 4 (4.2)               |
| K&L right n (%)    | 1                   | 6 (6.3)         | 5 (5.3)               |
|                    | 2                   | 54 (56.3)       | 40 (42.6)             |
|                    | 3                   | 36 (37.3)       | 49 (52.1)             |
| K&L left n (%)     | 1                   | 4 (4.2)         | 7 (7.4)               |
|                    | 2                   | 59 (61.5)       | 44 (46.8)             |
|                    | 3                   | 33 (34.4)       | 43 (45.7)             |
| WOMAC Pain         | mean ± SD           | 10.7 ± 4.1      | 10.3 ± 3.9            |
|                    | median (min.; max.) | 11 (1; 20)      | 10 (1; 20)            |
| WOMAC Stiffness    | mean ± SD           | 4.4 ± 2         | 4.1 ± 2               |
|                    | median (min.; max.) | 5 (0; 8)        | 4 (0; 6)              |
| WOMAC Function     | mean ± SD           | 38.2 ± 14.3     | 37.3 ± 13.8           |
|                    | median (min.; max.) | 41 (0; 68)      | 40 (1; 68)            |
| WOMAC Total        | mean ± SD           | 53.4 ± 19.1     | 51 ± 18.2             |
|                    | median (min.; max.) | 55.5 (4; 96)    | 53 (2; 96)            |
| Weight (Kg)        | mean ± SD           | 80.8 ± 16.1     | 77.9 ± 16.9           |
|                    | median (min.; max.) | 79.4 (50; 119.9)| 75.6 (51.7; 141)     |
| Body Mass Index    | mean ± SD           | 32.6 ± 11       | 31 ± 5.9              |
|                    | median (min.; max.) | 32.5 (19.5; 50)| 30 (21.1; 51.9)      |
| Waist/Hip Ratio    | mean ± SD           | 1 ± 0.1         | 0.99 ± 0.11           |
|                    | median (min.; max.) | 1 (0.74; 1.2)  | 0.99 (0.73; 1.27)     |
| Percentage of Body Fat | mean ± SD     | 39.4 ± 9        | 39 ± 7.7              |
|                    | median (min.; max.) | 42.7 (11.2; 51)| 39.5 (15.1; 66.1)    |
| Time Up and Go Test| mean ± SD           | 13.6 ± 5.9      | 15.6 ± 8.2            |
|                    | median (min.; max.) | 12.2 (5.8; 40.2)| 13.6 (6; 47.6)       |
| Five Time Sit to Stand Test | mean ± SD | 28.6 ± 15.5 | 26.3 ± 11.6 |
|                    | median (min.; max.) | 24.5 (10.7; 117.8)| 22.7 (11.1; 59.7)    |

T-Student Test; ** Mann-Whitney Test; * Chi-square Test; # likelihood ratio Test. IPAQ – International Physical Activity Questionnaire.

3.4. Adverse events

There were no unexpected events to the general health of the patients except for improvement or not of the symptoms related to osteoarthritis.

4. Discussion

Primary care in Brazil has not standardized nonoperative treatments for OA, although this is not an exclusive issue of developing countries. In Sweden, more than 50% of patients with hip or knee OA are referred to surgery without receiving core treatment [48]. There are several guidelines for the treatment of OA, especially OA of the knee [25,49–51], that
It has been suggested by most of the recent guidelines that a primary care physician. Because OA is a component of metabolic syndrome [49,50,56]. In 2012, a 6-week arthritis self-management treatment. Low-grade inflammation plays an important role [52,53] in the perpetuation of the symptoms affecting many aspects of quality of life, not only joint pain. The determination of the subtlety of whether pain is increased by low level inflammation or hip OA revealed that patients with knee and hip OA experienced significant reductions in symptoms and a decreased willingness to undergo surgery, while simultaneously using less OA medication and taking less sick leave [48,59]. The results indicated that the offering of that program as the first-line treatment for OA patients may reduce the burden of this disease. These studies were not performed in low- or middle-income countries [27,39,57,60–63]. In Brazil, as well as in other low- or middle-income countries, the population is aging, is gaining weight, possesses low education levels, possesses low income levels and does not exhibit exercise habits [17,20,21,28].

We decided to start a program in tertiary care that was led by orthopedic surgeons who are familiar with articular pain and who had acquired some experience with the clinical aspects of the disease. The remainder of the care team (social workers, a nutritionist, occupational therapists, physical therapists, psychologists and physical educators) had previous experiences with a multiprofessional educational program for osteoporosis that was led by professionals of the same institution [64].

The educational program was previously structured based on pilot studies [30,33,65,66]. We studied the effect of the two days of intervention at 6, 12 and 24 months after the initiation of the study in comparison to the effect of standard OA care by orthopedic surgeons. In this particular study, grade 4 K&L patients were excluded because of the diversity of the clinical presentations, especially in regard to instability (a factor that affects function), that can be observed among these patients. Among the limitations of our study were the difficulties that our patients exhibited in answering questionnaires, which constituted the main reason for choosing WOMAC [67] and objective measures such as TUG and FTSST. This study consisted of a single center study with a specific team of surgeons who were willing to emphasize the importance of changing habits as well as the methods for changing these habits. Our care providers were orthopedic knee and sports medicine surgeons who were free to prescribe medications and therapies that they found appropriate [39], as in accordance with current guidelines [22,24,68]. However, the actual consuming of medications by patients (both for pain and for comorbidities) was not controlled. There was also no control for the actual type, intensity and frequency of physical activity and a consequent lack of correlation between exercise and improvement [69]. Food intake was also not controlled. Additionally, the control of comorbidities was not assessed; however, from our data, only 8 patients in the IG and 12 patients in the CG were not overweight or obese. Of these patients, one patient in each group had only one painful knee. All of the other nonoverweight participants had both knees involved. In this respect, we believe that the groups were similar and that the majority of the patients had, at least, one comorbidity. Another limitation of our study was lack of control of self-efficacy or disease knowledge. The patients in both groups exhibited improved stiffness in all time points, with the best results observed in the IG. The IG exhibited improved pain at all of the time points, in respect to the baseline time point (p < 0.01). In general, the IG improved at six months, maintaining

### Table 2

Description of the WOMAC domains and the total score according to group and moment of evaluation and result of comparative tests.

| Variable/Group | Moment | P Group | P Moment | P Interaction |
|----------------|--------|---------|----------|---------------|
|                | Baseline | 6 months | 12 months | 24 months |
| WOMAC Pain     |         |         |          |             |
| Control        | mean ± SD | 10.7 ± 4.1 | 9.5 ± 4.1 | 9.8 ± 4.5 | 9.4 ± 4.5 | <0.001 | <0.001 | 0.001 |
| Intervention   | mean ± SD | 10.3 ± 3.9 | 8 ± 3.9 | 7.7 ± 3.9 | 8.1 ± 3.9 | <0.001 | <0.001 | 0.001 |
| WOMAC Stiffness| mean ± SD | 4.4 ± 2 | 4.1 ± 1.9 | 4.2 ± 2 | 3.9 ± 2 | <0.001 | <0.001 | <0.001 |
| WOMAC Function | mean ± SD | 38.2 ± 14.3 | 34.1 ± 14.1 | 35.1 ± 14.5 | 33.6 ± 14.2 | <0.001 | <0.001 | <0.001 |
| Control        | mean ± SD | 37.3 ± 13.8 | 29.5 ± 15.2 | 27.8 ± 13.4 | 30 ± 13.8 | <0.001 | <0.001 | <0.001 |
| Intervention   | mean ± SD | 53.4 ± 19.1 | 47 ± 19 | 49 ± 20.3 | 47 ± 19.7 | <0.001 | <0.001 | <0.001 |

Generalized equations with Poisson distribution and identity function. P group = Differences between groups in each moment. P moment = Differences between moments in each group. P interaction = differences in curves of the two groups during the study period.

offer a variety of evidence and effect sizes of the several modalities of treatment. Low-grade inflammation plays an important role [52,53] in the perpetuation of the symptoms affecting many aspects of quality of life, not only joint pain. The determination of the subtlety of whether pain is myofascial, perimeniscal, synovial or from the bone (as well as whether pain is increased by low level inflammation) may not be easy for a primary care physician. Because OA is a component of metabolic syndrome [55], it has been suggested by most of the recent guidelines that patients must change their lifestyle, including changing their diet and exercise habits [49,50,56]. In 2012, a 6-week arthritis self-management program questioned its practicality, due to a lack of enthusiasm from potential referrers and patients [57]. The effect size of education has been thought to vary between –0.10, 95% CI (–0.19 to 0.01) [58] and 0.29 (0.17–0.41) [27] for pain. In Sweden, a national structured educational program was previously structured based on pilot studies [30,33,65,66]. We studied the effect of the two days of intervention at 6, 12 and 24 months after the initiation of the study in comparison to the effect of standard OA care by orthopedic surgeons. In this particular study, grade 4 K&L patients were excluded because of the diversity of the clinical presentations, especially in regard to instability (a factor that affects function), that can be observed among these patients. Among the limitations of our study were the difficulties that our patients exhibited in answering questionnaires, which constituted the main reason for choosing WOMAC [67] and objective measures such as TUG and FTSST. This study consisted of a single center study with a specific team of surgeons who were willing to emphasize the importance of changing habits as well as the methods for changing these habits. Our care providers were orthopedic knee and sports medicine surgeons who were free to prescribe medications and therapies that they found appropriate [39], as in accordance with current guidelines [22,24,68]. However, the actual consuming of medications by patients (both for pain and for comorbidities) was not controlled. There was also no control for the actual type, intensity and frequency of physical activity and a consequent lack of correlation between exercise and improvement [69]. Food intake was also not controlled. Additionally, the control of comorbidities was not assessed; however, from our data, only 8 patients in the IG and 12 patients in the CG were not overweight or obese. Of these patients, one patient in each group had only one painful knee. All of the other nonoverweight participants had both knees involved. In this respect, we believe that the groups were similar and that the majority of the patients had, at least, one comorbidity. Another limitation of our study was lack of control of self-efficacy or disease knowledge. The patients in both groups exhibited improved stiffness in all time points, with the best results observed in the IG. The IG exhibited improved pain at all of the time points, in respect to the baseline time point (p < 0.01). In general, the IG improved at six months, maintaining
WOMAC Pain

| Variable | Group/Moment | Comparison | Mean difference | Standard error | p | Effect size |
|----------|--------------|------------|----------------|---------------|---|-------------|
| WOMAC Pain | Control | Baseline-6 months | 1.2 | 0.28 | <0.001 | 0.33 | 2.07 |
| | | Baseline-12 months | 0.89 | 0.36 | 0.356 | -0.22 | 2.00 |
| | | Baseline-24 months | 1.28 | 0.41 | 0.047 | 0.01 | 2.56 |
| | | 6 months-12 months | -0.32 | 0.27 | >0.999 | -1.17 | 0.54 |
| | | 6 months-24 months | 0.98 | 0.36 | >0.999 | -1.05 | 1.21 |
| | | 12 months-24 months | 0.40 | 0.29 | >0.999 | -0.51 | 1.31 |
| | Intervention | Baseline-6 months | 2.24 | 0.27 | >0.999 | 1.41 | 3.09 |
| | | Baseline-12 months | 2.60 | 0.34 | >0.999 | 1.55 | 3.65 |
| | | Baseline-24 months | 1.98 | 0.39 | >0.999 | 0.77 | 3.19 |
| | | 6 months-12 months | 0.36 | 0.25 | >0.999 | -0.41 | 1.13 |
| | | 6 months-24 months | -0.26 | 0.33 | >0.999 | -1.29 | 0.77 |
| | | 12 months-24 months | -0.62 | 0.26 | >0.999 | -1.43 | 0.19 |
| | | Baseline | Control-Intervention | 0.37 | 0.47 | >0.999 | -1.09 | 1.83 |
| | | 6 months | Control-Intervention | 1.41 | 0.43 | >0.999 | 0.238 | 0.07 |
| | | 12 months | Control-Intervention | 2.09 | 0.43 | >0.999 | 0.355 | 0.75 |
| | | 24 months | Control-Intervention | 1.07 | 0.45 | >0.999 | 0.173 | -0.34 |
| WOMAC Stiffness | Control | Baseline-6 months | 0.65 | 0.20 | 0.001 | 0.241 | 1.27 |
| | | Baseline-12 months | 0.57 | 0.16 | >0.999 | 0.16 | 0.98 |
| | | Baseline-24 months | 0.61 | 0.20 | 0.016 | 0.04 | 1.10 |
| | | 6 months-12 months | -0.04 | 0.15 | >0.999 | -0.44 | 0.36 |
| | | 6 months-24 months | 0.03 | 0.19 | 0.199 | 0.46 | 0.52 |
| | | 12 months-24 months | 0.08 | 0.16 | >0.999 | -0.34 | 0.49 |
| WOMAC Function | Control | Baseline-6 months | 6.34 | 0.50 | >0.999 | 2.77 | 5.91 |
| | | Baseline-12 months | 3.08 | 0.65 | >0.999 | 1.06 | 5.11 |
| | | Baseline-24 months | 4.26 | 0.75 | >0.999 | 1.91 | 6.60 |
| | | 6 months-12 months | -1.26 | 0.49 | 0.295 | -2.80 | 0.28 |
| | | 6 months-24 months | -0.09 | 0.66 | >0.999 | -2.14 | 1.97 |
| | | 12 months-24 months | 1.17 | 0.53 | 0.743 | -0.48 | 2.82 |
| | Intervention | Baseline-6 months | 7.62 | 0.49 | >0.999 | 6.09 | 9.14 |
| | | Baseline-12 months | 9.51 | 0.62 | >0.999 | 7.58 | 11.43 |
| | | Baseline-24 months | 7.27 | 0.72 | >0.999 | 5.03 | 9.51 |
| | | 6 months-12 months | 1.89 | 0.45 | >0.999 | 0.48 | 3.30 |
| | | 6 months-24 months | -0.34 | 0.61 | >0.999 | -2.24 | 1.56 |
| | | 12 months-24 months | -2.23 | 0.47 | >0.999 | -3.7 | -0.77 |
| | | Baseline | Control-Intervention | 0.85 | 0.89 | >0.999 | -1.93 | 3.69 |
| | | 6 months | Control-Intervention | 4.12 | 0.82 | >0.999 | 0.365 | 1.55 |
| | | 12 months | Control-Intervention | 7.27 | 0.81 | >0.999 | 0.651 | 4.73 |
| | | 24 months | Control-Intervention | 3.87 | 0.86 | >0.999 | 0.329 | 1.19 |
| WOMAC total | Control | Baseline-6 months | 6.02 | 0.56 | >0.999 | 4.26 | 7.78 |
| | | Baseline-12 months | 4.46 | 0.73 | >0.999 | 2.16 | 6.75 |
| | | Baseline-24 months | 5.97 | 0.86 | >0.999 | 3.29 | 8.65 |
| | | 6 months-12 months | -1.56 | 0.55 | 0.131 | -3.29 | 0.16 |
| | | 6 months-24 months | -0.05 | 0.75 | >0.999 | -2.38 | 2.28 |
| | | 12 months-24 months | 1.52 | 0.59 | 0.297 | -0.34 | 3.37 |
| | Intervention | Baseline-6 months | 10.01 | 0.54 | <0.001 | 6.32 | 11.71 |
| | | Baseline-12 months | 12.23 | 0.69 | <0.001 | 10.07 | 14.39 |
| | | Baseline-24 months | 9.35 | 0.81 | <0.001 | 6.81 | 11.89 |
| | | 6 months-12 months | 2.22 | 0.50 | <0.001 | 0.65 | 3.79 |
| | | 6 months-24 months | -0.66 | 0.68 | >0.999 | -2.80 | 1.48 |
| | | 12 months-24 months | -2.88 | 0.53 | >0.999 | -4.52 | -1.24 |
| | | Baseline | Control-Intervention | 2.37 | 1.05 | 0.647 | -0.89 | 5.64 |
| | | 6 months | Control-Intervention | 6.37 | 0.97 | >0.999 | 0.479 | 3.35 |
| | | 12 months | Control-Intervention | 10.15 | 0.96 | >0.999 | 0.770 | 7.16 |
| | | 24 months | Control-Intervention | 5.76 | 1.01 | >0.999 | 0.416 | 2.62 |

MD CI 95% = 95% confidence interval of the mean difference.

Results of comparisons of WOMAC domains and the total score between groups or moments of evaluation. There was a nonsignificant loss at 24 months (Tables 2 and 3) [39,45]. After the program, the WOMAC pain results were better in the IG than the CG, with small effect sizes of 0.238 and 0.355 at 6 and 12 months between groups (Table 3) [22,27,58,68]. The WOMAC function and the total data followed the sizes of 0.238 and 0.355 at 6 and 12 months between groups (Table 3) [22,27,58,68]. The WOMAC function and the total data followed the improvements, as shown in the WOMAC pain scores, with moderate effect sizes at 12 months (0.651 and 0.707, respectively). During rehabilitation, a clinically meaningful improvement in OA was defined as a reduction of at least 12–15% from a participant’s baseline WOMAC score [39,45]. According to these parameters, since the 6th month, the IG achieved meaningful improvements in the total WOMAC and subset results, with the group maintaining improvements until the time of the final evaluation, as described by Hurley et al. [39], whereas the CG did not demonstrate this effect. When compared to improvements that are provided by TKA [47], at 12 months, 42 of the 95 patients in the IG reached the MIC (a change in the score beyond which an individual is considered to have a clinical change provided by TKA) for the WOMAC total, whereas 21 patients had reached the MIC in the CG at this point. We believe that our significant results were due to the following factors: 1 – the patients were completely ignorant of the disease and self-management; 2 - patients had a team of professionals (physicians, a nutritionist, physical therapists, physical educators, occupational therapists, psychologists and social workers) repeating the same messages to aid with initial compliance [70,71]; and 3 - the program emphasized optimal exercise practices, beginning with physical therapy, but aiming for more intense physical fitness practices [34,69,72].
all of the consequences that are associated with reduced in

to be addressed, not only because of the progression of KOA [74,75] but

whereas seven patients lost 5 kg in the CG. This is an important variable

Thirteen of the 95 patients lost 5 kg or more at 24 months in the IG,

reduce the onset of radiographic knee OA and to improve disability [74,

IG exhibited reduced BMI by nearly one point at 24 months. The IG

Weight reduction, especially reductions in abdominal fat, as well as

inflammation, is

pressure [76]. Changes in WHR (Table 5) exhibited minor changes, with
tendencies of better results being observed in the IG group. Long-term
programs such as IDEA [63] have shown better results.

The objective measurement of lower limb strength is an important
assessment [77–79]. Both groups exhibited improved lower limb muscle
strength, according to the FTSTST and TUG tests (p < 0.001 for both), and
both groups reached the minimal detectable change (MDC) for the TUG
test [77]. The FTSTST results were better in the IG (p = 0.032, ES 0.156,
95% CI: 0.25 5.53). The objective improvement in muscle strength was
observed at 6 months and remained improved in the following evalua-
tions (Table 5), as seen in long-term programs [39,59].

Educational and self-management programs based on models for
appropriate care of the disease [80,81] are needed, especially in low- and middle-income countries [82]. The program presented here was based on guidelines [25,49–51] and models [80,81] of appropriate care; however, it should be improved in order for it to achieve the MIC, not only in strength but also in weight loss, pain, function and quality of life. For that we believe that more interventions with the nutrition, psychology, physical therapy and physical fitness groups are necessary to improve understanding and compliance.

5. Conclusion

An educational program focusing on patients with KOA and short-term schooling exhibited a moderate effect on function. In relation to TEOCORP and EMS, but these payments are not related to this research; RF or benefits from SANOFI-AVENTIS, ABBOTT and APSEN, but these payments are not related to this research. GPO has or may receive payments or benefits from APSEN, MYLAN and EUROFARMA, but these payments are not related to this research.

Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.oocarto.2020.100137.

Authors’ contributions

AFP: conception and design; CACS: conception and design; CHAC: conception and design, final approval of the article; FESF: conception and design; GCC: analysis and interpretation of the data; drafting of the article; critical revision of the article for important intellectual content; final approval of the article; GPO: conception and design; MIH: conception and design; MMM: conception and design; MUR: conception and design; RF: conception and design; TP: conception and design; OFNS: conception and design; OPC: final approval of the article; OPN: conception and design; final approval of the article; OPN: conception and design; OPC: final approval of the article; RF: conception and design; TP: conception and design.

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Ethical review committee statement

Ethics Committee for Analysis Certificate - CAAE 37436114.6.0000.0068.

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