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Feasibility of 'parkrun' for people with knee osteoarthritis: A mixed methods pilot study

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ABSTRACT

Objective: To investigate the feasibility of 'parkrun' for people with knee osteoarthritis (OA) and examine its potential to improve symptoms and increase physical activity.
Design: This uncontrolled mixed methods pilot study enrolled people with knee OA not meeting physical activity guidelines. Participants were asked to walk in four consecutive parkrun events supervised by an exercise physiologist/physiotherapist. Feasibility was assessed by recruitment data (numbers screened and time to enrol 15 participants), adherence to the protocol, acceptability (measured by confidence, enjoyment, difficulty ratings and qualitative interviews), and safety (adverse events). Secondary measures were changes in knee pain, function, stiffness, and physical activity levels.
Results: Participants (n = 17) were enrolled over 11 months and recruitment was slower than anticipated. Fourteen participants attended all four parkruns and three of these participants shortened the 5 km course to ~3 km. Across all four parkruns, 75% of participants reported high confidence that they could complete the upcoming parkrun and the majority (87%) enjoyed participating. Most participants rated parkrun either "slightly difficult" (38.5%) or "moderately difficult" (35%) and two mild adverse events were reported. Participants showed improvements in knee pain, function, stiffness, and physical activity levels.
Conclusions: This pilot study demonstrates parkrun's feasibility, acceptability, safety and, its potential to improve knee OA symptoms and physical activity levels. Participating in parkrun was acceptable and enjoyable for some, but not all participants. The scalability, accessibility and wide appeal of parkrun supports the development of larger programs of research to evaluate the use of parkrun for people with knee OA.

1. Introduction

Physical activity improves pain, function, and quality of life in people with osteoarthritis (OA) [1,2]. Despite this, only 13% of people with knee OA meet physical activity guidelines [3]. The reasons for low physical activity levels are complex but may be partly due to a common misconception that exercise could cause joint harm or worsen symptoms [4]. However, many of the barriers to physical activity participation are not unique to people with knee OA. Identifying effective, low-cost, accessible, and sustainable strategies to increase physical activity in people with knee OA is crucial to help them better manage their disease and reduce their risk of comorbidities.

'parkrun' is an international movement of free, 5 km walk/run events held once per week in public green spaces (www.parkrun.com). With over 400 sites in Australia and 2200 worldwide, parkrun represents a promising setting for physical activity promotion as it addresses many of the common barriers to physical activity [5]. parkrun has been shown to be attractive to non-elite runners and walkers [6,7] and appeals to population groups who are traditionally difficult to engage in physical activity (e.g., women, older adults, those who are overweight/obese, and those who are insufficiently active) [8,9]. There is potential for parkrun to meaningfully increase physical activity levels [6] and encourage the uptake of additional exercise to improve fitness [9]. Moreover, the emphasis on inclusion, opportunities for social interaction, rewards for

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participation, accountability, and gentle competition encourages maintenance, a key component of an effective intervention [9,10].

Research on the public health potential of parkrun is a new and emerging field [5]. Recently published studies and commentaries are showing acceptance and potential benefits to prescribing parkrun for patients in primary care [11–14]. However there is limited research into the potential for using parkrun to better manage chronic health conditions [15].

To the best of our knowledge this study is the first to investigate the feasibility of using parkrun for people with knee OA. A secondary aim was to examine its potential to improve symptoms and increase physical activity participation in people with knee OA.

2. Methods

2.1. Study design

This uncontrolled pilot study was conducted in Southern Tasmania, Australia. Participants with clinically diagnosed knee OA were asked to participate in four consecutive parkrun events at a pre-determined location, supported by study staff. Feasibility was assessed using mixed methods with quantitative data collected by surveys (outlined below) and qualitative data by interviews held with participants at both a screening/baseline and post-intervention appointment. Baseline interviews were conducted in person at the Menzies Institute for Medical Research, University of Tasmania. This research study was registered with the parkrun Research Board and Australia New Zealand Clinical Trials Registry (ACTRN: 12618001568202). Ethics approval was granted by the Human Ethics Committee Network Tasmania (H0017508). Written informed consent was obtained from all participants.

2.2. Recruitment and screening procedure

Recruitment took place between February and November 2019 by advertising on social media, in local newspapers and snowballing from other studies recruiting within the institution. Participants were initially screened over the phone against inclusion/exclusion criteria (described below), then attended a face-to-face baseline appointment to confirm eligibility, obtain written informed consent and collect the following information: demographic information (date of birth, highest education level, marital status), medical history (injury history, current medications, Adult Pre-Exercise Screening), current physical activity levels assessed by the International Physical Activity Questionnaire-Short Form (IPAQ-SF), and, height and weight. A physical examination was conducted by a research physician to confirm a diagnosis of knee OA according to the ACR criteria [16].

2.3. Inclusion and exclusion criteria

Participants were eligible if they were aged 45 years or over, met the ACR clinical criteria for knee OA [16] and had symptomatic knee OA for at least 6 months with a pain visual analogue scale (VAS) score of 20 mm–80mm/100 mm over the last 7 days. Participants needed to be able to walk 75–100 m and not meet physical activity recommendations [17] (i.e., physical activity no greater than 150 min/week of moderate to vigorous activity, which equates to <500 metabolic equivalents (MET) minutes (mins)/week (assessed using IPAQ-SF [18])). Participants needed to be willing and available to participate in the intervention, attend baseline and post-intervention interviews and provide informed consent. Participants with any conditions that precluded safe participation in exercise (e.g. a heart condition), as assessed by the Adult Pre-Exercise Screening Tool (stage 1) [19], could be enrolled provided they received medical clearance from their general practitioner (GP).

2.4. Intervention

Participants were given general information about parkrun at their baseline appointment and were provided with assistance to register. It was explained that once registered, they would receive a unique barcode which is scanned at the completion of each parkrun and records finish times. parkrun emails individual finish times to each participant and publishes them publicly on their event website. For this study we asked participants to attend the Queen's Domain parkrun for four consecutive Saturday parkruns. The course was chosen due to its central location in Hobart, its circular course format which allows for early withdrawal if required, and lack of significant uphill or downhill terrain. Each parkrun event was supervised by one of two exercise physiologists (EPs) or a physiotherapist who were qualified to administer exercise for OA patients. One research staff member (LS) also attended each parkrun to support the participants and collect data. All study staff were trained in the study protocols, including the administration of the intervention, monitoring and measuring knee pain and adherence. Participants did not receive additional information or resources for managing their OA and were advised to continue with their normal management strategies. However, they did have the opportunity to ask study staff questions related to their OA.

Participation in the intervention occurred between April 2019–January 2020. Participants completed a short questionnaire administered by research staff before and after each parkrun and their completion times were recorded through the pre-existing parkrun system. If a participant did not complete the full 5 km, time and distance was recorded manually by research staff.

2.5. Primary outcome measures

The primary outcome was feasibility assessed by:

2.6. Recruitment data

Recruitment data, determined by numbers screened, numbers eligible and interested, and time to enrol 15 participants.

2.7. Adherence to protocol

Adherence was measured as the number of participants completing all four parkruns and the number of participants who completed the full 5 km course.

2.8. Acceptability

Acceptability was assessed using three measures: confidence to complete the course, level of enjoyment and perceived level of difficulty. Confidence to complete the upcoming course was self-reported before each parkrun and rated on a scale of 1–10 with 1 being “not at all confident” and 10 being “extremely confident”. Enjoyment was measured after each parkrun using the first item of the Physical Activity Enjoyment Scale [11]. Participants rated their level of enjoyment from 7–1 (7 being “I hate it”, 1 being “I enjoy it”). Perceived level of difficulty was rated on a Likert scale from “not difficult”, “slightly difficult”, “moderately difficult” to “extremely difficult”.

Further details on acceptability were assessed during semi-structured qualitative interviews held with participants at the baseline and post-intervention appointment. Interviews were guided by an interview schedule (Supplementary File 1) with questions designed to assess acceptability of the intervention, including what participants liked and disliked about parkrun, how it suited their lifestyle, whether they were interested in continuing, and perceived change in symptoms. However,

all interviews followed the natural flow of the conversation and focussed on individual participant experiences [20].

2.9. Safety

All adverse events were monitored and recorded throughout the study by EPs/physiotherapists and research staff (LS). Adverse events were defined as any participation-related problem that lasted for >2 days and/or caused the participant to seek other treatment. To prevent adverse events, individual participants were supported to self-regulate their exercise intensity and knee pain levels and reduce the length of the course, if necessary, in consultation with the attending EP/physiotherapist. Each participant rated their pain on an 11-point numeric rating scale (NRS-11) [21] before and after each parkrun to monitor acute pain exacerbations. The difference between NRS-11 pain values was considered a change in pain evoked by the parkrun event. Acute increases in pain were monitored by the attending EPs/physiotherapists.

2.10. Secondary outcome measures

Knee pain, function, stiffness, and physical activity levels were assessed at baseline and post-intervention (1–2 weeks after the final parkrun). Knee pain was assessed by VAS and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [22]. Knee function and stiffness were also assessed by WOMAC. Physical activity levels were assessed as total MET mins per week using the IPAQ-SF. Medication usage & changes were recorded at baseline and post-intervention appointments.

2.11. Statistical analysis

All quantitative analyses were performed using STATA (version 16; StataCorp, College Station, TX, USA). Descriptive statistics (mean (SD)), frequencies and percentages with confidence intervals) were used to describe the characteristics of the sample, recruitment data, adherence to the protocol, medication usage, acceptability measures, secondary outcomes, and adverse events. Changes in outcomes were calculated as the difference between post-intervention and baseline measures and are presented as the mean change or percentages with 95% confidence intervals. Changes in physical activity levels are presented as the median change and inter-quartile ranges, as per the IPAQ-SF validity and reporting guidelines [23]. For confidence, enjoyment and difficulty ratings, results were averaged across all four parkruns.

Qualitative interviews were transcribed verbatim and analysed using NVIVO software (QSR International). All interviews were read and coded by LS using an iterative and inductive process. LS and KJ met regularly during the coding process to discuss coding decisions, emerging themes and to refine the analysis. Justification and criteria for coding was recorded within nodes and in the project log in NVIVO. Any disagreements were resolved via discussion. Coding decisions, key concepts, ideas, and reflections were recorded in the project log and memos by LS [24]. Transcripts were analysed thematically [25], key themes were identified and then built upon during analysis until no new themes were emerging. All illustrative quotes are identified as the participant "P" with a randomly assigned number e.g., P01/P12.

2.12. Integration of qualitative and quantitative findings

A variety of methods exist for integrating data in mixed methods studies. These include concepts of merging, connecting and embedding data [26,27]. In this study the data was merged, with complementary integration of data from qualitative and quantitative sources with respect to key outcomes: acceptability, adherence, pain, and function.

3. Results

3.1. Recruitment data

Twenty-seven participants were screened for eligibility and four were excluded for not meeting the inclusion criteria (Fig. 1). Six out of 23 eligible participants chose not to participate for several reasons: walk distance, perceived difficulty, ongoing illness, worsening pain, personal reasons, and one participant was unable to be contacted. While recruiting, it was noted that some participants expressed apprehension about participating because the name 'parkrun' led them to believe they would only be able to take part if they ran. Seventeen participants were enrolled over eleven months.

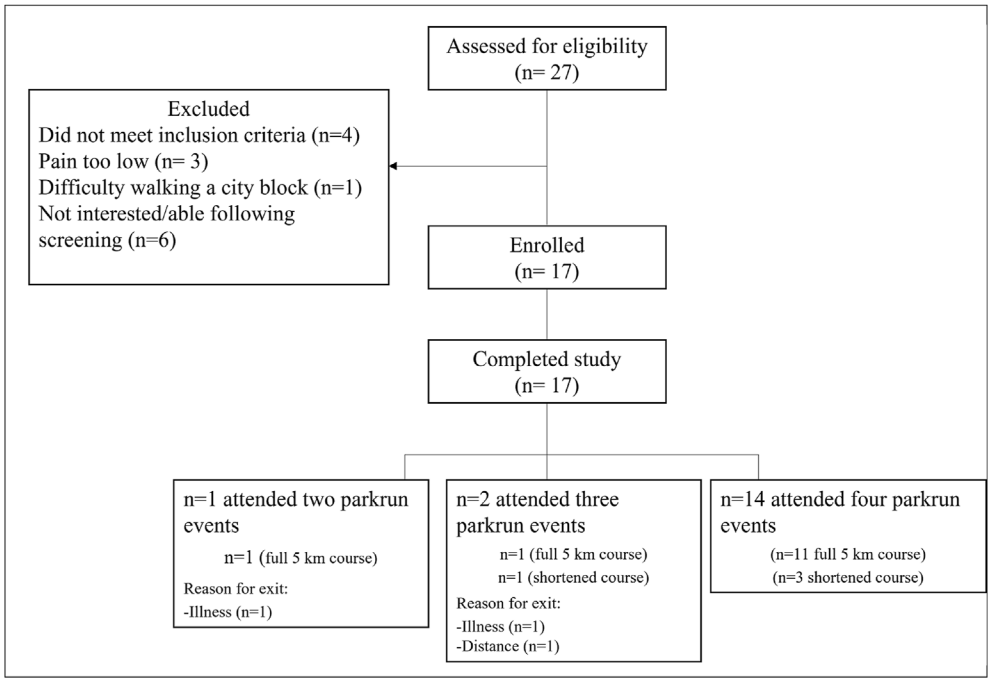

Fig. 1. Flow diagram of participant recruitment and completion.

3.2. Participant characteristics

Participant baseline characteristics are presented in Table 1. The mean age was 66.9 years (SD 7.7), the mean BMI was 29.9 kg/m^2 (SD 5.9) and there was a higher proportion of women (65% (n = 11/17)) than men. No participants had previously participated in parkrun, and all reported sedentary or low levels of physical activity with a median of 297 MET/min/week. During baseline interviews, participants reported their primary forms of physical activity were walking (purposefully for exercise or for leisure), gardening, and participating in sports like golf, tennis, and swimming. When asked about their thoughts on walking, most reported enjoying walking for exercise however emphasised that they preferred to walk with other people, for a specific purpose, or in a stimulating environment such as a bush walk rather than a city walk. Interviews yielded some reasons for low activity levels including knee pain, lack of motivation and time.

3.3. Adherence to protocol

Fourteen participants attended four parkrun events, with eleven of them adhering to the full protocol (full 5 km length course) and three of them shortening the 5 km course to ~3 km (Fig. 1). Two participants attended three parkrun events with one of them choosing to shorten the distance. One participant attended two full-length parkrun events. Participants who shortened the course indicated during their post-intervention interview that they were frustrated by their inability to complete the course and did not enjoy being at the back of the walking group. Participant 21 (P21) described their experience post-intervention: *"Well, I liked the community effort of it. What I didn't like was the fact that I was unable to complete the course, because of my difficulties."* Average completion times for each parkrun are outlined in Table 2.

Table 1
Baseline characteristics of participants.

Baseline characteristics (N = 17)	Mean (SD)[a]
Age, years	66.9 (7.7)
Women, *n* (%)	11 (65%)
Marital status *n (%)*	
Married/Partnered	14 (82%)
Divorced/Single	3 (18%)
Education level *n (%)*	
Year 11 or below	2 (12%)
Certificate III/IV	1 (6%)
University	14 (82%)
Weight, kg	83.4 (17.2)
Height, cm	166.8 (8.09)
BMI, kg/m^2	29.9 (5.9)
Physical activity levels, median MET/min/week (quartiles 1,3)[b]	297 (240, 396)
VAS pain (0–100 mm)	55.1 (11.6)
WOMAC pain score (0–500)	232.1 (63.4)
WOMAC function (0–1700)	741.4 (274.2)
WOMAC stiffness (0–200)	100.1 (31.2)
Medication usage	
Number of pain medicines, *n* (%)	
0	5 (29%)
1	8 (47%)
2	4 (23%)
Paracetamol usage, *n* (%)	7 (41%)
NSAIDS usage, *n* (%)	6 (35%)
Use of orthotics, *n* (%)	6 (35%)
Use of a knee brace[c], *n* (%)	3 (17%)
Number of chronic conditions	
None, *n (%)*	9 (53%)
One chronic condition, n (%)	3 (18%)
Two or more conditions, n (%)	5 (29%)

[a] Mean (SD) unless otherwise stated.
[b] 500 metabolic equivalents (MET) mins per week equates to 150 min moderate intensity physical activity per week.
[c] Knee brace used as needed, not specifically for the study.

Table 2
Average completion times per parkrun.

	Parkrun 1 Mean (SD)	Parkrun 2 Mean (SD)	Parkrun 3 Mean (SD)	Parkrun 4 Mean (SD)	Mean[b] (SD)
Completion time[a] (minutes/ seconds)	55.3 (5.2)	51.7 (5.8)	50.0 (4.8)	48.6 (5.8)	50.9 (2.2)
Total n	13	13	12	11	

Note, average time for completion reported by parkrun Australia is 32 min and 57 s (parkrun.com.au).
[a] Average completion time per parkrun for participants who completed the full 5 km course (n).
[b] Average time across all four parkruns.

3.4. Acceptability

3.4.1. Pre-parkrun questionnaires/interviews

On average, across all four parkruns, 75% of participants reported high confidence (>6/10) (Table 3). At study commencement 16 of the 17 participants had not heard of parkrun. During baseline interviews, participants described positive attitudes towards participating in parkrun. Participants reported the most appealing aspects of parkrun were the regular commitment, the fact it was a global phenomenon and the feeling of being a "part of something". Participants also enjoyed the feeling of being motivated to do more physical activity, perceived potential improvements to fitness, the nature/park environment of parkrun, and the convenience of the location. For example, P26 said at baseline: *"Well, yeah, I think it would be a good thing to walk with others, and so on. I think I'm actually looking forward to doing it."* While parkrun was generally acceptable, a small number of participants highlighted some concerns. These concerns included: their ability to finish the whole 5 km course, the difficulty of the terrain, the early 9:00am start time, whether they would need to run, and the potential for increased knee pain. For instance, P14 (baseline interview) explained: *"It is (a concern) mainly the 5 km and as long as its not too uphill or downhill, reasonably a smooth path it shouldn't be any trouble."*

3.4.2. Post parkrun questionnaires/interviews

Most participants (n = 15, 87%) enjoyed participating in parkrun (Table 3). Difficultly ratings varied, but on average across all four parkruns, 25.1% rated parkrun 'Not difficult', 38.5% 'Slightly difficult', and 35.0% 'Moderately difficult'. Only one participant rated their third parkrun as "Extremely difficult". There did not appear to be a trend of increasing or decreasing difficulty with each parkrun (Supplementary File 2). Over the course of the intervention, some participants increased their walking pace but did not progress to jogging or running. Participants described the social component and being part of a group/community exercising together as the most enjoyable aspects of parkrun. Other positive aspects were the ongoing commitment, a reason to get moving on the weekend, having other people to motivate them, and improving their completion time. P18 (post-intervention) described: *"Well, the social context and the setting … - the site, the location, and the social aspect of being there with a bunch of other people."* P21 (post-intervention) gave their reason for enjoyment as: *"The fact that a lot of other people are involved in it."*

The least enjoyable aspects reported by some participants were the time of the week/day (Saturday mornings at 9 a.m.), difficulty completing the event, and feeling discouraged by other participants who were fitter or faster. Having their time published publicly on the website was also a concern for some participants. As P18 (post-intervention) explained: *"I think what I liked the least is the taking your time and having it publicly displayed. Even if I was given my time emailed to me and it didn't appear on the bulletin board, or the set of results that was there [I would prefer that]."*

Table 3
Acceptability measures.

Outcome, across all four parkruns	% (SD)	Quotes
Score >6 for Confidence they could complete the upcoming parkrun (Scale 1–10, higher is more confident)	75.0 (6.5)	*"I think I'll be fine, because it's motivating, and it'll be out in the fresh air and I'll be in a nice place."* *"It is [a concern] mainly the 5 km and [I could do it] …. as long as its not too uphill or downhill, reasonably a smooth path it shouldn't be any trouble."*
Score <3 for Enjoyment (Scale 7–1, lower is more enjoyment)	87.4 (1.2)	*"Well, the social context and the setting [were enjoyable], the physical - the site, the location and the social aspect of being there with a bunch of other people."* *"[I enjoyed] The fact that a lot of other people are involved in it."* *"I think what I liked the least is the taking your time and having it publicly displayed …"*
Difficulty Level		*"Well, I liked the community effort of it. What I didn't like was the fact that I was unable to complete the course, because of my difficulties."* *"So, for me it was hard, but as an idea if people are able to walk better than me, well then yeah, I think it's great, a great thing."*
Not difficult	25.1 (8.4)	
Slightly difficult	38.5 (13.0)	
Moderately difficult	35.0 (16.0)	
Extremely difficult	1.6 (N/A)	

There were mixed reviews from participants about walking with a group of runners, with some neutral, others finding it enjoyable and motivating, and others finding it de-motivating. Most participants, however, were unconcerned by it. P14 (post-intervention) described: *"I would probably sooner walk with walkers. Yeah, with people my age sort of thing."* P23 (post-intervention) explained: *"Doesn't matter, they run off and they run back, and we pass each other and - you could be a stranger in the street, and it just doesn't matter. I think the concept of having a walking group with parkrun is fabulous …"*

Table 4
Change in numerical rating scale (NRS-11) knee pain before and after each parkrun.

	NRS score, 0–10		Change in NRS score, mean (95% CI)
	Pre-exercise, mean (SD)	Post exercise, mean (SD)	
First parkrun event ($n = 17$)	3.4 (1.8)	4.4 (2.2)	0.94 (0.005, 1.87)
Second parkrun event ($n = 17$)	3.1 (2.0)	4.0 (1.9)	0.94 (−0.33, 2.22)
Third parkrun event ($n = 16$)	3.8 (1.4)	4.4 (2.4)	0.62 (−0.54, 1.79)
Fourth parkrun event ($n = 14$)	3.0 (1.5)	3.3 (2.4)	0.28 (−0.66, 1.23)

NRS, Numerical rating scale, SD: standard deviation, CI: confidence interval.

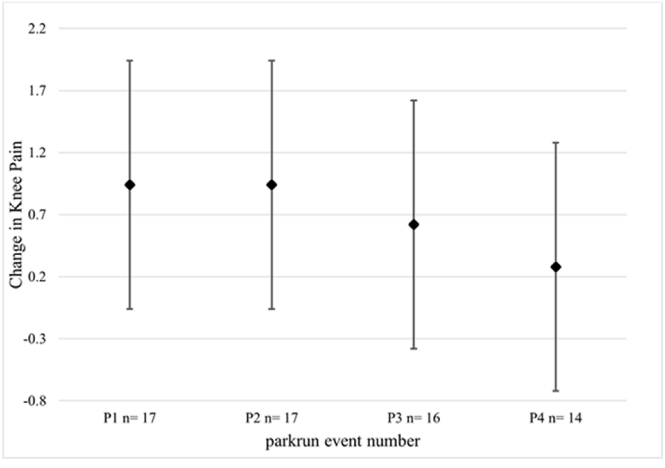

Fig. 2. Acute changes in knee pain on numerical rating scale (NRS-11) (0-10) before and after each parkrun.

3.4.3. Safety/adverse events

Two non-serious adverse events were reported (n = 1 foot pain, n = 1 increased knee pain). After a rest, both participants were able to continue the parkrun in which the event occurred with support from the attending EP/physiotherapist and remained in the study.

On average, participants reported an acute increase in their knee pain after each parkrun, but the increase in pain appeared to decrease with the subsequent parkruns. Mean increase on the NRS ranged between 0.94 and 0.28 (Table 4 and Fig. 2).

3.4.4. Secondary outcomes

VAS knee pain improved from baseline to post-intervention, a change of −17.7 mm (95% CI -29.4 to −5.9) (Table 5). Participants also showed improvements in WOMAC pain, function, stiffness, and physical activity levels. The number of participants not regularly taking any pain medication changed from 5 at baseline to 10 post-intervention (Table 6).

Table 5
Change in secondary outcomes from screening/baseline to post-parkrun intervention.

Symptoms	N Baseline Mean (SD)		N	Post Mean (SD)	Change (95% CI)
Knee pain VAS (0–100 mm)	17	55.1 (11.6)	17	37.5 (18.3)	−17.7 (−29.4, −5.9)
WOMAC pain score (0–500)	17	232.1 (63.4)	17	171.2 (91.3)	−60.8 (−107.2, −14.4)
WOMAC function (0–1700)	17	741.4 (274.2)	17	531.6 (251.9)	−209.8 (−367.0, −52.5)
WOMAC stiffness (0–200)	17	100.1 (31.2)	17	61.8 (44.6)	−38.3 (−61.1, −15.5)
Physical activity, median MET mins/week (quartiles 1,3)*	17	297 (240, 396)	16	438 (240, 819)	+141 (−99, 633)

VAS: Visual analogue scale, WOMAC: Western Ontario and McMaster Universities Arthritis Index, MET: metabolic equivalent, *500 MET mins/week equates to 150 min moderate intensity physical activity per week.

Table 6
Number and type of pain medication at baseline and post intervention.

Number and type of medication	Baseline n (%)	Post intervention n (%)
0	5 (29%)	10 (59%)
1	8 (47%)	6 (35%)
2	4 (23%)	1 (6%)
Paracetamol	7 (41%)	6 (35%)
NSAIDS	6 (35%)	2 (12%)

NSAIDS: Non-steroidal anti-inflammatories.

In line with the objectively measured improvements in symptoms, most participants reported feeling less pain and stiffness throughout the study. For example, P27 (post-intervention) described: *"Yes. In that four-week time, on the first few there was still a little bit of pain there after each [parkrun]. On the last one, and I pushed myself moderately hard, there was no pain at all. I was quite surprised. Whether it's the warmth or whatever, but it was far better."* P9 (post-intervention) affirmed: *"Yes I have noticed it's not as stiff as it was each time I did it. In the morning when I woke up it wasn't as stiff."* Some participants also mentioned that parkrun provided them with additional motivation to continue walking even when they were experiencing pain. P18 (post-intervention) explained: *"I have probably pushed through a bit more in ways that I wouldn't have done before. If I felt some niggling pains, I probably would have stopped and rested … but I thought well, let's keep going. I am determined to finish … I actually felt better at the end."*

Following the intervention, while not all participants said they would continue taking part in parkrun, a number intended to continue at the same parkrun or others in their local area. Most participants mentioned they were motivated to continue increasing their physical activity beyond parkrun by walking more, joining a gym or group exercise class, and being more active such as parking the car further away and walking. P14 (post-intervention) described: *"As I say, just probably walking a bit more than I was before. I wasn't walking much at all before whereas now I am keen to do walks for up to about half an hour."* While acknowledging that they should be more active, some participants admitted that they would probably not change their habits following the study. P23 (post-intervention) explained: *"I do short walks … But no, it probably won't change it. It might encourage me to do more stretching after I do exercise … It's reminded me that I need to do it."*

4. Discussion

This is the first study to assess the feasibility of using parkrun for people with a specific chronic disease. Our results show that parkrun is feasible, acceptable, and safe for some people with knee OA and has the potential to result in improvements in symptoms and overall physical activity levels.

There are however some considerations. Recruitment was slower than anticipated. This could have been due to several factors, including our institute recruiting for two OA exercise research studies simultaneously. However, the difficulty with recruitment may also be due to people's (un)willingness to try new forms of physical activity for their OA. For example, some participants expressed apprehension about participating in parkrun because the name led them to believe they would only be able to take part if they ran. However, for those who did choose to enrol in the study, after attending parkrun and viewing the diversity of participation firsthand, they no longer considered this a concern.

parkrun was acceptable for most, but not all participants. While there were some disease-specific concerns including increased pain and difficulty completing the full course, for most participants these were not significant enough to impede their participation. Enjoyment, confidence and difficulty ratings demonstrated parkrun to be a challenge but not prohibitively difficult for most participants. Prior research has shown that parkrun appeals to people for many reasons including its socially supportive nature, inclusivity, positive atmosphere and potential for socialisation [9] and our study shows these factors operate similarly in the case for participants with knee OA.

Some participants did not enjoy parkrun enough to want to continue participating, including participants who did not feel encouraged walking with a group of runners, those who could not complete the full course and those who preferred a more flexible walking schedule. Therefore, parkrun may not be suitable for all people with knee OA.

Participants were supervised by an EP or physiotherapist at each parkrun which could have had a positive impact on adherence and acceptability. parkrun as a standalone setting for physical activity promotion may not be as successful for people with a chronic disease without the support from staff or volunteers. However, for participants who were more independent, unsupervised participation would still be acceptable. Future research studies could evaluate the best ways to utilise parkrun as an option for people with knee OA. This may range from simply promoting parkrun as something that may be suitable for people with knee OA, to becoming part of stepped exercise prescription by primary care providers such as GPs, who could help their patients build towards parkrun participation as a target goal.

Most participants adhered to the full protocol and for those unable to complete the 5 km, the course was easily modifiable. Although, a number of participants expressed disappointment when they shortened the course. The course chosen for this study was a circular format which allowed for early withdrawal if required and relatively even terrain, which is not the case for all parkrun courses. When promoting parkrun to people with knee OA, it may be important to identify courses that are easily shortened/exited, with stable ground and few inclines/declines. For those participants who are initially unable to complete the full 5 km, over time their endurance may increase to complete the full course. While for some people, parkrun may be suitable as a target (end) goal, for 11 participants in our study they were able to complete parkrun as a starting point for their physical activity journey.

Parkrun was safe for participants with knee OA, with only two mild adverse events reported and both participants able to continue in the study. Small increases in pain were observed after each parkrun, and these increases in pain appeared to decrease with each successive walk. Acute increases in pain are expected when initiating a new exercise program [28]. The participants were not concerned about the increases in pain they experienced which is encouraging, given that people with knee OA have been known to avoid physical activity due to pain-related fear [29]. On average, participants reported an overall decrease in knee pain, and improvements in function and stiffness following the intervention. This may be attributable to contextual effects [30] and a larger, controlled study to definitively test parkrun as an effective exercise intervention for knee OA symptoms is needed.

Participating in parkrun may provide impetus for increasing activity more generally [31]. At the completion of our study participants reported being motivated to participate in various forms of exercise and physical activity such as continuing to attend parkrun, increasing incidental walking, going to the gym, and attending exercise classes. Whilst parkrun is accepted as being inclusive and appealing to a non-elite audience [9], there is an untapped potential for parkrun as a setting to improve physical activity in people with chronic disease.

A key strength of the study was its mixed methods design allowing for deeper understanding of the acceptability of parkrun for people with knee OA. We enrolled typical knee OA patients who were not meeting physical activity guidelines, improving the generalisability of the results to the wider OA population. Following the experience of people before, during and after participating in parkrun provided a useful understanding of both perceptions about parkrun and insight into acceptability. One limitation of the study is the small sample size which leads to imprecise estimates of outcome measures and limited variability among participant demographics, potentially restricting perspectives. However, whilst our sample size was small, no new themes emerged during the qualitative interviews, indicating thematic saturation was achieved [32]. Without a control group, we are unable to attribute causation to the intervention, however this pilot study provides useful data to support future controlled studies. Due to budgetary and time constraints, we were unable to use activity monitors to measure participant physical activity. Instead, we used self-report (IPAQ-SF) surveys which are less precise.

5. Conclusion

This pilot study demonstrates parkrun's feasibility, acceptability, safety and, its potential to improve knee OA symptoms and physical activity levels. Participating in parkrun was acceptable and enjoyable for some, but not all participants. A small number of people with knee OA

found parkrun to be too difficult to complete, or not enjoyable. Despite this and given the proportion of participants who did enjoy participating, the scalability, accessibility and wide appeal of parkrun supports the development of larger programs of research to evaluate its use to improve symptoms and physical activity in people with knee OA.

Author contributions

L.P. Sutton: Conception and design, Acquisition of data, Analysis and interpretation of the data. A. Lahham: Conception and design, Acquisition of data, Analysis and interpretation of the data. K. Jose: Conception and design, Analysis and interpretation of the data. V. Cleland: Conception and design, Analysis and interpretation of the data. A. Grunseit: Conception and design, Analysis and interpretation of the data. S. Balogun: Conception and design, Acquisition of data, Analysis and interpretation of the data. T. Winzenberg: Conception and design, Analysis and interpretation of the data. G. Jones: Conception and design. D. Aitken: Conception and design, Acquisition of data. M. Moore: Acquisition of data, Analysis and interpretation of the data. B. Antony: Acquisition of data.

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Declaration of competing interest

Authors L. Sutton, M.N Moore, A. Grunseit, D. Aitken are registered parkrunners.

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The views, thoughts, and opinions expressed in the manuscript belong solely to the author/s, and do not necessarily reflect the position of parkrun or the parkrun Research Board.

SD, standard deviation; BMI, body mass index; MET, metabolic equivalent; VAS, visual analogue scale; WOMAC, Western Ontario and McMaster Universities Arthritis Index; NSAID, non-steroidal anti-inflammatory drugs; OARSI, Osteoarthritis Research Society International.

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Appendix A. Supplementary data

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