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The Steps to Health Randomized Trial for Arthritis:

A Self-Directed Exercise Versus Nutrition Control Program

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Abstract

Background—Despite the established benefits of exercise for adults with arthritis, participation is low. Safe, evidence-based, self-directed programs, which have the potential for high reach at a low cost, are needed.

Purpose—To test a 12-week, self-directed, multicomponent exercise program for adults with arthritis.

Design—Randomized controlled trial. Data were collected from 2010 to 2012. Data were analyzed in 2013 and 2014.

Setting/participants—Adults with arthritis (N=401, aged 56.3 [10.7] years, 85.8% women, 63.8% white, 35.2% African American, BMI of 33.0 [8.2]) completed measures at a university research center and participated in a self-directed exercise intervention (First Step to Active Health®) or nutrition control program (Steps to Healthy Eating).

Intervention—Intervention participants received a self-directed multicomponent exercise program and returned self-monitoring logs for 12 weeks.

Main outcome measures—Self-reported physical activity, functional performance measures, and disease-specific outcomes (arthritis symptoms and self-efficacy) assessed at baseline, 12 weeks, and 9 months.

Results—Participants in the exercise condition showed greater increases in physical activity than those in the nutrition control group (p=0.01). Significant improvements, irrespective of condition, were seen in lower body strength, functional exercise capacity, lower body flexibility, pain, fatigue, stiffness, and arthritis management self-efficacy (p values <0.0001). More adverse events occurred in the exercise than nutrition control condition, but only one was severe and most were expected with increased physical activity.

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Conclusions—The exercise program improves physical activity, and both programs improve functional and psychosocial outcomes. Potential reasons for improvements in the nutrition control condition are discussed. These interventions have the potential for large-scale dissemination. This study is registered at Clinicaltrials.gov NCT01172327.

Introduction

Arthritis is the leading cause of disability among adults in the U.S.[1] By 2030, an estimated 67 million adults will have doctor-diagnosed arthritis and 25 million are projected to have arthritis-attributable activity limitations; a majority will be women and older than age 65 years.[2] These projected increases represent a significant challenge to healthcare and public health systems.[2]

Multicomponent exercise is recommended for arthritis and can provide therapeutic benefits,[3–5] including reduced pain and improved functional ability.[3] Although professional organizations recommend physical activity as a treatment modality for arthritis,[4] a majority of adults with arthritis do not engage in adequate amounts[6–8] and are less active than those without arthritis.[8,9] In 2010, CDC and the Arthritis Foundation[10] released a public health plan to address osteoarthritis, and physical activity was listed as a priority strategy for improving arthritis-related symptoms and activity limitations.

Multicomponent exercise programs, including those delivered in community settings,[11,12] are safe and effective for individuals with arthritis. The CDC Arthritis Program recommends six evidence-based group physical activity programs for individuals with arthritis, only one of which also has a self-directed format.[13] Regular attendance at classes may not be convenient, feasible, or desirable for many.[10] Indeed, participation in evidence-based group exercise programs among those with arthritis is low.[14] Further, group-based programs require facilities and trained instructors, thereby increasing costs and potentially limiting their availability in communities. Other modes of delivery are needed to overcome these obstacles.[10]

Self-directed exercise programs are one alternative that could appeal to many. If deemed safe and effective, these types of low-cost programs could have a wide reach and significant public health impact. The aims of this study are to examine the effects of a 12-week, self-directed, multicomponent exercise program, to determine whether effects were maintained 6 months after the program ended, and to evaluate program safety. The program, First Step to Active Health®, was designed in response to the National Blueprint: Increasing Physical Activity Among Adults Age 50 and Older.[15] This evidence-based program follows best practices for physical activity programs and behavioral counseling for older adults (i.e., incorporates endurance, strength, balance, and flexibility exercises and principles of behavior change; begins at a low intensity with the recommendation to increase intensity gradually for a better risk–benefit ratio; and emphasizes self-monitoring).[16] It has not been applied, however, to adults with arthritis but is consistent with recommendations for this population. It is hypothesized that the 12-week intervention will result in increased physical activity, improved functional performance, reduced symptoms of arthritis, and perceived self-efficacy to manage arthritis, and that these changes will be maintained.

Methods

Study Design

Participants were randomized to a self-directed multicomponent exercise program (First Step to Active Health) or an attention control self-directed nutrition program (Steps to Healthy Eating). Measures were taken at baseline, 12 weeks, and 9 months between March 2010 and July 2012. Primary outcomes were named a priori based on the funders' request for multiple domains of outcomes, because these outcomes were shown to improve in other exercise intervention studies and data were available to inform power calculations. Because functional performance and disease-specific outcomes were conceptualized to result from increased physical activity due to the intervention, physical activity should be viewed as the main outcome. Owing to the nature of the programs and the association between BMI and quality of life in adults with arthritis,[17–20] changes in weight were also examined. The study was approved by the University of South Carolina IRB.

Participant Recruitment

An a priori power calculation, assuming α=0.05, indicated 80% power to detect small differences (d=0.33) between conditions for physical activity with 300 participants. Target recruitment was set at 400 to plan for 25% attrition. The most common and successful recruitment strategies were e-mails to worksite Listservs and newspaper advertisements. Interested participants contacted the study office and completed a phone screen to assess eligibility status (Table 1).

This study used CDC's validated case definition of arthritis for public health interventions that has been used in Behavioral Risk Factor Surveillance System and the National Health Interview Survey since 1992.[13] This definition includes all community-dwelling adults with self-reported doctor-diagnosed arthritis, including all types of arthritis and rheumatic conditions.[13]

Procedure

Initially eligible participants were scheduled for a baseline measurement session at the university. Prior to this session, participants received an informed consent form and survey by mail. At the session, participants signed the informed consent form, turned in their survey, and completed physical, functional, and anthropometric measurements. A total of 24 baseline sessions (each with six to 30 participants) were conducted from March 27, 2010, to October 15, 2011.

A biostatistician generated a list of randomization assignments (equal numbers for intervention and control) that were placed in sealed opaque envelopes. At the end of the session, each participant selected and opened the next sealed opaque envelope to learn his/her condition assignment. Participants then met with a staff member who verbally delivered a written script that oriented participants to their self-directed program. The scripts were parallel for the two groups. Questions about the study protocol were answered, but participants were directed to review study materials if they asked questions about exercise or nutrition. Questions that could impact safety of the program were directed to the study

primary investigator (physical activity researcher); program manager (registered dietician); or another study investigator (physical therapist) present at the session.

Participants received reminders of their 12-week and 9-month follow-up visits and were sent the same survey in advance of both visits. All physical and functional measures were repeated on site (same location). The measurement staff was blind to randomization assignment at follow-up sessions. At the end of the 9-month visit, participants received all materials for the program to which they had not been exposed. Both programs were offered to all participants, hoping to minimize dropout after randomization. Participants received a small cash incentive for attending each measurement session and for completing self-monitoring logs.

Exercise Condition

This study tested a self-directed format of First Step to Active Health (www.firststeptoactivehealth.com/). The program is consistent with best-practice recommendations for physical activity programs and behavioral counseling for older adults from the American College of Sports Medicine.[16] These recommendations include targeting endurance, strength, balance, and flexibility, along with behavioral self-management strategies including planning, goal setting, and self-monitoring. The individualized, stepped approach is also consistent with promoting increased self-efficacy.[22] These behavioral self-management strategies are common to theories such as Social Cognitive Theory[23] and have been shown to be critical for behavior change.[24,25] Each participant received a First Step to Active Health Kit and a folder containing 12 weekly self-monitoring logs (in duplicate), stamped return envelopes for the logs, a one-page safety sheet that outlined arthritis-specific recommendations, and a study expectations calendar.

Each intervention kit contained a program manual, a rubber resistance band (Thera-Band), and four progressive guides or “steps” with illustrated foldouts demonstrating exercises. The program manual included self-assessment and other tools to help participants set goals, customize their program, enhance motivation, and ensure safety. Each of the four steps emphasizes a different exercise component: Step 1, cardiovascular fitness; Step 2, flexibility; Step 3, upper and lower body strength; and Step 4, balance. Participants were directed to begin with Step 1 and add each subsequent step as they were comfortable. Progression was self-paced, but participants were encouraged to incorporate all steps by the end of 12 weeks. Participants received a handout on where to purchase foam balance pads (shown in two of ten balance exercises) as well as no-cost alternatives (e.g., firm pillow). Weekly self-monitoring logs asked participants to report their latest step and their daily participation (*yes/no*) as well as frequency, duration, sets, and repetitions for exercises for their latest step and all previous steps, as applicable.

Nutrition Control Condition

Given the high rates of comorbidities (e.g., hypertension, obesity) that could benefit from dietary change among adults with arthritis, a credible attention control program called Steps to Healthy Eating, based on the MyPyramid approach (which has since been replaced with MyPlate, www.choosemyplate.gov), was developed. Although MyPyramid and MyPlate

have five food groups, only four were chosen in order to match the number of steps in the exercise program (dairy not included). Participants received a Steps to Healthy Eating kit that contained a program manual and four progressive guides or "steps" (fruits, vegetables, grains, and meat and beans or proteins), as well as a folder with 12 self-monitoring logs (in duplicate); stamped return envelopes for the logs; and a study calendar. The colorful kit had the same "look and feel" and behavioral approach as the exercise kit, and the same advice was provided regarding ordering of and progression through the four steps. The weekly nutrition self-monitoring logs were parallel to the exercise logs.

Primary Outcome Measures

Self-reported physical activity—The 42-item Community Health Activities Model Program for Seniors (CHAMPS) questionnaire measures total hours per week of moderate- to igorous-intensity (≥ 3.0 METs) leisure-time physical activity (LT MVPA; excluded household activities).[26,27] For each item, participants reported whether they had engaged in the activity in a typical week in the past 4 weeks, the number of times per week, and the total number of hours per week (in six categories ranging from *less than 1 hour a week* to *9 or more hours per week*).

Functional performance—The 30-second chair stand measures lower body strength.[28,29] Participants sat in the middle of a chair with their back straight, feet flat on the floor, and hands on the opposite shoulder crossed at the wrist. Participants rose to a full stand and returned to a fully seated position, without using their arms. One practice of one to three repetitions was followed by one 30-second trial. The score was the total number of unassisted stands (higher score indicated greater strength).

The 6-minute walk test measures functional exercise capacity.[30,31] A 38-meter walking course was marked with cones in a level, carpeted hallway. Participants were instructed to walk as quickly as possible (not run) for 6 minutes. Assistive devices could be used. The score was the total distance walked (meters) in 6 minutes (higher score indicated better functional capacity).

The seated reach test measures lower body flexibility.[32] Without shoes, participants sat on a raised mat with their legs extended, knees straight, and feet positioned against a sit and reach box. With their arms outstretched, hands overlapping, and middle fingers even, participants slowly bent forward, reaching as far forward as possible toward their toes and pushing a marker forward. Participants were given two practice and three test trials. The score was the total distance reached to the nearest 0.5 cm, using the best of the three trials (higher score indicated better flexibility).

Disease-specific measures—Participants rated their arthritis symptoms in the past 2 weeks on a visual numeric scale from 0 (no symptoms) to 10 (severe symptoms).[33] Separate items evaluated pain, stiffness, and fatigue (higher score indicated worse symptoms).

An eight-item version of the Arthritis Self-Efficacy Scale,[34] based on the 20-item instrument,[35] measured participants' confidence on a scale of 1 (very uncertain) to 10 (very certain) in their ability to manage symptoms of arthritis. Responses were summed to yield a

score ranging from eight to 80 (higher scores indicated greater confidence). The sample coefficient α was 0.92.

Safety Monitoring

The 12 weekly logs asked participants if they had *a serious change in health* or *a serious injury or fall*. An endorsement of either item resulted in a follow-up telephone call. At both follow-up visits, or in response to log follow-up telephone calls (as necessary), participants rated the severity of 11 symptoms including contraindications to exercise that occurred for the first time (e.g., chest pain, passing out) and worsening of arthritis symptoms. *Mild* was defined for participants as "symptom did not interfere with usual activities," *moderate* as "symptom interfered somewhat with usual activities," and *severe* as "symptom was so bothersome that usual activities could not be performed." Participants also reported (*yes/no*) the onset of 14 health conditions, ten of which might require healthcare provider review prior to continuing with an unsupervised exercise program (e.g., heart attack, torn ligament). An additional form was completed by the project coordinator or principal investigator if participants reported "moderate" or "severe" symptoms or the onset of a health condition that might limit unsupervised exercise. The severity, seriousness, and likely relation to the program were coded. This paper reports adverse events, defined as events rated by study staff as "likely" or "definitely" study-related.

Other Measures

Participants reported their age, gender, race, marital status, and highest grade or years of education completed and rated their general health on a scale from 1 (*excellent*) to 5 (*poor*). They reported the number of years they have had arthritis and current use (*yes/no*) and days of use in the past week for acetaminophen; non-steroidal anti-inflammatory drugs (NSAIDs); cyclooxygenase 2 (COX-2) inhibitors; oral steroids; narcotic pain relievers; or any other over-the-counter and prescription medications for their arthritis (open-ended question). Open-ended medications were coded to drug class. Disease-modifying antirheumatic drugs (DMARDs) were added because of their frequent use. Current use of each class of medication or at least 1 day of use in the past 7 days was coded to indicate use (1=*yes*, 0=*no*). An overall measure of drug use (*yes/no*) was also created. Height to the nearest 0.25 inch and weight to the nearest 0.10 pound was measured by trained staff. BMI was computed as weight (kg)/height (m^2).

Statistical Analyses

Data were analyzed in 2013 and 2014 with SAS software, version 9.3. Baseline differences between conditions as well as between those lost versus retained at follow-up visits were tested with *t*-test for continuous, Fisher's exact test for dichotomous, and chi-squared test for categorical variables. Intent-to-treat analyses were conducted with repeated measures analysis of variance (SAS PROC MIXED function). Condition × Time interactions tested whether the exercise condition showed greater improvement than the nutrition control condition. Each model controlled for marital status due to borderline baseline condition difference, and education (high school graduate or lower versus some college or greater), gender, and age, as these variables are often associated with the outcomes of interest. If the

Condition × Time interaction was not significant, the analysis was rerun without the interaction term to more accurately estimate the time effect (i.e., whether there was a change in time in the outcome of interest, irrespective of condition assignment). Two approaches were used to deal with the skewed distribution of LT MVPA. First, a square root transformation of the variable was used in the analyses as described earlier. Second, the outcome at each time point was dichotomized (≥ 2 hours/week for LT MVPA) and analyses were conducted using the SAS PROC GLIMMIX function. All analyses used a maximum likelihood–based approach to accommodate data missing at random. This approach allows all participants to be retained in analyses, even if they are missing outcome measurements,[36] and it has been cited as preferable to imputation techniques for dealing with missing data.[37] To assess magnitude of change relative to baseline, Cohen's effect sized[38] was calculated for within-condition changes and between-condition changes (if the interaction was significant). Percentage change relative to baseline also was calculated.

Results

There were no baseline differences by condition (Table 2). Participants tended to be women (86%); middle-aged (mean age, 56.3 years); married or partnered (61%); and white or black (64% and 35%, respectively). Comorbid health conditions were common, with hypertension and hypercholesterolemia most prevalent. Participants had arthritis for an average of 10.3 years.

Retention for the conditions combined at the 12-week and 9-month visits was 79.3% and 74.3%, respectively. Retention did not differ by condition: $\chi^2(1, N=401)= 0.09$, $p=0.81$, at 12 weeks; $\chi^2(1, N=401)=0.60$, $p=0.49$, at 9 months. Reasons for attrition are presented in Figure 1. More women than men were retained at the 12-week visit (81.1% vs 68.4%, $p=0.03$). Participants retained at the 9-month visit were older (57.1 vs 54.0, $p=0.02$); more likely to be women (76.2% vs 63.2%, $p=0.048$); and more likely to be taking arthritis medication (76.5% vs 61.7%, $p=0.02$), particularly NSAIDs (79.1% vs 66.0%, $p=0.004$), than those not retained.

Adverse events occurred for ten participants: nine in the exercise condition and one in the nutrition control condition. One was rated mild, eight moderate, and one severe. The severe event was a torn meniscus resulting from a treadmill fall. The nine moderate events were muscle pulls/strains, a sprained ankle, and increased symptoms of arthritis (e.g., fatigue, pain). One nutrition participant reported an increase in blood sugar due to eating too much fruit (rated as mild).

An average of 9.4 (4.3) logs were returned for the exercise condition and 9.6 (4.2) for the nutrition control condition (12 possible), $t(399)=-0.46$, $p=0.65$. Physical activity results are shown in Table 3. The exercise condition showed greater increases over time in hours/week of LT MVPA and in the percentage of participants engaging in ≥2 hours/week of LT MVPA than the nutrition control condition. In the exercise condition, participants reported significant increases in LT MVPA at 12 weeks and 9 months. In the attention control group, participants reported significant increases in LT MVPA at 9 months, but only as assessed with the continuous outcome measure.

None of the interactions reached statistical significance for functional performance measures (Table 4); that is, the exercise condition did not show greater improvements over time than the nutrition control condition. However, main effects revealed significant improvements from baseline to 12 weeks and baseline to 9 months (conditions combined) for chair stands, the 6-minute walk, and seated reach.

For disease-specific outcomes (Table 5), the Condition × Time interaction was significant only for stiffness. The interaction, however, was not easily interpreted. Both conditions reported significant reductions in stiffness from baseline to 12 weeks and baseline to 9 months. The mean values did not differ by condition at any time point. The pattern of reduction was slightly different. Stiffness ratings were lower (not significant) at 12 weeks but higher (not significant) at 9 months in the nutrition control versus exercise condition. For pain, fatigue, and arthritis management self-efficacy, main effects revealed significant improvements from baseline to 12 weeks and baseline to 9 months (conditions combined).

Finally, weight remained stable in the exercise condition but significantly decreased by about 2 pounds in the nutrition control condition at 9 months, Condition × Time interaction $F(2,584)=3.73$, $p=0.02$(data not shown).

Discussion

The unique aspect of this study is that it tests the effect of a low-intensity, self-directed exercise program on a variety of behavioral, functional, and disease-specific outcomes in a sample of adults with arthritis. The home-based intervention requires very little staff time and is low-cost, safe, and convenient to participants. This type of intervention has potential for being delivered and disseminated to large numbers of adults with arthritis in a variety of settings, including healthcare practices, worksites, and churches. It incorporates best practices for physical activity programs and behavioral counseling for older adults.[16]

The First Step to Active Health intervention improved all of the studied outcomes. The increase in LT MVPA is meaningful—approximately 1 hour per week. Other, much more intense interventions, such as in the Fitness, Arthritis, and Seniors Trial (FAST),[39] have shown increased disability over time in adults with knee osteoarthritis who receive only standard care. Thus, although the magnitude of improvements is relatively small, the fact that this study not only prevented further impairments, but actually improved outcomes, is meaningful. These results are consistent with recent study findings that the self-directed format of the 6-week Walk with Ease program is as effective as a group-based format.[40] It is also important to note that unsupervised exercise did not contribute to a worsening of symptoms of pain, fatigue, or stiffness. Furthermore, although more adverse events were documented in the exercise condition than in the nutrition control condition, the majority were not severe and similar to what has been reported in exercise trials in general populations, and expected (e.g., muscle pulls/strains). Only one severe adverse event occurred.

An unexpected outcome is that improvements were also found in the nutrition control condition. This condition received the same attention as the exercise condition, and

participants were directed to implement similar behavioral strategies, but targeting healthy eating instead of exercise. Although it is not clear what accounts for these improvements, at least three explanations are plausible. First, the nutrition control condition significantly increased LT MVPA at 9 months. It appears that participants entered the study motivated to become more active (or became motivated to add in exercise after experiencing success with dietary change) and found a way to realize these changes. The difference in self-reported mean increases in LT MVPA between conditions may have been too small to result in statistically significant improvements over time in the functional and psychosocial outcomes. Second, on average, the attention control participants lost two pounds by the 9-month follow-up whereas the exercise participants showed no change in weight. Though this finding may be viewed as a "success" for both conditions (i.e., participants on average did not gain weight) given the negative association between obesity and quality of life and physical functioning in adults with arthritis,[17,18,41,42] it is unlikely that this small change in weight would have driven significant improvements in functioning. Finally, a testing effect cannot be ruled out. Although care was given to address familiarity with testing procedures prior to data collection, improvements seen over time, particularly for functional outcomes, could have been caused by increased familiarity and comfort with the tests combined with motivation and effort to improve scores.

A limitation of the study is the lack of a no-treatment control condition that is typical in other exercise interventions. The inclusion of this condition might have helped to clarify the findings. Nonetheless, the authors thought that equating attention across conditions was a more stringent test of the intervention. Second, a self-report measure of physical activity is used. Although the measure is validated, pedometers or accelerometers would have reduced social desirability biases and reporting errors, but may not have captured activity from resistance and balance exercises. Third, self-reported doctor-diagnosed arthritis and not clinically confirmed arthritis is used. Furthermore, all types of arthritis are included. Although this inclusion may enhance generalizability to a wider range of people, it limits the ability to examine differences within a specific arthritis diagnosis. Fourth, participants lost at the 9-month follow-up were younger than participants retained, perhaps because the original program was developed for mid-life and older adults and portrays photos from people in these age groups. Those retained were more likely to be women and take arthritis medications, particularly NSAIDs. Fifth, it is difficult to control and accurately assess adherence to the program when it is self-directed, although the logs provided some assessment of adherence. Finally, study results are best generalized mostly to women with arthritis who are well educated with low to moderate levels of symptom severity and functional impairment.

Despite these limitations, this study provides evidence to support recommending First Step to Active Health as an exercise program for adults with arthritis. This program adds a more flexible format to the existing list of evidence-based programs,[13] and it may appeal to subgroups of the arthritis population with less access to community programs.[43,44] The strengths of the study include the large sample, wide age range, relatively high retention rate, inclusion of functional measures, 6-month post-intervention follow-up, and the inclusion of diverse and meaningful outcomes. Although the magnitude of change is relatively modest, the potential for scalability of this low-cost intervention underscores its

promise for making changes at a broader, public health level. Furthermore, adding in additional support (e.g., telephone, e-mail), incorporating the intervention into settings with built in support and accountability (e.g., provider practices), or perhaps even combining the exercise and nutrition intervention, might increase the magnitude of effects.

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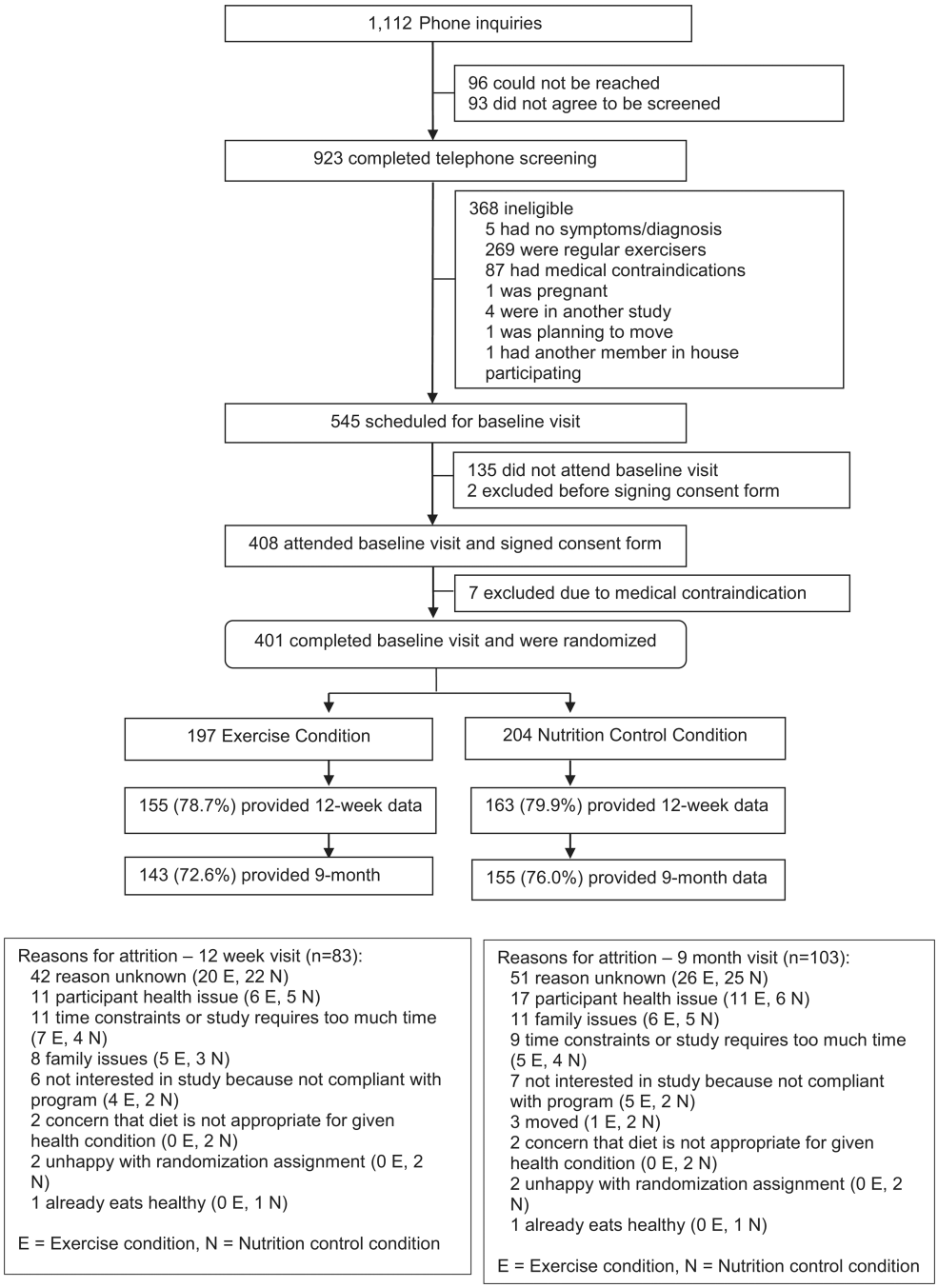

Figure 1.
Study flowchart.

Table 1

Eligibility criteria for Steps to Health

Participants were eligible to participate if they:
• were told by a health care professional that they have some form of arthritis
• reported at least one symptom of arthritis (joint pain, stiffness, tenderness, decreased range of motion, redness and warmth, deformity, crackling or grating, fatigue)
• were 18 years or older
• were the only one in their household participating in the study
• were not planning to move out of the area in the next 9 months
• were able to read and write in English
• were not participating in another research study (unless it was an observational study without any intervention or medication)
Participants were ineligible to participate if they:
• endorsed an item on the Physical Activity Readiness Questionnaire (PAR-Q)[21]:
– were told by a health care provider that they had a heart condition and should only do exercise recommended by a doctor
– experienced chest pain during rest or exercise
– experienced dizziness or loss of consciousness
– had a bone or joint problem (besides arthritis) that could be made worse by exercise
– knew of any other reason they should not do exercise
– had uncontrolled hypertension (Z160/100) (participants were not excluded if they took medication for hypertension and their blood pressure was controlled)
• had a fall in the past year that required medical assistance
• were pregnant, breastfeeding, or planning to become pregnant in the next year (women)
• were diabetic and taking insulin
• could not walk longer than 3 minutes without a rest
• could not stand without assistance for more than 2 minutes
• could not sit in chair without arms for more than 5 minutes
• were already physically active (aerobic activities ≥3 days/week for ≥30 minutes/day or strength training ≥2 days/week for ≥20 minutes/day)

Table 2

Baseline sample characteristics, by condition assignment, % (*n*) unless otherwise noted

Baseline characteristics	Exercise (*n*=197)	Nutrition (*n*=204)	*p*-value
DEMOGRAPHIC CHARACTERISTICS			
Age (years; M±SD [range])	56.2±10.4 (19–78)	56.4±11.0 (23–87)	0.8718
Gender			1.0000
Women	85.8 (169)	85.8 (175)	
Men	14.2 (28)	14.2 (29)	
Race[a]			0.4660
White	66.0 (130)	61.8 (126)	
Black/African American	33.5 (66)	36.8 (75)	
Other or biracial	0.5 (1)	1.0 (2)	
Missing	0.0 (0)	0.5 (1)	
Hispanic/Latino ethnicity	1.0 (2)	1.0 (2)	N/A
Education			0.4605
High school, GED, or lower	11.7 (23)	14.2 (29)	
At least some college	88.3 (174)	85.3 (174)	
Missing	0.0 (0)	0.5 (1)	
Employment			0.3351
Employed or self-employed	70.6 (139)	65.7 (134)	
Not employed	29.4 (58)	34.3 (70)	
Income ($)			0.4580
<40,000	24.9 (49)	27.5 (56)	
40,000–69,999	27.9 (55)	30.9 (63)	
≥70,000	43.7 (86)	37.3 (76)	
Missing	3.6 (7)	4.4 (9)	
Marital status			0.0527
Married or partnered	65.5 (129)	55.9 (114)	
Not married	34.5 (68)	44.1 (90)	
GENERAL HEALTH CHARACTERISTICS			
Self-reported comorbidities			
Hypertension	49.2 (97)	50.0 (102)	0.9205
High cholesterol	43.4 (85)	39.2 (80)	0.4176
Osteoporosis	13.8 (27)	11.8 (24)	0.5531
Stroke	2.0 (4)	0.5 (2)	0.4411
Cancer	13.3 (26)	8.3 (17)	0.1454
Health rating (1–5, 1=excellent; M±SD [range])	2.9±0.9 (1–5)	3.0±0.8 (1–5)	0.3197
BMI (M±SD [range])	32.5±8.5 (15.8–60.7)	33.5±7.9 (19.1–58.0)	0.2332
DISEASE-SPECIFIC CHARACTERISTICS			

Baseline characteristics	Exercise (*n*=197)	Nutrition (*n*=204)	*p*-value
Arthritis duration (years; M±SD [range])	10.9±9.3 (0.3–50.0)	9.8±9.8 (0.2–50.0)	0.2474
Current medication use related to arthritis			
Tylenol/acetaminophen	36.6 (72)	32.8 (67)	0.4634
NSAIDs	66.5 (131)	60.3 (123)	0.2143
COX-2 inhibitors	14.2 (28)	10.3 (21)	0.2858
Oral steroids	9.1 (18)	6.9 (14)	0.4629
Narcotic pain relievers	14.2 (28)	19.1 (39)	0.2282
DMARDs	11.2 (22)	11.8 (24)	0.8766
Any of above	87.3 (172)	82.8 (169)	0.2626
Functional measures (M±SD [range])			
Chair stands in 30 seconds (*n*)	10.0±3.5 (0–19)	9.9±3.5 (0–24)	0.8087
6-minute walk distance (m)	500.3±89.3 (189.6–684.0)	488.1±92.9 (151.5–721.6)	0.1794
Seated reach (cm)	21.8±9.2 (−5.0–46.5)	21.6±10.6 (−11.5–49.5)	0.8439
Disease-specific measures (M±SD [range])			
Pain (0–10)	4.6±2.3 (0–10)	4.9 ±2.3 (0–10)	0.2209
Stiffness (0–10)	5.1±2.5 (0–10)	5.5±2.6 (0–10)	0.1007
Fatigue (0–10)	4.9±2.6 (0–10)	5.1±2.7 (0–10)	0.3748
Arthritis management self- efficacy (1–10)	6.4±2.2 (1–10)	6.3 ±2.1 (1–10)	0.6975
Physical activity (M±SD [range])			
Leisure time MVPA (hours/week)	1.8±2.5 (0–13.3)	1.5 ±2.1 (0–9.5)	0.2607

[a]For race, *p*-value is for the comparison of white to other races.

COX-2, cyclooxygenase 2; DMARDs, disease-modifying antirheumatic drugs; GED, General Educational Development test; MVPA, moderate- to vigorous-intensity physical activity; N/A, not applicable; NSAIDs, non-steroidal anti-inflammatory drugs.

Table 3

Changes in self-reported moderate- to vigorous-intensity leisure-time physical activity by condition and time, M (95% CI) unless otherwise noted

Self-reported MVPA	Exercise	Nutrition	Model 1[a] Condition × Time
Leisure-time MVPA (hours/week)[b]			*F*=4.22 (***p*=0.015**)
Baseline	2.1 (1.5, 2.9)	1.8 (1.2, 2.4)	
12 weeks	**3.1 (2.4, 3.8)**	2.3 (1.7, 2.9)	
d (% change)[c]	0.45 (44.3)	0.13 (13.8)	0.34
9 months	**3.0 (2.3, 3.7)**	**2.7 (2.0, 3.3)**	
d (% change)[c]	0.34 (33.0)	0.21 (21.8)	0.14
Leisure-time MVPA (% reporting ≥2 hours/week)			*F*=4.50 (***p*=0.01**)
Baseline	25.5 (17.5, 35.7)	22.4 (15.2, 31.7)	
12 weeks	**53.0 (40.5, 65.0)**	25.0 (16.7, 35.6)	
d (% change)[c]	0.59 (107.4)	0.06 (11.6)	0.55
9 months	**39.0 (27.7, 51.7)**	26.0 (17.3, 37.0)	
d (% change)[c]	0.29 (52.9)	0.08 (16.0)	0.22

Note: Boldface indicates significant difference from baseline value ($p < 0.05$).

[a] Adjusted for condition assignment, time, marital status, education, gender, and age.

[b] For leisure-time MVPA, means in original units are reported, but statistical analyses, effect sizes, and percent change are based on square root transformation.

[c] Effect size d and % change are calculated relative to baseline values and use adjusted means.

MVPA, moderate- to vigorous-intensity physical activity.

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Table 4

Changes in functional performance outcomes by condition and time, M (95% CI) unless otherwise noted

Functional performance outcomes	Exercise	Nutrition	Combined	Model 1[a] Condition × Time	Model 2[b] Time
Chair stands in 30 seconds (*n*)				*F*=0.22 (*p*=0.80)	*F*=98.33 (***p* <0.0001**)
Baseline	10.2 (9.4, 10.9)	10.2 (9.5, 11.0)	10.2 (9.5, 10.8)		
12 weeks	**11.4 (10.6, 12.2)**	**11.6 (10.9, 12.4)**	**11.5 (10.9, 12.2)**		
d (% change)[c]	0.36 (12.2)	0.40 (13.8)	0.38 (13.1)		
9 months	**12.2 (11.4, 13.0)**	**12.2 (11.5, 13.0)**	**12.2 (11.5, 12.9)**		
d (% change)[c]	0.58 (19.7)	0.57 (19.5)	0.57 (19.6)		
6-minute walk (m)				*F*=0.58 (*p*=0.56)	*F*=10.17 (***p* <0.0001**)
Baseline	497.0 (478.9, 515.1)	489.0 (471.6, 506.4)	493.0 (477.4, 508.6)		
12 weeks	501.6 (483.15, 520.1)	**497.8 (480.0, 515.6)**	**499.7 (483.9, 515.6)**		
d (% change)[c]	0.05 (0.9)	0.09 (1.8)	0.07 (1.4)		
9 months	**509.20 (490.7, 527.8)**	**500.0 (482.1, 517.9)**	**504.6 (488.7, 520.5)**		
d (% change)[c]	0.14 (2.5)	0.12 (2.2)	0.13 (2.4)		
Seated reach (cm)				*F*=0.81 (*p*=0.44)	*F*=20.68 (***p* <0.0001**)
Baseline	18.0 (16.0, 20.0)	18.0 (16.1, 20.0)	18.0 (16.1, 20.0)		
12 weeks	**19.0 (16.9, 21.1)**	**19.0 (17.0, 21.0)**	**19.0 (17.0, 21.0)**		
d (% change)[c]	0.11 (5.6)	0.10 (5.7)	0.10 (5.7)		
9 months	**20.2 (18.1, 22.3)**	**19.6 (17.5, 21.6)**	**19.9 (17.5, 21.6)**		
d (% change)[c]	0.24 (12.1)	0.15 (8.6)	0.19 (10.3)		

Note: Boldface indicates significant difference from baseline value ($p < 0.05$).

[a] Adjusted for condition assignment, time, marital status, education, gender, and age.

[b] Adjusted for condition assignment, marital status, education, gender, and age. Model 2 was run only in instances where Condition × Time interaction was not significant.

[c] Effect size d and % change are calculated relative to baseline values and use adjusted means.

Table 5

Changes in disease-specific outcomes by condition and time, M (95% CI) unless otherwise noted

Disease-specific outcomes	Exercise	Nutrition	Combined	Model 1[a] Condition × Time	Model 2[b] Time
Pain (0–10)				*F*=2.70 (*p*=0.07)	*F*=21.57 (***p* <0.0001**)
Baseline	4.7 (4.2, 5.2)	4.9 (4.5, 5.4)	4.8 (4.4, 5.2)		
12 weeks	**4.3 (3.8, 4.9)**	**4.2 (3.7, 4.7)**	**4.3 (3.8, 4.7)**		
d (% change)[c]	−0.15 (−7.6)	−0.33 (−15.6)	−0.25 (−11.8)		
9 months	**3.9 (3.4, 4.4)**	**4.2 (3.7, 4.7)**	**4.1 (3.6, 4.5)**		
d (% change)[c]	−0.36 (−17.8)	−0.30 (−14.0)	−0.33 (−15.8)		
Stiffness (0–10)				*F*=3.11 (***p*=0.046**)	
Baseline	5.3 (4.8, 5.8)	5.6 (5.2, 6.1)			
12 weeks	**4.6 (4.0, 5.1)**	**4.3 (3.8, 4.8)**			
d (% change)[c]	−0.30 (−14.3)	−0.53 (−24.1)	0.24		
9 months	**4.4 (3.8, 4.9)**	**4.5 (4.0, 5.1)**			
d (% change)[c]	−0.37 (−17.5)	−0.44 (−19.6)	0.07		
Fatigue (0–10)				*F*=2.79 (*p*=0.06)	*F*=41.42 (***p* <0.0001**)
Baseline	4.7 (4.1, 5.2)	4.8 (4.3, 5.3)	4.7 (4.3, 5.2)		
12 weeks	**3.7 (3.2, 4.2)**	**3.9 (3.4, 4.4)**	**3.8 (3.4, 4.3)**		
d (% change)[c]	−0.36 (−20.4)	−0.34 (−19.0)	−0.35 (−19.6)		
9 months	**3.4 (2.8, 3.9)**	**4.1 (3.6, 4.6)**	**3.7 (3.3, 4.2)**		
d (% change)[c]	−0.49 (−27.5)	−0.28 (−15.3)	−0.38 (−21.1)		
Arthritis management self-efficacy (1–10)				*F*=1.71 (*p*=0.18)	*F*=9.92 (***p* <0.0001**)
Baseline	6.1 (5.7, 6.6)	6.1 (5.7, 6.5)	6.1 (5.8, 6.5)		
12 weeks	6.4 (5.9, 6.8)	6.3 (5.9, 6.8)	**6.3 (6.0, 6.7)**		
d (% change)[c]	0.11 (3.7)	0.11 (3.6)	0.11 (3.8)		
9 months	**6.8 (6.4, 7.3)**	6.4 (6.0, 6.8)	**6.6 (6.2, 7.0)**		
d (% change)[c]	0.33 (11.2)	0.15 (5.3)	0.24 (8.2)		

Note: Boldface indicates significant difference from baseline value ($p < 0.05$).

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[a] Adjusted for condition assignment, time, marital status, education, gender, and age.

[b] Adjusted for condition assignment, marital status, education, gender, and age. Model 2 was run only in instances where Condition × Time interaction was not significant.

[c] Effect size d and % change are calculated relative to baseline values and use adjusted means.