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POMELO [Prevention Of MusclE Loss in Osteoarthritis] pilot randomized clinical trial, which has been funded by the Canadian Arthritis Society and is being conducted in 2021-2024.

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Competing Interests

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Abstract

Objective Interventions for knee osteoarthritis (OA) in adults with a large body size [defined as a BMI≥35 kg/m^2] often prioritize weight-loss, which may overshadow specific benefits for physical function, metabolic health, and body composition. As part of the development of a future clinical study, we gathered perspectives from individuals living with knee OA and a large body size to inform the proposed intervention design and delivery.

Methods Purposive and voluntary sampling was used to engage individuals ≥40 years of age with self-reported knee OA and a BMI≥35 kg/m^2. An anonymous electronic survey was distributed on social media between April-June 2020. Open-ended questions addressed a proposed 12-week multimodal intervention (involving targeted nutrition, resistance exercises, and self-management support). An optional semi-structured interview was offered upon completion, with interviews recorded and transcribed verbatim. Reflexive thematic analysis and interpretation guided by an acceptability framework was used to identify recommendations for the intervention design and delivery.

Results Twenty individuals living across Canada completed the survey (100% female; 18 aged <65 years and 2 ≥65 years). Ten individuals completed the interview. From aggregate survey and interview data, three recommendations were generated: 1) the effectiveness of the intervention for health improvement (specifically mobility and pain) must be emphasized to avoid perceived weight-loss expectations; 2) extend support beyond 12-weeks and consider terminology free from weight-bias to enhance acceptance; 3) include optional customization of intervention delivery to reduce acceptability-related burden.

Conclusion These female patient-derived recommendations may improve perceived intervention acceptability, and thereby may enhance participant enrollment and retention in clinical trials.

Keywords

Osteoarthritis, body mass index, obesity, patient-and-public involvement, qualitative

Introduction

Interventions for knee osteoarthritis (OA) in adults with obesity often focus on weight-loss as a principal outcome. This emphasis on weight-reduction may overshadow the value and importance of nutrition and exercise for improving metabolic health, physical function and contributing to OA-related pain relief. Optimizing body composition (maintaining or increasing muscle mass while reducing adiposity, without weight change necessarily) may be a more pragmatic and beneficial approach, particularly as an individuals' control over their body weight is limited[1], and weight regain after weight loss is pervasive due to biological factors[2]. This weight-loss-and-regain pattern can shift body composition ratios of muscle and fat mass, predisposing to the development or progression of sarcopenic obesity[3] (a serious health condition of low muscle mass and function with excess fat mass[4]). Further, the evidence to support a benefit of weight loss in individuals with obesity and advanced-stage knee OA is unclear[5–7]. Considering these factors, there is a need to develop and test multimodal OA interventions that can optimize body composition rather than emphasize weight loss for individuals with obesity or a large body size[8].

Multimodal treatment approaches that include exercise and nutrition are known to improve body composition, strength and physical function[9], however they have not been adequately examined in adults who have both advanced knee OA and a large body size [defined herein as a body mass index (BMI) ≥35 kg/m^2, with further explanation of this purposeful terminology choice in **Table 1**]. Exercise is effective and recommended for everyone with OA, even in late-stages of the disease[10]. Resistance exercise may be particularly beneficial for adults with a large body size, as it can influence muscle mass and strength preservation relative to sarcopenic obesity prevention or exacerbation[11,12], and improve metabolic complications related to higher adiposity[13]. It is also tolerable even with advanced knee OA[14,15], and shown to have positive impacts on pre-operative function, strength and recovery after total knee arthroplasty[14,16]. Targeted nutrition can complement resistance exercise interventions through contributions to reducing adiposity and enhancing muscle mass[17]. Higher protein diets support anabolism and maintenance or increases in muscle mass[18].

The addition of self-management psychoeducation support (defined as patient education, advice or information[19]) as a complementary intervention modality may add further benefits to

multimodal interventions[16], including alleviating concerns about pain with exercise[20] or risk of damaging their joint further[21]. Psychoeducation can also enhance self-efficacy and provide tools and strategies for changing behaviours[22]. Taken together, this supports the potential benefit of a multimodal intervention that combines resistance exercise, nutrition and self-management support to optimize body composition and physical function in adults with advanced knee OA and a large body size. This type of approach has been under-examined to-date.

Importantly, there is a benefit of tailoring an intervention design to meet the needs and preferences of its intended recipients[23]. This can be accomplished through public-and-patient-engagement, whereby through consultation and dialogue the lived-experience and perspectives of potential end-users can be addressed in the development and preparation stage of new interventions. This involvement early in the research design process may improve acceptability and usability of new interventions[23], and reduce the known knowledge gap that occurs between efficacy of an intervention in a research setting and effectiveness in real-world clinical populations.

The aim of this engagement project was to connect and consult with members of the public who have knee OA and a BMI ≥35 kg/m^2 to incorporate their perspectives in the design and delivery of a multimodal intervention intended to prevent muscle loss. This specific population has not been previously consulted in the development of interventions for OA, despite the known benefits of patient involvement in this process[24].

Methods

Approach and design

A qualitative description approach[25] was used to engage with members of the public who have a large body size and knee OA. Engagement followed a consultation and dialogue model[26,27], whereby individuals with lived-experience provided feedback on a research intervention during the planning stage[26,27]. Knowledge gained from this work is informing the intervention protocol and conduct of a pilot randomized clinical trial [the POMELO (Prevention Of MusclE Loss in Osteoarthritis) study, registered on clinicaltrials.gov, identifier NCT05026385], but can inform the design of any multimodal OA interventions. This public-engagement project was conducted between April-June 2020, and received prior approval from the University of Alberta Health

Ethics Review Board. An electronic-survey (detailed in *Appendix B*) was used to facilitate the gathering of impressions on the proposed multimodal intervention. This project is grounded in constructivism, whereby there is an a priori understanding of the appropriateness of an intervention that is expanded, modified and confirmed through considering end-user perspectives[28].

Participants and recruitment

Purposive and voluntary sampling was used to engage participants. An electronic survey link was distributed on the Obesity Canada (OC) website and social media accounts (Twitter, Facebook). The link was also shared on social media by the research team and the leads of the OC Connect, a public engagement platform of OC. OC is a national charitable organization that works with policymakers, health professionals and the public on obesity education, research and advocacy. The link was open for eight-weeks (April 6 until June 3, 2020). Individuals were eligible for inclusion if they self-reported that they were ≥40 years old, had a BMI ≥35 kg/m^2, and had been told by a doctor that they have arthritis or OA in one or both knees. The consent process included a BMI calculator link to support self-assessment of eligibility. Participants were able to self-enroll and participate anonymously.

Survey process and data collection

The survey was managed using Research Electronic Data Capture (REDCap) tools hosted at the University of Alberta. Informed and implied consent of potential participants was collected electronically. Consenting participants provided demographic data about themselves prior to initiating the survey. This included their biological sex, gender-identity, age-group (40-49, 50-64, 65 years or older), residing area (specific province or territory, and general urban or rural setting), employment status, and estimated yearly household income (<$50,000, $50,000-99,000, ≥$100,000). Participants reported which knee(s) were affected by arthritis, their perception on the severity and how long they had been living with this condition, and whether a doctor had previously recommended they lose weight to help their arthritis.

Participants were provided with a written description of the proposed 12-week intervention plan, including weekly nutrition education, resistance exercises three times per week, and bimonthly self-management support for OA. After reading about the intervention, participants answered

open-ended electronic survey questions to share their perspectives. Survey questions were developed based on input from the research team, literature on patient treatment preferences[29], and advice from patient-engagement specialists. The full description of the intervention and survey questions are included in *Appendices A and B.*

At the completion of the survey, participants were directed to a separate REDCap database (unlinked to their survey to ensure responses remained anonymous) where they had the option to input their name and email address. This indicated their interest in being contacted for a one-on-one interview with a member of the study team to provide additional detailed perspectives. Individuals who agreed to an interview were contacted through email to arrange a time and method preference (videoconferencing or phone). Interviews were conducted by a research team member (KG) between May 13 and June 2, 2020. The interviews followed a semi-structured format, guided by a list of open-ended questions (*Appendix C*). Ongoing data review was used to determine when information redundancy (defined as no new insights arising) was reached and the survey could be closed to further enrollment. Written field notes were made by the researcher during the interview, and all interviews were audio recorded and transcribed verbatim. Participants did not personally review their transcripts.

Analysis

The written text from surveys and the transcribed information from interviews were aggregated and examined using a framework approach[30]. The researchers verified the transcripts for accuracy and completeness, and followed the recursive and reflexive process for thematic analysis proposed by Clarke and Braun[31]. This included immersion in the data, reading and re-reading of transcripts, survey responses, and field notes to identify manifest (directly observable) and latent (underlying) content, and identifying broader meaning through generalizations and patterns. The results are reported following consolidated criteria recommendations[32].

Framework of Acceptability

To provide an interpretative guide for the analyses, a framework was selected to support the relevance of findings. Acceptability is an important concept when considering behavioural OA interventions[33], defined as the perception of the healthcare intervention as appropriate or satisfactory[34]. The acceptability of an intervention has typically been assessed in trials through

rates of participant accrual, retention and adherence[33]. However, Sekhon et al.[35] argue that this may be too simplistic, as acceptability also involves cognitive and emotional responses to the proposed intervention[35]. Specifically, they propose a conceptual framework of acceptability for healthcare interventions that includes seven constructs (affective attitude, burden, ethicality, intervention coherence, opportunity costs, perceived effectiveness, and self-efficacy[35]); **Table 2** provides a brief description of each construct within this framework. They suggest that the perception of the acceptability of a healthcare intervention can be influenced positively or negatively under each of these concepts. This framework was used to guide our interpretation of patterns and themes into specific recommendations for the intervention design and delivery that could potentially influence perceived acceptability.

Results

The online survey was completed by twenty females living in four Canadian provinces (Alberta=7, British Columbia=5, Ontario=7, and Quebec=1). Participants predominantly reported bilateral knee OA (75%), with symptom onset ≥5 years prior (85%). A detailed description of survey respondent characteristics is provided in **Table 3**. Eleven survey participants further provided their contact information for a potential interview, and ten interviews were successfully completed [mean age of participants 54.7 years (SD 9.7, min 41, max 68); 50% were held via videoconferencing]. One participant was unable to be reached to arrange an interview. None of the participants had a prior relationship with any member of the study team.

Manifest results indicated an overall positive response to the proposed intervention, with 90% of survey respondents reporting that the intervention would be personally helpful to them: "*I have arthritis but don't qualify for surgery sometimes I really feel alone"(Survey participant 4). "My BMI is 46, I've had one knee replaced, & don't want the other one done because I was in pain for almost 2 years post-surgery. Trying to do it on my own is almost impossible. A 12 week program that would help me to lose weight, gain muscle, & improve functioning would be helpful." (Survey participant 9).*

Participants liked that the intervention was personalized: *"Comprehensive and tailored for those not just a bit on the overweight scale" (Survey participant 18). "That its individualized. I don't*

have full range of motion in my knees and would need alternatives to some exercises" (Survey participant 13).

Dislikes were primarily related to the length of the intervention: *"I've done 12 weeks of food and exercise programs before. It's not long enough for habit forming" (Survey participant 8). "Does not address mental health & emotional eating. Only 12-weeks" (Survey participant 9). "That potentially there will be no improvement and that it is only a 12 week program" (Survey participant 20).*

Participants felt that additional supports should be added: *"Address the individual's specific cause of obesity" (Survey participant 5). "More time with the dietician. Many of us have further dietary needs because of other health conditions" (Survey participant 8). "Referrals to where to go to sustain the behavior" (Survey participant 20).*

A few respondents specifically noted concerns regarding perceived weight stigma: *"Buys into stereo types that obese people are the way they are because they don't eat right and don't exercise" (Survey participant 5). "People are in charge of their bodies. You can explain everything to them, but nothing should ever be forced, that's as bad as fat shaming" (Survey participant 16).*

Self-management was identified as the most important component of the proposed intervention by the majority of survey respondents (45%; 9/20), with 25% selecting exercise, and 25% reporting that all components were equally important. *"I really don't think any are more or less important. For myself, my nutrition is good...but may not be the same for everyone" (Survey participant 9). "Nutrition: Perhaps not least important but likely least able to achieve" (Survey participant 14). "There are many on line resources such as Canada food guide, weight watchers, etc that can tell basic nutrition aspects, watch calories and for which people who have been overweight all their lives likely already are aware of the a b c's" (Survey participant 18). "I think for weight loss the nutrition component is most important, but for muscle building the exercise component is most important" (Survey participant 2).*

Latent results and reflection on the perspectives shared generated three prevailing patterns or themes. These were interpreted and identified by the researchers as key recommendations to consider in the intervention design and delivery to improve prospective acceptability by future

individuals. **Table 4** provides an overview of these three recommendations with illustrative participant quotes linked to constructs of acceptability. In summary, the three recommendations were:

1. Emphasize health gains over weight loss

The importance and potential benefits of the intervention relative to improving health (specifically OA-related aspects, such as increased strength and mobility, and decreased pain) should be emphasized to align acceptability-related coherence and expectations. Participants perceived that an expected outcome of the intervention would be weight loss, or expressed internal (i.e. personal) or external (i.e. from physicians or surgeons) expectations in this respect. These perceptions of weight-loss as a primary outcome, when it is not, need to be explicitly addressed and reframed to align participant expectations with the anticipated outcomes.

2. Support and language matter

The desire for extended support was strongly expressed by participants, and could influence acceptance and perceived effectiveness of the intervention. Participants overwhelmingly recommended an extension beyond the 12-week intervention timeline to elicit improvements in health. For some individuals, this concept of extended support was related to a need for access to comprehensive care for adiposity-related health (i.e. specific health providers, or healthcare coverage for associated costs), or a desire for positive and non-weight-biased connections with healthcare providers. For others, concerns were related to length of engagement, with anticipated expectations that 12-weeks is insufficient to elicit change based on lived-experiences. Concerns with language and terminology used (i.e. exercise, nutrition, counsellor) were brought forward by participants, indicating that attention to terms are critical when describing an intervention. Further, there was expressed anxiety relative to perceived or anticipated obesity stigma, emphasizing the importance of providing a supportive and unbiased intervention environment to ensure alignment with participant values.

3. Include options for customization

Opportunities to customize the proposed intervention by enabling participant autonomy to choose the delivery method or access to some components (i.e. remote or home-based exercise delivery; group versus individual sessions; opportunities to self-select additional education

sessions of interest) could influence perceived burden and support self-efficacy, thus enhancing acceptability.

Discussion

Acceptability is a critical component of interventions in healthcare, and understanding and incorporating the perceptions of potential participants in the design phase before enrollment is invaluable. This qualitative public-engagement work with females who have knee OA and a large body size generated three key recommendations to incorporate into a multimodal OA clinical intervention: 1) emphasize anticipated health improvements, 2) consider terminology and extended support, and 3) offer options for customization. Multiple constructs from the theoretical framework of acceptability[35] were connected within these three recommendations, supporting the complexity of developing an intervention that will be perceived as acceptable by all potential participants.

The importance of emphasizing health improvements anticipated from an intervention is critical in this clinical population, otherwise the focus may remain on weight loss as illustrated in our results. Aligning participant expectations and coherence with the intervention goals (in this case, improved muscle mass and physical function) may reduce the risk of expectations for weight change or perceptions of ineffectiveness. This could have a positive effect on enrollment and completion, and potentially reduce participant attrition. Prior qualitative work highlights that weight loss is often a motivator for exercise in women with a large body size[36], which can have negative consequences on continued involvement if body weight remains stable. Disentangling this perceived connection with weight loss is critical to emphasize the known benefits of exercise for OA-related health[37]. Further, qualitative studies identify that patients with a large body size are self-aware of the benefits of weight reduction for knee OA[21,38], but they also have lived-expertise regarding the difficulty of sustained weight loss[1,2]. This could lead to disengagement from an intervention based on prior negative experiences if they perceive weight loss as the primary goal. Therefore, clear communication of anticipated health improvements achieved through behavioural OA interventions that are uncoupled from weight change expectations is necessary. This will require targeted efforts from researchers and clinical providers designing OA interventions, as perceptions of weight loss as the primary goal for large bodies is widely present and maintained in societal biases[39].

The recommendation for extended support in the multimodal intervention may reflect participants' experiences of weight-based biases and barriers in access to comprehensive OA care[40]. There is variability in access to effective treatments for adiposity-related chronic disease, including bariatric surgery and medications[41,42]. This is paired with restricted access to surgical treatments for knee OA based on BMI categories[40,43]. Further, individuals with a large body size may have experienced weight-stigma in interactions with OA healthcare professionals[44,45]. Our findings suggest that perceived or anticipated obesity stigma could have impacts on intervention acceptability and contribute to avoidance of potentially beneficial care[46]. Therefore, planned OA interventions should actively contrast and prevent perceptions of bias to engage and involve this clinical population. Purposeful terminology and clear communication strategies around the intervention could support perceived acceptability. This includes avoiding labels that can be perceived as stigmatizing[47] [*Table 4*: *"Now that I'm obese (I hate that word)"*]. Further, including descriptions for terms (i.e. exercise: resistance-based to build muscle mass and strength; nutrition: strategies to promote muscle building nutrient intake) could clarify the objective of the intervention modality choice and reduce inadvertent perceptions of a 'move more, eat less' weight-focused approach[1]. Expanding the intervention timelines beyond 12 weeks may also improve self-efficacy for ongoing self-management. Longer term or extended contact (biweekly or monthly) has been shown to positively influence sustained behaviour change in adiposity-related health[48], and may thus enhance perceptions of intervention effectiveness.

Positive responses about intervention personalization were identified in our results, however, it was clear that this is a heterogeneous clinical population with diversity in life stage and health status. This is reflected in disparate participant responses (*Table 4*): *"I would question the ability to fit in this time commitment when working full time and having children"* versus *"I'm retired and I miss the structure of going to work and somewhere to go and something to do"*; and *"I have other health issues that would have to be addressed"* versus *"I am generally in excellent health considering my size".* This variability in employment and health status should be anticipated and considered in the intervention design. Adding flexibility and opportunities to enable participant autonomy for some intervention components could reduce perceptions of burden and opportunity costs that could hamper perceived acceptability. In this regard, customization is distinct from personalization, both fitting under an umbrella of individualization as defined by Ansmann and Pfaff[49]. Customization allows the intervention to be adapted to

patient-preferences (considering social, psychological and cultural dimensions), whereas personalization relates to biological dimensions (i.e. energy needs, functional capacity).

This public-engagement work is unique, and our findings support the value of consulting with end-users beginning from the intervention design phase. To our knowledge, no prior studies have engaged with this OA clinical population in this approach without focusing on weight loss[50].

Strengths and limitations

A strength of this public-engagement work was the high rate of survey participants who completed an interview (50%). This level of engagement may be a result of our purposeful approach and use of non-stigmatizing language. Perspectives shared were limited to female participants, as no males engaged in the online survey. This could be due to our method of sharing the survey link through social media avenues which may reach females more than males. This may also reflect the challenges with engaging men in discussions and treatments relevant to weight-related health, possibly requiring a medical-trigger event to instigate engagement[51]. There are gendered experiences related to having a large body size, with greater societal stigma and weight-biases reflected on women compared to men[52]. We were able to engage individuals with varied ages and socioeconomic circumstances, however information on race was not collected so the ethnic diversity of our participants is unknown. Additionally, this project may inadvertently have captured the voices of individuals who are already involved in some measure or interest in weight-related advocacy through their connections to Obesity Canada. The terms ‘patient’ and ‘public’ are included throughout this work to identify that participants were simultaneously members of the public and individuals managing a chronic health condition.

Conclusion

Females with knee OA and a large body size expressed positive feelings about a multimodal OA intervention targeted to prevent muscle loss and improve function. In sharing their perspectives, three key recommendations relevant to intervention acceptability were generated. Integrating these recommendations in the design and delivery of future multimodal OA interventions may improve perceived acceptability from this clinical population, and thereby support and enhance participant enrollment and retention.

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Table 1. Purposeful terminology and rationale in this patient-engagement project

Term	Definition	Rationale
Obesity	A chronic disease where excess adiposity negatively affects health[53]. Obesity is not diagnosed using BMI alone[53].	Obesity is routinely identified in patients and/or research participants with knee OA simply by BMI (based on WHO population definitions[54]). However, clinical guidelines recognize that obesity is a chronic disease not diagnosed in individuals simply using BMI[53]. Not all individuals with a large body size can be presumed to have adiposity-related chronic disease. Within this project there was no aim to diagnose obesity or assess adiposity-related health.
Large body size	A term used herein to describe individuals with a BMI ≥35 kg/m^2 who may or may not have the chronic disease of obesity.	This term (large body size) reflects our understanding that not all individuals with a BMI ≥35 kg/m^2 have obesity as defined above. This approach aims to avoid assumptions based on body dimensions and reflect that obesity identification requires diagnostic approaches beyond BMI. It also recognizes that broadly applying potentially perceived stigmatizing terms ["obesity" or "severe obesity"[47]] could negatively impact public and patient engagement efforts.

BMI = Body Mass Index, OA = osteoarthritis, WHO = World Health Organization

Table 2. Seven constructs in the acceptability of healthcare interventions framework

Construct	Definition
Affective attitude	An individuals' feeling about the intervention
Burden	Perceived effort required from the individual to participate in the intervention
Ethicality	How the intervention fits with the individuals' values
Intervention coherence	Extent of understanding how the intervention works
Opportunity costs	Values, profits or benefits that must be given up to participate
Perceived effectiveness	Perception that the intervention will achieve its purpose
Self-efficacy	An individuals' confidence they can complete the behaviours required in the intervention

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Table 3. Description of survey participants

Characteristic	**Participants, n (%)**
Gender, woman	20 (100)
Age category:	
40-49 years	7 (35)
50-64 years	11 (55)
65+ years	2 (10)
Reside in urban centre	14 (70)
Employment status:	
Work full-time or part-time	15 (75)
On disability leave	2 (10)
Retired, laid-off, unreported	3 (15)
Annual household income:	
< $50,000	6 (30)
$50,000 - $100,000	7 (35)
>$100,000	4 (20)
unreported	3 (15)
Knee(s) affected:	
Right	2 (10)
Left	3 (15)
Both	15 (75)
Length of time from arthritis symptom onset:	
<5 years	3 (15)
5-10 years	8 (40)
10-20 years	6 (30)
>20 years	3 (15)
Self-reported severity of knee arthritis:	
Mild	4 (20)
Moderate	9 (45)
Severe	7 (35)
Weight loss previously advised by physician to help arthritis symptoms, yes	19 (95)
Previous total knee arthroplasty, yes (unilateral)	2 (10)

Table 4. Three key recommendations, with illustrative quotes linked under constructs of acceptability

Recommendation	Illustrative comments from participants
1. Emphasize health gains over weight loss	**Perceived effectiveness** *"I've always attributed my problem to my weight and I figured if I lost weight, it would relieve the pressure. So I really haven't focused on my knee, on finding a program for arthritis. I always thought it'd be the weight that would help my walking, so I focused on my weight more, if that makes any sense."* Interview J *"I guess to help lose weight. Just to get the weight off the knees, it'd probably be a big help."* Interview A *"you could start off with just moving enough to try and help your joints, but even the doctors I went to […], they told me unless I lose weight, they're not going to help me. This is exactly what I was told."* Interview H
	Intervention coherence *"It seems like it is based on the basics of weight-loss and lifestyle changes."* Survey 11 *"I assume you think these things will reduce my arthritis but you don't discuss it."* Survey 17
	Self-efficacy *"So I think approaching it more from that angle, as being overall health rather than, 'Oh, this would help you lose weight', when an obese person is sick and tired of being told they need to lose weight."* Interview I *"I've gone to various things like The Weight Loss [clinic], I've gone to Weight Watchers, I've gone to Nutrisystem, I've done Jenny Craig. I've done them all."* Interview J *"But I have heard from so many people that that's the very first thing that they hear when they go to their doctor for anything is: 'Well, you need to lose weight.' So I think what you're doing sounds good by not putting it out there-- not making it one of the three components of your study."* Interview E
	Affective attitude *"I would be looking for something that was not just good nutrition but also would help with weight loss or at least weight maintenance."* Interview I *"Helping people, whether they want to lose weight or not lose weight, but helping them to feel better about their joints, their knee."* Interview G
2. Support and language matter	**Intervention coherence** *"'Exercise, nutrition' automatically that says, 'Eat less, move more'. That's what that says because fat people have heard that all their lives, right? […] I honestly think we need to get rid of that word 'exercise'. You could talk about in terms of mobility."* Interview C *"Learning where I need to start is most important for me. Learning how to do something and be confident is also important. […] I worry about doing exercise that a skinny little thing would put me through. This is done by someone who knows the issues posed by obesity."* Survey 11
	Affective attitude *"[Follow-up] every couple of weeks, a month, every month kind of thing. Just a random email or videoconference sign-up to ask, 'How you doing? How's things going?' And that would be fine. At least you know someone's caring enough to follow-up with you, right?* Interview A

Recommendation	Illustrative comments from participants
	"[Dislikes]*: That potentially there will be no improvement and that it is only a 12-week program.* [Missing]*: Referrals to where to go to sustain the behavior.* [Length: too short] *12-weeks while helpful at times is not enough time to stay on track."* Survey 20
	Self-efficacy *"Does self-managed mean no other person will help me?"* Survey 14 *"I have battled with food addiction issues most of my life, I've never had well rounded support in dealing with it earlier. If I had I might not have the physical issues I do now."* Survey 10 *"If you made it clear exercises classes would offer some privacy. Only for larger people. Not intimidating."* Survey 13
	Opportunity costs *"Health behaviour change councillor- not feeling trusting of this person already"* Survey 17 *"People with a BMI in this range have likely been embarrassed to seek help like this due to be body shamed by some medical professionals and gyms."* Survey 18 *"Buys into stereotypes that obese people are the way they are because they don't eat right and don't exercise. […] Stop the shame."* Survey 5
	Ethicality *"Many of us have gone through this type of thing before. We've been made to feel as if it's our fault we are large. I personally have gained weight because of my arthritis and asthma. Now that I'm obese (I hate that word) it's suddenly my fault when I received no help before."* Survey 8 *"I get that a lot of people are like, 'No, big women can't be healthy' And they're perpetuating this thought that […] you can't be overweight and healthy. Well, I think you can be overweight and healthy."* Interview D
3. Include options for customization	**Self-efficacy** *"I am generally in excellent health considering my size."* Survey 2 *"I still am very physical with my job despite my arthritis."* Survey 17 *"I am not strong & have poor balance, so need to start slowly."* Survey 9 "[Missing]: *More time with the dietician. Many of us have further dietary needs because of other health conditions."* Survey 8
	Burden *"Location will be the most important. I know I take transit and I won't travel 2 hrs by bus to go to a program and the time you schedule it for. […] There are so many programs out there that people can pay for but there are people out there like myself that cannot afford it."* Survey 7 *"I'm not a big group support person and I would question the ability to fit in this time commitment when working full time and having children."* Survey 3
	Affective attitude *"*[Dislikes]: *Looks or seems too rigid.* [Missing]*: Let the patient give suggestions or ask about alternative treatments."* Survey 16 *"I have other health issues that would have to be addressed. My arthritis is not my worst problem."* Survey 8 *"I think a program like this would be great if people can afford it [.] I know I would participate the main thing is to understand each person that participates [.] I know I have had trainers who pushed me to[o] hard in the past I couldn't walk for a week."* Survey 7

Recommendation	Illustrative comments from participants
	Opportunity costs *"And I think, again, from my own perspective, if I was having to travel somewhere, if it was in winter, it would be more of a chore. It would be like, 'Okay, well, we have to cancel this week because of the snow.' […] I would have no problem going three or four times a week provided it fitted in with the rest of my schedule."* Interview I *"I also find that I'm quite young in comparison to some of the other people in the groups."* Interview A *"It all depends on when the group meetings will happen, as many people work full-time."* Survey 1 *"I'm retired and I miss the structure of going to work and somewhere to go and something to do. And I actually think I'd look forward to something like that."* Interview J

Appendices

Appendix A. Written description of proposed intervention provided to survey participants

We are developing an intervention for adults who have a large body size and advanced knee arthritis. This intervention is based on research that suggests improving body composition (particularly muscle mass) and increasing strength may have advantages over weight-loss focused approaches when knee arthritis is more advanced. The proposed intervention is planned as a combination of personalized nutrition, progressive resistance exercise, and a self-management support group provided over a 12-week period. This intervention program will initially be provided at no-cost to participants at a centralized location.
Here is an overview of the proposed intervention:

Nutrition:

- Personalized nutrition recommendations will be provided for all participants.
- Participants will have their energy needs precisely estimated at the beginning of the program to estimate how many calories they need each day.
- Each participant will then receive one individualized nutrition counselling session with a Registered Dietitian (RD). The RD will provide recommendations for a higher protein diet to promote maintenance or increased muscle mass.
- Additionally, participants will attend a weekly nutrition education group with the RD for 12-weeks.
- Each month, participants will also complete and return to the RD a three-day food record (writing down all food and drink consumed over a three-day period).

Exercise:

- A personalized progressive resistance training exercise program will be provided for all participants. Resistance training (also called strength training) involves repeat lifting, pulling or pushing a weight to improve strength and muscle. Progressive means the training is adjusted as the individual gets stronger.
- Participants will each have an individual session with a Qualified Exercise Professional (QEP) to design a resistance training exercise program that addresses personal factors that may require alternative exercise approaches or techniques.
- Participants will then attend supervised group exercise sessions at a centralized location three-times per week, for 12 weeks. Each session will last approximately one hour, and begin with a 15-20 minute warm-up to reduce arthritis-related pain flares. The session will then involve resistance training exercises involving the whole body. Exercises will be either machine-based or use free weights, depending on the participant needs and preferences. The QEP will supervise the sessions and instruct, adjust or alter exercises for participants as needed and advise on progression.
- Participants will be encouraged to participate in physical activity (including activities such as swimming, walking or cycling) outside of the supervised exercise sessions as part of a healthy lifestyle approach.

Self-Management Support Group:

- All participants will meet in-person as a group twice per month with a health-behaviour change counsellor to discuss strategies to manage their arthritis symptoms and support ongoing healthy lifestyle behaviours (including sleep, physical activity, nutrition, and stress management).

Appendix B. Electronic survey questions regarding the proposed intervention

1. What do you like about the proposed intervention?
2. What do you dislike about the intervention?
3. What do you feel is missing from this intervention, or could be changed to improve the intervention?
4. Do you feel this intervention would be helpful to you personally? Please comment further.
5. Do you feel this intervention is appropriate for adults living with knee arthritis and a large body size? Please comment further.
6. In your current state of health, would it be feasible for you to participate in this intervention that includes nutrition, exercise and self-management support? Please comment further.
7. What are your thoughts about the LENGTH of the intervention (12 weeks): a) just right b) too short, c) too long. Please comment further
8. What aspect of the intervention do you feel is the MOST important? a) nutrition, b) exercise, c) self-management. Please comment further.
9. What aspect of the intervention do you feel is the LEAST important? a) nutrition, b) exercise, c) self-management. Please comment further.
10. What education material (if any) should be provided with the intervention (i.e. paper handouts, website, online-videos)?
11. What are your recommendations on how we could best enroll and retain patients in this type of intervention?
12. Do you think patients would pay for a program such as this? If yes, what is a fee you would be willing to pay for an intervention program like the one proposed?
13. What other methods of delivery should we consider for this intervention? [i.e. internet videoconferencing, telehealth videoconferencing (available at local hospital), home exercise alternatives, community exercise alternatives (i.e. at YMCAs, or city/town recreation facilities), virtual reality options (i.e. simulated experiences using 3D digital technology), other options not stated]
14. Please share any final comments, concerns, ideas or suggestions for the development of this intervention that we may not have not discussed or considered.

Appendix C. Semi-structured interview guide

1. Have you previously participated in any treatment programs for knee arthritis? What has been effective in managing your symptoms?
2. What would be the most important goal or outcome for you after an intervention program such as this?
3. Are there parts of this intervention that you feel are most important? How about least important?
4. What would you expect/hope to receive out of:
    a. a nutrition education program?
    b. a self-management program for arthritis?
    c. an exercise program?

What might be most or least important for you in these three areas? Would you have any concerns with participating in a resistance/strength training program?

5. Do you feel that this intervention could appear to support a "move more eat less" approach by including a focus on nutrition and exercise? Is there alternate messaging that could be used to reduce this perception?
6. Accountability has been mentioned by survey respondents as important. How could we encourage and support ongoing involvement?
7. What might stop you from participating in this intervention?
8. What might encourage you to participate?
9. Survey respondents have indicated that 12-weeks is a good start, but longer support would be beneficial. Do you agree or disagree with this, and what type and length of support would you find beneficial?
10. Have you found any arthritis programs or online resources that have been personally helpful for you? Have you found any that have been designed for individuals with a large body size?
11. Is there anything else you would like to share or add to your responses?