Protocol for the POMELO (Prevention Of MusclE Loss in Osteoarthritis) randomized pilot feasibility trial

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ABSTRACT

Objective: Individuals with advanced knee osteoarthritis (OA) and a large body size [a body mass index (BMI) ≥35 kg/m²] have a higher risk of complications with total knee arthroplasty (TKA), and hence may be ineligible for surgery unless they reduce their BMI. However, pre-TKA weight-loss has not been shown to reduce surgical infection risk and may inadvertently increase risk for muscle loss and development of sarcopenic obesity (low muscle and low strength with higher fat mass). This suggests that a knee OA management approach that doesn't focus on weight change (weight-neutral) may be beneficial. This study examines if a weight-neutral behavioural intervention is feasible and acceptable to participants, and improves muscle mass and physical function in comparison to usual care.

Design: This pilot randomized clinical trial compares a 12-week multimodal intervention [including targeted nutrition, progressive resistance exercise, and arthritis self-management support] to usual care. Co-primary outcomes are feasibility and acceptability, with secondary outcomes of change in lean soft tissue and physical function within and between groups at 3-months and 9-months from baseline. Change in waist circumference, fat mass, blood biomarkers, energy metabolism, OA-related pain and function, health-related quality of life, self-efficacy for arthritis management, and interest in pursuing a TKA within and between groups will be explored.

Conclusion: This study will inform future development of more personalized knee OA treatment approaches for adults with larger bodies. Further, this will contribute to effective alternative treatment pathways that reduce inequities in access to OA care for this understudied patient population.

1. Introduction

Individuals living with a large body size [defined as a body mass index (BMI) ≥35 kg/m²] are neglected in care pathways for advanced knee osteoarthritis (OA). These individuals may be unable to access surgical treatment for knee OA due to associations between BMI and increased risk of infection after total knee arthroplasty (TKA) [1]. They are instead provided with simplistic recommendations to reduce their BMI to be eligible for surgery [2]. These individuals are susceptible to engaging in unsupervised restricted eating or fad diets to attempt to lose weight, with potential for unfavourable consequences [3]. This includes a risk for inadvertent muscle loss [4] and development or worsening of sarcopenic obesity (defined as low muscle mass and low strength with high fat mass) [5]. Sarcopenic obesity can have negative impacts on mobility, increased surgical complication risk and risk of mortality [6], and should be regarded in this population. Muscle loss can also reduce energy expenditure, leading to a vicious cycle of weight regain [7] primarily through increased fat mass. Patients may end up with a body composition profile that has lasting detrimental impacts on their health and quality of life. Importantly, there is uncertainty whether losing weight is appropriate advice for this population due to limited evidence of a benefit for reducing TKA surgical risk [8,9]. Therefore, keeping and improving patients’ muscle mass and physical function may be a relevant and important treatment priority.

Currently, no alternative models of advanced knee OA care have been specifically developed to meet the needs of these individuals. This has left few options and limited access to care, which may contribute to a higher utilization of opioids and analgesics in this patient group [10]. This area signifies a gap in healthcare services and a health equity dilemma that is important to address. This group is disproportionately comprised of...
individuals who experience disadvantage in society, including women, individuals from minority groups, and those with fewer socio-economic resources [11]. New approaches are desperately needed for managing advanced knee OA in adults with a large body size, particularly as the prevalence of a BMI ≥35 kg/m² is rising, currently including more than 1.9 million Canadians [12] and anticipated to incorporate 1/4 of the USA population in the coming decade [13]. Rates in Europe and countries worldwide have also grown [14], suggesting this is an international issue of importance.

Personalized knee OA treatment recommendations must meet the needs of these patients, including moving beyond a focus on BMI and weight loss and considering alternative approaches that may improve body composition, physical function, and health-related quality of life without weight reduction. This is especially important as current OA clinical practice recommendations do not align with strong evidence of the chronic nature of obesity and challenges with sustained weight-loss without access to surgical or pharmaceutical treatments [15]. Further, individuals at any BMI level can have established OA disease without other adiposity-related health impairments [16] suggesting that strategies for effective and long-term OA management may be the priority to address.

2. Objective

The POMELO study aims to determine if a multimodal behavioural intervention designed to improve body composition and physical function (through personalized nutrition, resistance exercise, and chronic disease self-management support) is feasible and acceptable for individuals with a BMI ≥35 kg/m² and advanced knee OA. The secondary objective is to examine the effects of the intervention on muscle mass and physical function in comparison to usual care.

3. Methods

3.1. Acronym

The title and acronym selected for this trial [POMELO: Prevention Of Muscle Loss in Osteoarthritis] was purposeful. Muscle loss prevention is a critical topic in OA care, relevant both for OA symptoms and sarcopenia risk. The pomelo fruit provides a unique analogy for the hidden burden of low lean mass in individuals with a larger body size. The relatively large size of the pomelo does not always reflect the amount of fruit inside, similar to human body composition where bigger individuals can’t accurately be assumed to all have greater muscle mass (Fig. 1).

3.2. Trial design and setting

The POMELO study is a parallel-arm, randomized pilot and feasibility trial. The study design and delivery plan was developed and refined using patient-and-public engagement, previously reported [17]. A study flow overview is provided in Fig. 2, outlining the 3-month intervention or usual care phase, followed by 6-months of maintenance, for a total 9-month study involvement. Participants are recruited from a centralized orthopaedic clinic in Alberta, Canada, requiring a referral from primary care providers for consultation with orthopedic surgeons. Assessments and delivery of the multimodal intervention are conducted at the University of Alberta in Canada. The trial was registered on www.clinicaltrials.gov, Identifier NCT05026385 in August 2021 [18].

3.3. Participant eligibility

Adults ≥40–75 years of age, with BMI ≥35 kg/m² and unilateral or bilateral advanced knee OA are eligible for inclusion. Knee OA severity is determined by radiographic confirmation of Kellgren-Lawrence (KL) grade ≥2 with clinical symptoms, confirmed by screening physicians. Individuals must consent and communicate in English and have an internet-connected device at home. Exclusion criteria include prior hip or knee arthroplasty, prior bariatric surgery, inflammatory arthritis, post-traumatic joint fracture, neurological conditions (e.g. multiple sclerosis), or any medical condition where exercise or nutrition adjustments are contraindicated.

3.4. Recruitment

Patients attending an initial consultation appointment at the clinic are screened for eligibility and interest in research participation by clinic staff. The study research assistant follows-up to discuss study involvement and informed consent. After consenting, participants attend a

Fig. 1. Pomelo fruit analogy where hidden low muscle mass can be present but missed in individuals with a large body size. The pomelo is the largest citrus fruit, bigger than a grapefruit. Despite its large outer size and shape, the inside ratio of fruit to rind in a pomelo is not apparent until you open it. Some pomelos have lots of fruit inside, while others may have a much smaller amount. This is akin to muscle mass in people with a large body size, where low muscle mass or muscle loss (i.e. sarcopenia or sarcopenic obesity) can be present but hidden. Investigation of body composition is necessary to identify hidden abnormalities.
Consent and Enrollment
Baseline Assessment
Randomization
Intervention
Usual Care
12-week personalized intervention
Usual routine
Interim Assessment 3-Months
Maintenance Period of 6-Months
Final Assessment 9-Months

Fig. 2. Participant flow through the POMELO study.

Baseline assessment on a separate date at the University of Alberta. Demographics collected at baseline include age, biological sex, gender, ethnicity, education, living arrangements, comorbid conditions, and smoking and alcohol intake.

3.5. Assessment visits

Study participants attend in-person assessments at baseline, 3-months, and 9-months. An overview of timelines and assessments are provided in Table 1.

3.6. Anthropometrics and body composition

Anthropometrics assessed at each visit include height measured to nearest 0.1 cm on a 235 Heightronic or SECA 264 digital stadiometer. Weight is measured to nearest 0.1 kg on a calibrated Health-o-meter® digital scale. BMI is calculated. Waist circumference is measured at the top of the iliac crest over light clothing with a non-elastic tape measure. Calf circumference is measured at the widest point of the gastrocnemius muscle while standing. The average of three consecutive measures at each site is recorded. Body composition is assessed using dual-energy x-ray absorptiometry (DXA) (GE Healthcare Lunar iDXA, ENCORE software version 18). Total body and regional lean soft tissue (LST), fat mass (FM) and bone mineral concentration (BMC) are assessed. Percent FM is calculated. Appendicular lean soft tissue (ALST), determined by LST of arms + legs and adjusted by height (in square meters), is considered as a surrogate measure of muscle mass [20].

3.7. Energy metabolism

Resting energy expenditure after an overnight fast is assessed using indirect calorimetry. This includes baseline assessment using open circuit indirect calorimetry (Vmax Spectra 29c; Sensormedics, USA). Participants rest for 10-min in a supine position prior to testing. The automated gas analyzer, calibrated before each test, records respiratory parameters. Expired and inspired gases are collected breath-by-breath for 30 min during quiet rest in a supine position. Participants shoulders and head are under a clear canopy, and they are advised to breathe normally and remain awake. An additional measurement of metabolic rate at baseline and subsequent assessments is conducted using a portable calorimetry device (Q-NRG®, COSMED, Italy) [21] following the same process but a shorter time duration (15-min). This testing is completed for exploratory analysis of change in energy metabolism during the study period, and validation of this novel device against more sophisticated measures in this population [22].

3.8. Blood biomarkers

Participants have venous blood drawn for assessment of insulin, glucose, lipids, liver enzymes, thyroid function, albumin, and c-reactive protein after an overnight fast. Testing is conducted at community clinical laboratory facilities (Dynalife®).

3.9. Strength and physical function

Participants complete a maximal handgrip strength, chair stand test (CST), and 6-min walk test (6MWT) at each assessment visit. These measures are accepted for both knee OA and sarcopenia-related assessments [23,24]. Maximal isometric grip strength is assessed bilaterally using a hydraulic Jamar handgrip dynamometer. Participants are seated with their elbow positioned at 90°, and instructed to squeeze the dynamometer with maximal effort. The highest of three attempts in each hand is recorded to nearest 0.5 kg. Participants then complete a 30-s CST. Beginning from a seated position in a standardized chair with arms across the chest, participants stand fully and return to a seated position. Repetitions completed during a 30-s timed interval are recorded. The 6MWT is completed indoors in a measured loop marked with cones. The full distance walked in a continuous 6-min timed interval is recorded. Participants can use assisted devices they normally use for ambulation (i.e. brace, cane, or walker).

3.10. Muscle quality

Muscle cross-sectional area, thickness, and echogenicity of the rectus femoris is assessed using B mode ultrasound (GE Logiq e), analyzed with ImageJ software (v.1.52a). Ultrasound assessment is completed bilaterally at baseline, and right leg only at subsequent visits for exploratory analyses. Landmarking of the anterior superior iliac spine (ASIS) and superior border of the patella is completed with participant in a supine position. The midpoint between these points is measured and marked horizontally on the thigh in ink. The distance between the medial and lateral femoral epicondyles is measured, the midpoint marked on the knee and aligned with the ASIS for an intersecting vertical midline mark in the sagittal plane where images are taken.
Table 1
POMELO study activities and timelines.

| Assessment        | Baseline | Intervention or Usual Care phase | Interim | Maintenance phase | Final |
|-------------------|----------|----------------------------------|---------|------------------|-------|
|                   | Months 1-3 (outlined in weekly detail) | Months 4-9 |                   |                   |       |
| **Assessment**    |          |                                  |         |                  |       |
| Demographics      | X        | X                                | X       |                  |       |
| Anthropometrics   | X        |                                  |         |                  |       |
| Body composition  | X        |                                  |         |                  |       |
| Indirect calorimetry | X   |                                  |         |                  |       |
| Blood tests       | X        |                                  |         |                  |       |
| Physical function tests | X  |                                  |         |                  |       |
| PROMS             | X        |                                  |         |                  |       |
| Surveys           | X        |                                  |         |                  |       |
| Interviews        | X        |                                  |         |                  |       |
| 3-day food record | X        |                                  | X       |                  | X     |
| 7-day activity record | X  |                                  | X       |                  | X     |
| Nutrition consult with RD | I    |                                  |         |                  |       |
| Exercise consult with CEP | I   |                                  |         |                  |       |
| **Intervention**  |          |                                  |         |                  |       |
| Nutrition | I | I | I | I | I | I | I | I | I |
| Exercise   | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Self-management | I | I | I | I | I | I | I | I | I |
| **Maintenance**  |          |                                  |         |                  |       |
| Support check-ins | X | X |                                  |         |                  |       |

CEP = Clinical Exercise Physiologist, I = intervention group, RD = Registered Dietitian, PROMS = Patient-reported outcome measures, U = usual care (control) group, X = both intervention and control group, Δ = three times per week.

*In-person assessment visits take place at intake (baseline), interim (3-months), and study end (9-months).

3.11. Patient-reported outcome measures (PROMS)

Health-related quality of life is assessed using the Euroqol Foundation EQ-5D-SL [25]. Knee OA-related pain and function is assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [26]. Chronic disease self-efficacy is assessed with the PROMIS short forms for Managing Daily Activities and Managing Symptoms [27], and the Arthritis Self-Efficacy Scale [28].

3.12. Nutrition and physical activity behaviours

Usual food and beverage intakes are recorded over a 3-day period, and usual physical activity routine over a 7-day period. These recordings are requested at regular intervals during the study (baseline, 6-weeks, 3-months, 6-months, and study end).

3.13. Randomisation and blinding

After baseline assessments are completed, participants are randomly allocated into intervention or usual care (control) arms. A consultant statistician developed a randomization list using a random number generator, allocating individuals to the intervention and control arms at a 1:1 ratio. The randomization list is concealed by blocked cells in an Excel spreadsheet and unveiled by a member of the research team as each subsequent participant completes all baseline testing. Participants and study personnel are not blinded to group assignment due to the nature of the intervention and need for the study team to coordinate intervention activities. Double blinding was not able to be included in this pilot, and it was not designed as a superiority trial. The outcome of change in muscle mass is assessed and quantified by x-ray technicians blinded to group allocation. All other outcomes are assessed by research team personnel following rigorous protocols to avoid measurement biases.

3.14. Intervention group

Participants in the intervention arm receive a personalized multimodal intervention delivered over a 3-month (12-week) intensive period. The intervention includes three components: a) targeted nutrition recommendations, b) self-management support, and c) a progressive resistance exercise program (Fig. 3). The intervention period begins with baseline consultations with a Registered Dietitian (RD) and Clinical Exercise Physiologist (CEP) to personalize the intervention. Nutrition in the intervention group is optimized with a focus on adequate protein and energy intakes, supported by baseline resting energy expenditure, body weight, and 3-day food record assessments. The RD provides individualized recommendations for each participant during a one-on-one videoconferencing consultation. Protein intake of 1.2 g/kg of body weight is encouraged, with an isocaloric intake. Following the consultation, participants are invited to attend a biweekly nutrition education session held over videoconferencing and led by the RD (six sessions in total over the 12-weeks). Education session topics focus on healthy eating patterns, maintaining an isocaloric diet (balanced energy intake with output), encouraging high fibre and protein (within recommended ranges), and decreasing saturated fats and simple sugar intake (an overview of topics is provided in Table 2). An educational video on each nutrition topic is shared through an electronic link with participants prior to the session, and then discussed at the live videoconferencing session including opportunities for questions. The 3-day food records periodically collected over the study duration will enable post-hoc evaluation of recommendation adherence.

Arthritis self-management is encouraged through biweekly peer group support and discussion sessions held via videoconferencing on alternate weeks from nutrition topics, Table 2. These sessions are facilitated by an Occupational Therapist (OT), and designed to support long-term behavioural health changes (including sleep, physical activity, and stress management), address barriers and facilitators that arise [29], and enhance self-efficacy for managing OA symptoms [30].

Attendance at biweekly peer support and nutrition sessions is recorded and encouraged but not required for ongoing study participation. Attendance data collected will inform feasibility and acceptability outcomes.

Exercise in the intervention group consists of a whole-body progressive resistance exercise program personalized to each participant by the CEP during a one-on-one consultation. Eight resistance exercises are included: squats (or leg press), lunges, leg extension, leg flexion, hip hinge (deadlifts), upper back rows, chest press, and shoulder press. Modifications or an alternative exercise targeting the same muscle group is substituted if necessary. Participants are advised to complete the
exercises three times per week on non-consecutive days. After the first two weeks of familiarization, participants are instructed to train to exercise fatigue (unable to complete another concentric repetition) between 8 and 12 repetitions max (RM). Three sets of each exercise are recommended, adjusting the resistance to ensure volitional exercise failure at 8–12 RM in each set with approximately 2-min of rest between sets. Participants can complete the exercises at home with loaned dumbbells and/or resistance bands. Optional supervised sessions led by the CEP are offered three times per week for additional support, held either at a private research gym facility or through videoconferencing. Participants track their exercise completion on a recording sheet which is returned to study staff at the end of the intervention. The CEP also provides one-on-one check-ins biweekly for each participant through phone or videoconferencing to support exercise progression and completion. No specific recommendations for aerobic exercise are provided and participants can choose to complete additional physical activity outside of the intervention following public health guidelines.

3.15. Usual care (control) group

Participants allocated to the usual care arm will continue to complete their usual activities and routine management of their arthritis. Participants may decide to initiate exercise, change their nutrition, or attempt weight-loss, and they are not prohibited from making adjustments (Fig. 3). This is designed pragmatically, as arthritis is a dynamic condition and individuals may make behavioural adjustments as part of routine arthritis self-management. Study participants in usual care receive no advice from study intervention staff, and the only contact provided is email or phone check-ins from study staff to encourage retention to study end. As an incentive for completion, participants in this arm receive individual consultation appointments with each of the RD and CEP after final study assessments at 9-months.

3.16. Maintenance period

After the initial 3-months of study involvement, both groups move to a 6-month maintenance phase. During this time participants receive check-ins by phone or email approximately every two-months to encourage retention to study end. No contact with intervention staff is provided over this period, however individuals in the intervention arm can continue to use loaned exercise equipment.

3.17. Primary outcomes

Co-primary study outcomes are feasibility and acceptability. Feasibility will be determined by completion rates of ≥80%, and per-protocol adherence (defined as attendance at the prescribed intervention

| Type of session     | Topic of session                                      |
|---------------------|-------------------------------------------------------|
| Self-management     | Chronic nature of osteoarthritis                      |
| Nutrition           | Understanding our macros                              |
| Self-management     | Managing arthritis pain                               |
| Nutrition           | Setting the stage                                     |
| Self-management     | Good sleep with arthritis                             |
| Nutrition           | Foods that fight inflammation                         |
| Self-management     | Managing stress                                       |
| Nutrition           | Curbing cravings                                      |
| Self-management     | Movement and physical activity                        |
| Nutrition           | Meal planning                                         |
| Self-management     | Energy management and resources                       |
| Nutrition           | Healthy eating tips                                   |

*Personalized nutrition advice, progressive resistance exercise, self-management peer support

**Participants follow their usual routine and decisions on food and activity behaviours

Fig. 3. Illustration of the intervention and usual care groups in the POMELO study.
components, i.e. exercise three times per week) of ≥60% [31]. These are recognized feasibility outcomes for OA intervention trials [32]. Acceptability will be determined in consultation with participants to assess if the treatments were consistent with their values and preferences [33]. This will be measured through data collected from electronic surveys and interviews with participants in both arms to explore experiences and satisfaction [34]. Survey questions will assess participants’ understanding of their knee OA, interest in TKA within the next 1, 2, or 5 years [35], and their satisfaction with the intervention or usual care using a 4-item Likert scale. Participants will be asked to provide further perspective on the acceptability of the intervention through open-ended questions (i.e. what they liked/disliked, their perception of the influence on behaviour change and improvement in health or outcomes). A subgroup of participants will be invited to a phone or videoconference interview with a research team member at the 9-month timepoint to explore detailed experiences of adherence, acceptance, and satisfaction. Questions asked will follow a semi-structured interview guide, and relate to constructs under the Theoretical Framework of Acceptability [36]. The number of interviews will depend on when sufficient information power is reached, and analysis of interview data will occur concurrently to identify areas needing clarification.

3.18. Secondary outcomes

Secondary outcome is change in muscle mass (ALST) and physical function parameters of CST and 6MWT within and between groups at 3-months and 9-months. A mean difference in change in muscle mass ≥+0.5 kg between groups is projected to be relevant [37], after adjusting for precision error with repeat measures [38]. A mean improvement in 6MWT distance of ≥50 m, and increased number of repetitions (≥2) in the CST is considered clinically relevant for individuals with advanced knee OA [23,39,40].

3.19. Exploratory outcomes

Exploratory objectives include assessing the effects of the intervention on OA-pain symptoms, waist circumference, fat mass, energy metabolism, blood biomarkers, health-related quality of life, self-efficacy, and change in interest in proceeding to have surgery (TKA) in future, compared within and between groups at study completion.

3.20. Data management

Study data is managed in a Research Electronic Data Capture (REDCap) [41] system hosted at the University of Alberta. Demographic and outcome questionnaires, food and activity records, and satisfaction surveys are shared through an electronic link and completed remotely by participants through this system.

3.21. Sample size

The calculated total sample for this pilot study is n = 50 (n = 25 participants randomized in each arm) based on the primary outcome of feasibility [42]. This sample provides adequate power (0.80) for the secondary outcomes to detect a change in 6MWT and CST with small to medium effect size (f^2 = 0.4) [23], ALST with a small effect size (f^2 = 0.2) [43,44], and account for drop-out rates anticipated at 16% [45].

3.22. Statistical methods

Descriptive and qualitative analyses will be used to assess the co-primary outcomes of feasibility and acceptability. Secondary and exploratory outcomes will be analyzed using intention-to-treat. Within group differences (pre-to-post at 3-months and 9-months) will be analyzed using two-way repeated measures ANOVA. Between group differences (intervention versus usual care) will be analyzed using Students t-test or Mann Whitney U test. Categorical outcomes will be compared using Chi square. Consideration of sex and gender will be included depending on sample. Biological sex differences are relevant when considering body composition and strength, and gender can affect treatment pathways in knee OA [46] with likely implications on experiences of pain, function, and health-related quality of life. KL grade of OA will be reported in the descriptive results, and any differences between groups addressed through posthoc analyses.

Data from surveys and interviews will be examined using thematic analysis. Two independent reviewers will independently read transcribed interview data and complete inductive coding, then categorizing codes into themes.

3.23. Reporting

The Consolidated Standards of Reporting Trials (CONSORT) extension to randomized pilot and feasibility trials will be followed for reporting study results [47], with changes due to extenuating circumstances related to COVID-19 reported following the CONSERVE statement [48].

4. Discussion

Individuals with a large body size may benefit from alternative knee OA treatments designed specifically to meet their unique needs. There is a wide knowledge gap in this area, especially considering that few individuals with a BMI ≥35 kg/m^2 have been included in prior knee OA studies, possibly due to equipment weight limitations, concerns around motivation, or fewer eligible individuals [49]. Further, earlier studies have predominantly examined weight-loss as a preferential treatment outcome [50-53]. This focus on weight reduction may overshadow the importance of OA-related disability reduction through improvements in strength and function [54]. Exercise and nutrition are of critical benefit in this respect [55], however they may be viewed more as tools for energy expenditure and caloric restriction [56]. Shifting this narrative and exploring the value of exercise and nutrition to preserve muscle mass and improve strength and mobility without weight-change may be especially important [57,58], considering the limited evidence of a benefit of weight-loss in end-stage OA related to surgical risk and outcomes after TKA [49].

Exercise is accepted as a universally important tool of knee OA management [59]. Resistance exercise may be particularly beneficial for improving muscle mass and strength [37] and reducing OA-related pain up to 30% [60]. It can also have potential positive impacts on metabolism and reduced visceral fat [61] depending on exercise stimulus [62]. When resistance exercise is combined with nutrition (a multimodal approach), this can maximize anabolic potential, particularly when adequate protein intake is consumed [63]. A study by de Zwart et al. [64] found over 65% of individuals with knee OA had a protein intake below the recommended daily allowance of 0.8 g/kg, and low intake was associated with decreased strength [64], supporting its importance. A recent systematic review and meta-analysis [65] reported a benefit of resistance exercise in combination with protein intake (after eight to nine weeks) for improving strength, muscle mass, and pain-reduction in adults with lower extremity OA. The addition of chronic disease self-management education and support may confer additional benefits through enhancements in self-efficacy and engagement [66].

While recruitment into intervention studies can be challenging in adults with chronic disease, through ongoing patient-engagement we have addressed design factors to improve retention [17]. This includes offering personalized nutrition and exercise advice, and flexible intervention delivery including options of where and when to complete the exercises (i.e. supervised in-person sessions or home exercise facilitated by exercise equipment loan).

Study results will support the development of further treatment strategies targeted for this clinical population, potentially leading to
scalable interventions that are effective in improving health outcomes and implementable in clinical settings. This may contribute to future reductions in TKA access if patients have improved function and quality of life as a result of targeted non-surgical care. Surgical treatment of OA is not inevitable, and this intervention may provide an effective approach for long term non-surgical OA management in this population. Further, patient outcomes and recovery may be enhanced in those who eventually proceed to TKA, by improving nutritional and functional status, and muscle reserves prior to surgery. Important healthcare implications may be achieved as a result, through cost-savings if patients stay in hospital for shorter durations with fewer complications, and through overall health improvements related to enhanced nutrition and physical function.

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**Declaration of competing interest**

KG conceptualized the study and all authors were involved in the study design. All authors revised the manuscript for intellectual content and have read and approved the final version.

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**Availability of data and materials**

Data sharing is not applicable as no datasets were generated or analyzed.

**Ethics approval**

Provided by the Health Research Ethics Board at the University of Alberta, Edmonton, Alberta, Pro00107201, on March 31, 2021.

**Trial status**

Enrollment began September 21, 2021 and is expected to be completed in 2023.

**Authors’ contributions**

KG conceptualized the study and all authors were involved in the study design. All authors revised the manuscript for intellectual content and have read and approved the final version.

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