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TITLE PAGE

Absence of improvement with exercise in some patients with knee osteoarthritis: A qualitative study of responders and non-responders

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Abstract (249/250 words)

Objective

To compare the perceptions of patients about why they did, or did not, respond to a physiotherapist-supported exercise and physical activity program.

Methods

Qualitative study within a randomised controlled trial. Twenty-six people (of 40 invited) with knee osteoarthritis sampled according to response (n=12 responders and 14 non-responders based on changes in both pain and physical function at 3- and 9-months after baseline) to an exercise and physical activity intervention. Semi-structured individual interviews were conducted. Inductive thematic analysis was undertaken within each sub-group, using grounded theory principles. A deductive approach compared themes/subthemes across sub-groups. Findings were triangulated with quantitative data.

Results

(Sub)themes common to responders and non-responders included the intervention components that facilitated engagement, personal attitudes and expectations, beliefs about osteoarthritis and exercise role, importance of adherence and perceived strength gains with exercise. In contrast to responders who felt empowered to self-manage, non-responders accepted responsibility for lack of improvement in pain and function with exercise, acknowledging that their adherence to the intervention was sub-optimal (confirmed by quantitative adherence data). Non-responders believed their excess body weight (supported by quantitative data) contributed to their outcomes, encountered exercise barriers (comorbidities, stressors and life events) and perceived that the trial measurement tools did not adequately capture their response to exercise.

72 **Conclusion**

73 Responders and non-responders shared some similar perceptions of exercise. However, along
74 with perceived limitations in trial outcome measurements, non-responders encountered
75 challenges with excess weight, comorbidities, stressors and life events which led to sub-optimal
76 adherence, and collectively were perceived to contribute to non-response.

77

78 **Keywords:** osteoarthritis; exercise; physiotherapy; non-responder; pain; qualitative

79

80 **Significance and Innovations**

- 81 • Non-responders accepted responsibility for lack of improvement in pain and function
82 with exercise, acknowledging that their adherence was sub-optimal.
- 83 • Non-responders believed their excess body weight contributed to their outcomes,
84 encountered exercise barriers (such as comorbidities, stressors and life events) and
85 perceived that trial measurement tools did not adequately capture their response to
86 exercise.
- 87 • Qualitative design provides richer information over the few existing quantitative
88 studies that explore moderators of exercise response and have yielded little
89 information to date

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Over 260 million people globally have knee osteoarthritis (OA) (1), a condition that accounts for a considerable proportion of global disability. Joint pain and physical dysfunction are common features of knee OA and the main reasons that drive people to seek care from health professionals (2, 3). There is no cure for knee OA and arthroplasty is typically reserved for people with end-stage disease whose joint pain has not been adequately relieved by appropriate non-surgical approaches.

Clinical guidelines advocate non-drug non-surgical strategies (4-6), focused on self-management. Exercise and physical activity are recommended as standard care for all people with OA throughout the course of the disease (7). Muscle weakness is common in knee OA (8, 9) and knee extensor weakness may increase the risk of worsening of knee pain and deterioration in physical functioning over time (10, 11). Thus muscle strengthening is an important component of exercise management (12). Given that walking >6,000 steps/day protects against functional decline in people with knee OA (13), and over 50% of men and nearly 80% of women with or at risk of knee OA do not meet public health recommendations for physical activity (14), promotion of general physical activity is also advocated.

Although meta-analyses show, on average, moderate improvements in pain and function with exercise in knee OA (15, 16), it is widely recognised that symptomatic improvements are not achieved by all people (i.e. some people are ‘non-responders’ to exercise) (17). Indeed, our own clinical trials in people with knee OA who underwent physiotherapist-supported strengthening exercise and physical activity show that only 40-60% of participants reported global improvements in pain and physical function immediately after intervention (18-20). It is not clear why some people with knee OA ‘respond’ to exercise while others do not. A range of factors are barriers to exercise participation and have been postulated to play a role in

determining treatment response, including but not limited to, beliefs about OA and the role of exercise, capability to exercise, adherence, therapeutic relationship with the clinician, motivation, self-efficacy, health status and mood (17, 21-25). The limited research exploring factors associated with exercise response is largely confined to quantitative secondary analyses of randomized controlled trials (RCTs) (24). Qualitative studies that increase our understanding of factors that patients perceive to influence response to exercise-based treatment may facilitate earlier identification of individuals at risk of non-response and may help guide a more personalized patient-centred approach to exercise management.

Thus, the aim of this qualitative study was to compare the perceptions of patients about why they did, or did not, respond to a physiotherapist-supported exercise and physical activity program.

Patients and Methods

Design

We used a qualitative design, based on an interpretivist paradigm, where knowledge about a phenomenon is developed by gathering perceptions and interpretations of participants who experience it (26). The phenomenon of interest in this study was symptomatic response and non-response to an exercise intervention for knee OA. This study was nested within our non-inferiority RCT (27) comparing exercise and physical activity delivered via in-person physiotherapist consultations to videoconferencing with a physiotherapist for people with knee OA (Australian New Zealand Clinical Trials Registry ACTRN12619001240134). The Consolidated Criteria for Reporting Qualitative Research checklist (28) guided reporting of this study. Institutional human ethics approval was obtained and participants provided consent.

Participants

People with knee OA were recruited for this qualitative study from both arms of the RCT. Recruitment procedures and selection criteria for the RCT have been published (27). Briefly, people were recruited from the community in Victoria, Queensland, and New South Wales, Australia via advertisements and our volunteer database. Participants met National Institute for Health and Care Excellence (29) clinical criteria for OA (age ≥ 45 years; activity-related knee joint pain and; morning knee stiffness ≤ 30 mins), amongst other eligibility criteria, in order to participate in the RCT.

Purposive sampling from both trial arms was based upon RCT global rating of change data, which classified trial participants as “responders” or “non-responders”. Global rating of change in i) knee pain and ii) physical function were each rated by participants at 3 months and 9 months post-randomisation using 7-point Likert scales (response options from “much worse” to “much better” compared to baseline). For each outcome at each time-point, participants recording “moderately better” or “much better” were classified as improved, with all others classified as not improved. This approach is consistent with how we plan to analyse and interpret this outcome in our over-arching non-inferiority trial (27). For this qualitative study, participants classified as improved for both pain and function at 3 months, and who maintained improvement on both at 9 months, were deemed “responders”. Conversely, participants classified as not improved on both pain and function at 3 months, and who remained not improved on both at 9 months, were deemed “non-responders”. Purposive sampling (August 2021 to May 2022) recruited each subgroup from participants completing the trial via email invitation.

Quantitative data were extracted from the RCT, including age, gender, body mass index, geographical location, employment status, comorbidities, number of consultations attended, consultation modality (in person or videoconferencing) and self-reported adherence to i) strengthening exercises and ii) the physical activity plan.

Interventions

Briefly, the exercise and physical activity program (27) involved five individual consultations over 3 months with one of 15 trial physiotherapists (in person or via videoconferencing). Physiotherapists prescribed an individualised strengthening program (5-6 home exercises, three times/week), selected from an “Exercise Booklet” of 37 exercises. Participants were provided with exercise resistance bands. Review and modification of the strengthening program occurred at each consultation. An individualised physical activity plan was also devised, aiming to increase physical activity to, or maintain it at, recommended levels (30). Participants were provided a wearable activity tracker and individualised step goals, which were reviewed and modified at each consultation. Participants were encouraged to use a “Knee Plan and Log Book” for recording adherence and monitoring progress. Education about OA and its management occurred at all sessions, supplemented by an “Osteoarthritis Information” booklet. Participants were advised how to independently progress their program and were encouraged to continue with it, after consultations ended, until 9-months post-randomisation.

Interviews

A semi-structured interview guide was developed (Table 1), informed by similar research in chronic whiplash (31) and broader research on barriers and facilitators to exercise in OA (22, 23). The interview explored participant’s perceptions about why they did/did not respond to the exercise intervention, including beliefs about OA and exercise, mood and psychological factors,

lifestyle and other health problems and the therapeutic relationship with the physiotherapist. Individual telephone interviews were conducted by SEJ, a female PhD-qualified non-clinician researcher trained in qualitative methodologies, who was otherwise unknown to participants and was not involved in the RCT. All interviews were conducted with participants in their own home or workplace, (on average) around 7 weeks after completion of 9-month RCT outcome assessment and lasted approximately 45 minutes. Interviews were audio-recorded and transcribed verbatim by an external provider. Audio-recordings and transcripts were deidentified, with transcripts assigned gender-matched pseudonyms to maintain confidentiality. All data were stored on a password-protected university server.

Data analysis

Reflexive thematic analysis, applying principles of grounded theory, was performed separately for responders and non-responders. After transcription, interviews were read by SEJ to familiarize with the data. Transcripts were then re-read and open coding, using an inductive approach, used to identify topics and patterns of ideas. To demonstrate credibility and confirmability, inductive analysis was also performed by a second researcher RKN (physiotherapist with qualitative research experience not involved in the RCT). Both researchers independently organised codes into categories before discussing identified topics and patterns. Transcripts were also read by RSH (physiotherapist who leads the RCT and experienced qualitative researcher). Topics identified by both SEJ and RKN were reviewed and discussed with RSH, and in collaboration, final axial coding was performed (32), whereby closely related codes were examined and collated to generate themes and subthemes within the subgroups. In this latter stage, a deductive approach compared and contrasted themes and subthemes relevant to the research question across the responders and non-responders. Agreement was strong amongst researchers (SEJ, RKN and RSH) therefore additional input

into theme generation was not sought. Themes and subthemes are presented across responders and non-responders with exemplary quotes (33). To ensure trustworthiness, findings were triangulated with relevant quantitative data from the RCT. For example, when a subtheme related to available quantitative data from the RCT, we considered if the quantitative data supported the qualitative finding for responders and non-responders. Data management was supported by using NVivo 12 software (QSR International Pty Ltd), to organize, store and index manual coding by SEJ and RKN, and for cross-referencing with quotes.

Analysis occurred concurrently with data collection. Data collection within each sub-group ceased when the authors felt confident of having achieved, or at least closely approached, inductive thematic saturation (34). Specifically, inductive thematic saturation was determined via consensus between the authors who independently coded all manuscripts (SEJ, RKN) and was confirmed by a third author (RSH). Inductive thematic saturation was defined as the point in coding where there were mounting instances of the same codes, and where new codes did not lead to new theme generation nor new insights related to the research question.

Results

Twelve (out of 16 invited) responders (mean SD age 57 (7) years) and 14 (out of 24 invited) non-responders (mean (SD) age 67 (9) years) were interviewed (Table 2). Almost all participants attended 100% of their physiotherapist consultations, except for one responder and one non-responder (each attending four out of five). Themes and subthemes, with exemplary quotes, are summarised in Table 3. Figure 1 summarises the similarities and differences across sub-groups.

Theme 1: Facilitators

Responders and non-responders spoke about *accountability and monitoring*, finding that tracking steps, recording exercise, and reporting to their physiotherapist was motivating. When consultations stopped and external accountability ceased, it was more difficult to maintain exercise and physical activity habits, although the activity tracker helped keep participants accountable. Most participants believed that *individualisation*, guided by the physiotherapist, ensured their program suited their needs. Non-responders reflected that individualization was important when challenges were encountered to ensure that the exercise and physical activity program was achievable. Responders and non-responders described a *positive therapeutic relationship* with their physiotherapist. Participants generally trusted their physiotherapist, perceived them as knowledgeable and felt they understood their knee problems.

Theme 2: Personal attitudes & expectations

Both sub-groups felt that there was *nothing to lose* by participating in the exercise and physical activity program. Participants described personal traits rooted in *acceptance and realism* with respect to their knee problems and the outcomes they expected from exercise. Participants did not expect a cure for their pain, rather, they largely had realistic functional goals they hoped to achieve. Whilst most responders held a ‘no pain, no gain’ attitude towards their exercises, some non-responders were more resigned about their knee and less accepting of any pain encountered with exercise. Participants largely had *perceived good health*, despite most reporting co-morbidities (Table 2). Unique to non-responders was *accepting responsibility*. Non-responders felt they were responsible for their non-response to exercise, acknowledging that adherence to exercise and physical activity goals was not as good as it should have been. This converges with quantitative data (Table 2) showing half of non-responders self-reported less than the prescribed number of exercise sessions at three months (compared with only one responder) and variable adherence to physical activity.

266

267 **Theme 3: Osteoarthritis beliefs**

268 Responders and non-responders believed that *exercise is important* for managing knee OA.
269 Responders believed that exercise played a crucial role in relieving their knee OA symptoms,
270 in particular the strengthening exercises. Whilst non-responders also believed exercise was
271 important, belief systems were based more on ‘logic’ rather than actual experiences. The
272 subtheme *it’s degenerative* arose from both subgroups, reflecting participant beliefs that their
273 knees were ‘worn out’ and OA was an inevitable aspect of ageing associated with cartilage and
274 bone breakdown. Only non-responders reflected on their *body weight as a contributor* to OA,
275 believing that extra weight likely contributed to their knee problems and lack of response with
276 exercise. These perceptions converge with quantitative data (Table 2) showing a higher
277 prevalence of obesity amongst non-responders (n=7 (50%) compared to responders (n=3
278 (25%)). Some non-responders reflected on how past experiences with weight loss had helped
279 their knee and some described weight loss that they had observed as a result of the exercise and
280 physical intervention, which they considered a positive outcome.

281

282 **Theme 4: Self-efficacy**

283 Both subgroups felt that *exercise adherence* was important in determining intervention
284 outcome. Responders were quite adherent to the self-directed exercise program and physical
285 activity plan, although for some, adherence declined once their knee pain had reduced. This
286 converges with quantitative data (Table 2), which shows all but one responder performed the
287 recommended number of exercise sessions (or more) at 3 months, and that seven (58%) reported
288 reduced adherence at 9 months. Non-responders described more variable patterns of exercise
289 adherence (convergent with data in Table 2), often not doing as many exercise sessions as
290 prescribed or only adhering for a short duration. Non-responders were more likely to reduce or

stop exercise in response to any aggravation in knee pain or when they encountered barriers that made adherence a challenge (e.g. life stressors). Only responders spoke of being *empowered for self-management*, believing that they could continue, or start up again, with their exercise and physical activity program in the future if they needed to, having developed knowledge and confidence to self-manage.

Theme 5: Barriers

Amongst non-responders only, barriers to the exercise and physical activity intervention emerged. Many described negative impacts of *comorbid health conditions* (such as cardiovascular disease, cancers, balance issues and fibromyalgia as well as acute illnesses such as the flu) on their capacity to undertake the strengthening exercises and/or physical activity goals. Exercise often aggravated existing comorbid musculoskeletal health problems, such as hip or back pain, causing participants to stop exercising. Another barrier was *stressors and life events*. Non-responders described circumstances that caused significant emotional or mental stress and/or impacted on their ability to adhere to their exercise and activity program. These included caring responsibilities, significant health problems affecting loved ones, moving house and the impacts of COVID-19.

Theme 6: Outcomes

Participants discussed beneficial effects of exercise on parameters other than pain and function, with both responders and non-responders describing *strength gains*. For non-responders, improvements in knee strength were viewed as a beneficial intervention outcome. Non-responders often felt that the methods used to measure intervention outcomes in the trial were inadequate. This subtheme of *measurement limitations* was unique to non-responders. There was dissatisfaction with the time-limited recall period for surveys, with non-responders often

reporting that the recall period was not reflective of their outcomes at other time points and therefore may not have captured the intervention benefits they gained. Others felt that the measures of pain and physical function (primary outcomes of the trial upon which ‘response’ was determined) did not capture their main knee OA-related problems, and had the surveys asked about other issues (e.g., falls, weight loss) or more personally-relevant activities (e.g., ability to ride a bike, drive long distances, ski, do martial arts), then beneficial intervention outcomes may have been observed.

Discussion

We compared the perceptions of patients about why they did, or did not, respond to a physiotherapist-supported exercise and physical activity program. We found similarities across both sub-groups, including the intervention components that facilitated engagement, personal attitudes and expectations, beliefs about OA and the role of exercise, the importance of adherence and perceived strength gains from exercise. There were also key differences. Responders felt empowered to self-manage, whilst non-responders accepted responsibility for lack of improvement in pain and function, acknowledging that their adherence to the intervention was sub-optimal. Non-responders believed their excess body weight contributed to their outcomes, encountered numerous barriers to exercise and physical activity and felt that the measures for determining intervention outcomes in the trial had limitations.

Our results show a complex and inter-related array of factors are perceived to contribute to responsiveness to an exercise and physical activity intervention amongst people with knee OA. Our work builds on qualitative work in younger people with chronic whiplash, which also showed that therapeutic relationship, self-efficacy, acceptance, exercise experiences and beliefs are important (31). We found that responders and non-responders to exercise shared some

similar perceptions and beliefs. Both sub-groups found the intervention components engaging and highlighted strong therapeutic relationships with their physiotherapist. This is important because prior research has shown that strong therapeutic alliance facilitates adherence to exercise in people with knee pain (22). A mixed-methods Cochrane Review (35) recommends that optimal delivery of exercise for OA should include information about safety and value of exercise; prescribe exercise tailored to individual's abilities and needs; challenge inappropriate OA beliefs and provide support. However, we found no evidence that non-responders differed from responders in their perceptions about any of these factors, suggesting they did not explain exercise non-response in our sample.

Non-responders accepted responsibility for not achieving improvements in pain and function, acknowledging sub-optimal adherence to exercise and physical activity goals. It's important to note that waning exercise adherence was also described by responders, consistent with research showing that trajectories of adherence typically decline over time (36). Although non-responders recognized the importance of exercise adherence, adherence was variable, often because it aggravated knee pain or because other barriers (such as comorbidities, stressors, life events) were encountered. Non-responders also believed that extra body weight contributed to their knee problems and lack of success with exercise. Our prior qualitative work in people with knee OA and comorbid obesity (37) found numerous physical (such as the complexity of performing weightbearing exercise movements) and psychological (such as fear of pain) challenges to participating in strengthening exercises amongst this cohort. Our findings support secondary analyses of RCTs (24) in knee OA showing that presence of obesity and/or anxiety/depression predict poorer pain and function outcomes with physiotherapist-led exercise interventions.

Our responders to exercise felt empowered to self-manage their OA, because of knowledge they had gained about OA and exercise safety and the confidence they developed to independently continue or resume exercising when required. This was not identified in non-responder data. Although few exercise RCTs in people with OA have evaluated exercise effect moderators, there is some evidence that people with higher pain self-efficacy at baseline are more likely to report greater improvements in pain with physiotherapist-supported exercise and online pain coping skills training (38). Emerging evidence also suggests that increases in self-efficacy may partially explain why pain and physical function improve with exercise (39). Research is warranted to identify effective strategies for improving self-efficacy to manage pain with knee OA, including to engage in exercise and physical activity. Non-responders to exercise therapy may require additional strategies, such as educational approaches based on empowerment (40) or psychological approaches (41) for pain coping and stress management.

Similar to people with chronic whiplash (31), we observed a discrepancy between response to exercise and physical activity measured by our RCT outcome measures and how participants perceived they responded. Although non-responders did not improve with respect to knee pain or function, they felt they had responded in other beneficial ways to the exercise and physical activity program. Some described weight loss, whilst others described improved ability to perform personally-important tasks and activities, including driving, mowing the lawn, walking inside the home and cycling. Along with responders, many described improved muscle strength, which was not measured in the RCT. Researchers should consider incorporating participant-specific outcomes instead of, or in addition to, generic or disease-specific measures when evaluating exercise response. Measurement tools, such as the patient-specific functional scale (42), that allow participants to nominate a specific activity for re-assessment may improve detection of exercise response.

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392 Our findings may guide researchers and clinicians to better identify patients at risk of non-
393 response to exercise therapy and to consider strategies to optimize outcomes for this sub-group.
394 Proactively screening for comorbidities, in particular musculoskeletal problems, and using this
395 information to individualise exercise programs at the outset is warranted. Careful monitoring
396 of the impact of exercise on knee pain and comorbidities may alert the clinician to problems as
397 soon as they arise. Clinicians should be aware that aggravation in knee pain can deter some
398 people from exercising and should teach patients how to positively deal with pain flares.
399 Stressors and life events are unavoidable challenges encountered by many patients. Clinicians
400 should be sensitive to the adverse impacts these circumstances have on individuals and support
401 the patient as much as possible to re-engage with exercise as soon as is feasible. Recognising
402 the importance of accountability and monitoring, patients should be encouraged to monitor
403 exercise adherence (e.g., using log books, diaries, wearables, mobile apps) and clinicians should
404 regularly review adherence so that problems can be identified in a timely manner. Evidence-
405 based strategies that may boost adherence include additional physiotherapy consultations over
406 a longer time frame (booster sessions) (43), use of messages (email, SMS) to remind and
407 motivate people to exercise and support adherence (44) or digital exercise programming
408 systems with or without remote clinician support (45, 46).

409

410 Strengths of this study include its qualitative design, which provides richer information over
411 the few existing quantitative studies that explore moderators of exercise response and have
412 yielded little information to date (47). Our study was nested within an RCT, which provided
413 unique opportunities for purposive sampling of responders and non-responders and allowed
414 triangulation with quantitative data. Our interview guide encouraged participants to explore a
415 range of biopsychosocial factors that may have contributed to exercise (non)response. There

are also limitations. Fourteen other participants were eligible and invited to participate but did not respond or declined. It's not clear if their data would have changed our findings. There are alternative approaches to determining responder status in OA RCTs (48) and our findings may not necessarily apply to alternative approaches. Our findings cannot be transferred to people of non-English speaking backgrounds as our RCT and this qualitative study limited inclusion to those who could speak English. Our study design does not allow conclusions about causation of exercise non(response), thus findings are hypothesis-generating and should be tested in RCTs by evaluating moderators (e.g., presence of comorbidities, overweight/obesity) of exercise effects.

In conclusion, responders and non-responders shared some similar perceptions of a physiotherapist-supported exercise and physical activity program. However, along with perceived limitations in trial outcome measurements, non-responders also encountered challenges with excess weight, comorbidities, stressors and life events which led to sub-optimal exercise adherence, and collectively were perceived to contribute to non-response.

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Author contributions

RSH, NEF & TR obtained funding for the clinical trial. PK coordinated the trial. RSH & KLB conceived the idea for the qualitative study. SJ conducted the interviews. SJ, RKN & RSH conducted analyses. All authors contributed to the interview guide, interpretation of findings

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441 and drafting of the paper. All authors approved the final version. RSH takes responsibility for
442 this work (ranash@unimelb.edu.au).

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445 **Conflict of interest**

446 Nil.

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References

1. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2018;392(10159):1789-858.
2. Paskins Z, Sanders T, Hassell AB. What influences patients with osteoarthritis to consult their GP about their symptoms? A narrative review. *BMC Fam Pract*. 2013;14:195.
3. Teo PL, Bennell KL, Lawford B, Egerton T, Dziedzic K, Hinman RS. Patient experiences with physiotherapy for knee osteoarthritis in Australia-a qualitative study. *BMJ Open*. 2021;11(3):e043689.
4. Kolasinski SL, Neogi T, Hochberg MC, Oatis C, Guyatt G, Block J, et al. 2019 American College of Rheumatology/Arthritis Foundation Guideline for the Management of Osteoarthritis of the Hand, Hip, and Knee. *Arthritis Care Res (Hoboken)*. 2020;72(2):149-62.
5. Bannuru RR, Osani MC, Vaysbrot EE, Arden NK, Bennell K, Bierma-Zeinstra SMA, et al. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. *Osteoarthritis Cartilage*. 2019;27(11):1578-89.
6. The Royal Australian College of General Practitioners. Guideline for the management of knee and hip osteoarthritis. 2nd edn. East Melbourne, Vic: RACGP, 2018.
7. Rausch Osthoff AK, Niedermann K, Braun J, Adams J, Brodin N, Dagfinrud H, et al. 2018 EULAR recommendations for physical activity in people with inflammatory arthritis and osteoarthritis. *Ann Rheum Dis*. 2018;77(9):1251-60.
8. Deasy M, Leahy E, Semciw AI. Hip Strength Deficits in People With Symptomatic Knee Osteoarthritis: A Systematic Review With Meta-analysis. *J Orthop Sports Phys Ther*. 2016;46(8):629-39.

9. Bennell K, Hunt M, Wrigley T, Lim B, Hinman R. Role of muscle in the genesis and management of knee osteoarthritis. *Rheum Dis Clin N Am*. 2008;34:731-54.
10. de Rooij M, van der Leeden M, Heymans MW, Holla JF, Hakkinen A, Lems WF, et al. Prognosis of Pain and Physical Functioning in Patients With Knee Osteoarthritis: A Systematic Review and Meta-Analysis. *Arthritis Care Res (Hoboken)*. 2016;68(4):481-92.
11. Culvenor AG, Ruhdorfer A, Juhl C, Eckstein F, Oiestad BE. Knee Extensor Strength and Risk of Structural, Symptomatic, and Functional Decline in Knee Osteoarthritis: A Systematic Review and Meta-Analysis. *Arthritis Care Res (Hoboken)*. 2017;69(5):649-58.
12. Holden MA, Button K, Collins NJ, Henrotin Y, Hinman RS, Larsen JB, et al. Guidance for implementing best practice therapeutic exercise for people with knee and hip osteoarthritis: what does the current evidence base tell us? *Arthritis Care Res (Hoboken)*. 2021;73(12):1746-53.
13. White DK, Tudor-Locke C, Zhang Y, Fielding R, LaValley M, Felson DT, et al. Daily walking and the risk of incident functional limitation in knee osteoarthritis: an observational study. *Arthritis Care Res (Hoboken)*. 2014;66(9):1328-36.
14. Chang AH, Song J, Lee J, Chang RW, Semanik PA, Dunlop DD. Proportion and associated factors of meeting the 2018 Physical Activity Guidelines for Americans in adults with or at risk for knee osteoarthritis. *Osteoarthritis Cartilage*. 2020;28(6):774-81.
15. Fransen M, McConnell S, Harmer AR, Van der Esch M, Simic M, Bennell KL. Exercise for osteoarthritis of the knee. *Cochrane Database Syst Rev*. 2015;1:CD004376.
16. Uthman OA, van der Windt DA, Jordan JL, Dziedzic KS, Healey EL, Peat GM, et al. Exercise for lower limb osteoarthritis: systematic review incorporating trial sequential analysis and network meta-analysis. *BMJ*. 2013;347:f5555.
17. Moseng T, Dagfinrud H, van Bodegom-Vos L, Dziedzic K, Hagen KB, Natvig B, et al. Low adherence to exercise may have influenced the proportion of OMERACT-OARSI

responders in an integrated osteoarthritis care model: secondary analyses from a cluster-randomised stepped-wedge trial. *BMC Musculoskelet Disord*. 2020;21(1):236.

18. Bennell KL, Nelligan RK, Kimp AJ, Schwartz S, Kasza J, Wrigley TV, et al. What type of exercise is most effective for people with knee osteoarthritis and co-morbid obesity?: The TARGET randomized controlled trial. *Osteoarthritis Cartilage*. 2020;28(6):755-65.

19. Bennell KL, Campbell PK, Egerton T, Metcalf B, Kasza J, Forbes A, et al. Telephone Coaching to Enhance a Home-Based Physical Activity Program for Knee Osteoarthritis: A Randomized Clinical Trial. *Arthritis Care Res (Hoboken)*. 2017;69(1):84-94.

20. Hinman RS, Campbell PK, Lawford BJ, Briggs AM, Gale J, Bills C, et al. Does telephone-delivered exercise advice and support by physiotherapists improve pain and/or function in people with knee osteoarthritis? *Telecare randomised controlled trial. Br J Sports Med*. 2020;54(13):790-7.

21. Lawford BJ, Bennell KL, Campbell PK, Kasza J, Hinman RS. Association Between Therapeutic Alliance and Outcomes Following Telephone-Delivered Exercise by a Physical Therapist for People With Knee Osteoarthritis: Secondary Analyses From a Randomized Controlled Trial. *JMIR Rehabil Assist Technol*. 2021;8(1):e23386.

22. Moore AJ, Holden MA, Foster NE, Jinks C. Therapeutic alliance facilitates adherence to physiotherapy-led exercise and physical activity for older adults with knee pain: a longitudinal qualitative study. *J Physiother*. 2020;66(1):45-53.

23. Dobson F, Bennell KL, French SD, Nicolson PJ, Klaasman RN, Holden MA, et al. Barriers and Facilitators to Exercise Participation in People with Hip and/or Knee Osteoarthritis: Synthesis of the Literature Using Behavior Change Theory. *Am J Phys Med Rehabil*. 2016;95(5):372-89.

24. Legha A, Burke DL, Foster NE, van der Windt DA, Quicke JG, Healey EL, et al. Do comorbidities predict pain and function in knee osteoarthritis following an exercise

intervention, and do they moderate the effect of exercise? Analyses of data from three randomized controlled trials. *Musculoskeletal Care*. 2020;18(1):3-11.

25. Holden MA, Burke DL, Runhaar J, van Der Windt D, Riley RD, Dziedzic K, et al. Subgrouping and Targeted Exercise programmes for knee and hip Osteoarthritis (STEER OA): a systematic review update and individual participant data meta-analysis protocol. *BMJ Open*. 2017;7(12):e018971.

26. Thanh NC, Thanh T. The interconnection between interpretivist paradigm and qualitative methods in Education. *American Journal of Educational Science*. 2015;1(2):24-7.

27. Hinman RS, Kimp AJ, Campbell PK, Russell T, Foster NE, Kasza J, et al. Technology versus tradition: a non-inferiority trial comparing video to face-to-face consultations with a physiotherapist for people with knee osteoarthritis. Protocol for the PEAK randomised controlled trial. *BMC Musculoskelet Disord*. 2020;21(1):522.

28. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007;19(6):349-57.

29. National Clinical Guideline Centre (UK). Osteoarthritis: Care and Management in Adults. London: National Institute for Health and Care Excellence (UK); 2014 Feb. PMID: 25340227.

30. Department of Health and Aged Care, Australian Government. Australia's Physical Activity and Sedentary Behaviour Guidelines and the Australian 24-Hour Movement Guidelines 2019 [cited 2019 April]. Available from: <https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-strateg-phys-act-guidelines#npa1864>.

- 547 31. Griffin AR, Moloney N, Leaver A, Jagnoor J, Michaleff ZA, Lin CC, et al. Experiences
548 of responsiveness to exercise in people with chronic whiplash: A qualitative study.
549 *Musculoskelet Sci Pract.* 2021;54:102380.
- 550 32. Charmaz K. Grounded theory. Objectivist and Constructivist Methods. In: Denzin N,
551 Lincoln Y, editors. *Handbook of Qualitative Research*. 2nd ed. ed. Thousand Oaks, California:
552 Sage; 2000. p. 509-37.
- 553 33. Mays N, Pope C. Qualitative Research: Rigour and qualitative research. *BMJ*.
554 1995;311(6997):109.
- 555 34. Saunders B, Sim J, Kingstone T, Baker S, Waterfield J, Bartlam B, et al. Saturation in
556 qualitative research: exploring its conceptualization and operationalization. *Qual Quant*.
557 2018;52(4):1893-907.
- 558 35. Hurley M, Dickson K, Hallett R, Grant R, Hauari H, Walsh N, et al. Exercise
559 interventions and patient beliefs for people with hip, knee or hip and knee osteoarthritis: a mixed
560 methods review. *Cochrane Database Syst Rev.* 2018;4:CD010842.
- 561 36. Nicolson PJA, Hinman RS, Kasza J, Bennell KL. Trajectories of adherence to home-
562 based exercise programs among people with knee osteoarthritis. *Osteoarthritis Cartilage*.
563 2018;26(4):513-21.
- 564 37. Lawford BJ, Bennell KL, Allison K, Schwartz S, Hinman RS. Challenges With
565 Strengthening Exercises for Individuals With Knee Osteoarthritis and Comorbid Obesity: A
566 Qualitative Study With Patients and Physical Therapists. *Arthritis Care Res (Hoboken)*.
567 2022;74(1):113-25.
- 568 38. Lawford BJ, Hinman RS, Kasza J, Nelligan R, Keefe F, Rini C, et al. Moderators of
569 Effects of Internet-Delivered Exercise and Pain Coping Skills Training for People With Knee
570 Osteoarthritis: Exploratory Analysis of the IMPACT Randomized Controlled Trial. *J Med*
571 *Internet Res.* 2018;20(5):e10021.

39. Lima YL, Lee H, Kline DM, Dobson FD, Hinman RS, Bennell KL, et al. How do non-surgical interventions improve pain and physical function in people with osteoarthritis? A scoping review of mediation studies. *Arthritis Care Res.* 2022;Jul 22; doi: 10.1002/acr.24983. Online ahead of print.
40. Egerton T, Bennell KL, McManus F, Lamb KE, Hinman RS. Comparative effect of two educational videos on self-efficacy and kinesiophobia in people with knee osteoarthritis: an online randomised controlled trial. *Osteoarthritis Cartilage.* 2022;30(10):1398-1410.
41. Zhang L, Fu T, Zhang Q, Yin R, Zhu L, He Y, et al. Effects of psychological interventions for patients with osteoarthritis: a systematic review and meta-analysis. *Psychol Health Med.* 2018;23(1):1-17.
42. Stratford P, Gill C, Westaway M. Assessing disability and change on individual patients: a report of a patient specific measure. . *Physiother Can.* 1995;47:258-63.
43. Nicolson PJA, Bennell KL, Dobson FL, Van Ginckel A, Holden MA, Hinman RS. Interventions to increase adherence to therapeutic exercise in older adults with low back pain and/or hip/knee osteoarthritis: a systematic review and meta-analysis. *Br J Sports Med.* 2017;51(10):791-9.
44. Bennell K, Nelligan RK, Schwartz S, Kasza J, Kimp A, Crofts SJ, et al. Behavior Change Text Messages for Home Exercise Adherence in Knee Osteoarthritis: Randomized Trial. *J Med Internet Res.* 2020;22(9):e21749.
45. Bennell KL, Marshall CJ, Dobson F, Kasza J, Lonsdale C, Hinman RS. Does a Web-Based Exercise Programming System Improve Home Exercise Adherence for People With Musculoskeletal Conditions?: A Randomized Controlled Trial. *Am J Phys Med Rehabil.* 2019;98(10):850-8.

46. Lambert TE, Harvey LA, Avdalis C, Chen LW, Jeyalingam S, Pratt CA, et al. An app with remote support achieves better adherence to home exercise programs than paper handouts in people with musculoskeletal conditions: a randomised trial. *J Physiother.* 2017;63(3):161-7.
47. Quicke J, Runhaar J, van der Windt D, Healey EL, Foster N, Holden M. Moderators of the effects of therapeutic exercise for people with knee and hip osteoarthritis: A systematic review of sub-group analyses from randomised controlled trials. *Osteoarthritis & Cartilage Open.* 2020;2(4):100113.
48. Pham T, van der Heijde D, Altman RD, Anderson JJ, Bellamy N, Hochberg M, et al. OMERACT-OARSI initiative: Osteoarthritis Research Society International set of responder criteria for osteoarthritis clinical trials revisited. *Osteoarthritis Cartilage.* 2004;12(5):389-99.

Fig 1: Similarities and differences across responders and non-responders.

612 Table 1. Interview guide.

OVERALL EXPERIENCES
#1 Tell me about your overall experience with the PEAK program? <i>Prompts:</i> <i>What motivated you to volunteer?</i> <i>What treatment were you expecting to receive when you signed up?</i> <i>Was there anything included in the PEAK program that surprised you/was unexpected?</i>
#2 At 3 and 9 months, your trial survey indicated that you experienced an [improvement/no improvement] in pain and function. Do you feel that you were a person who had “responded” to the treatment program? By responder I mean someone in whom the treatment “worked”..... <i>Prompts:</i> <i>What worked for you? What didn’t work for you? Why? Why not?</i>
#3 At 3 and 9 months, your trial survey indicated that you experienced an [improvement/no improvement] in pain and function. How did this outcome compare to what you were expecting to achieve when you signed up? <i>Prompts:</i> <i>What benefits/positive effects were you expecting?</i> <i>What side/negative effects did you expect?</i>
#4 Why do you think you [improved/did not improve]? Think about the exercise program, the physical activity plan, the physiotherapist, your own knee problems, your general health and your lifestyle when you answer. <i>Prompts:</i>
RESPONDERS <i>Were there other things that contributed to this improvement?</i> <i>What was the most helpful/best part of the program?</i> <i>What wasn’t so good?</i>
NON-RESPONDERS <i>Was something missing from the PEAK program?</i> <i>Was something included that wasn’t good for you?</i> <i>What do you think would have helped you more?</i>
OSTEOARTHRITIS/CHRONIC KNEE PAIN
#5 What do you think are the most effective treatments for chronic knee pain caused by osteoarthritis? <i>Prompts:</i> <i>What treatments have you tried?</i> <i>What worked/didn’t work?</i>
#6 What do you think causes your knee pain? <i>Prompts:</i> <i>How much control do you have over your knee pain?</i>
#7 How does your knee pain make you feel? <i>Prompts:</i> <i>How well do you cope with your knee pain? Why/why not?</i>
EXERCISE & PHYSICAL ACTIVITY
#8 How important do you think strengthening exercise is for your knee problems? Why? <i>Prompts:</i> <i>Have you done much exercise over your lifetime?</i> <i>What have your past experiences with exercise been like?</i>

Do you consider strengthening exercise to be “therapeutic” (provide definition of ‘therapeutic’ as: ‘like medicine’)? Why/why not?

#9 How did you feel about the strengthening exercises that were prescribed for you by the PEAK physiotherapist?

Prompts:

How did your body respond to the strengthening exercise?

How closely did you follow the dosage/frequency/repetitions prescribed by the physio (including after the physio consults had ended)? Why/Why not?

What was easy/challenging about the exercises? What did you like/not like?

How well did the strengthening program suit your needs? How did the program change over time?

How much did you log/record your exercise sessions?

How motivated were you to exercise?

#10 How important do you think general physical activity is for your knee problems? Why?

Prompts:

How important do you think physical activity is for your general health and well-being?

Do you consider general physical activity to be “therapeutic” (provide definition of ‘therapeutic’ as ‘like medicine’)? Why/why not?

#11 How did you feel about the physical activity program prescribed for you by the PEAK physiotherapist?

Prompts:

How did your body respond to the general physical activity recommended by the physio?

How closely did you follow the physical activity plan (including after the physio consults had ended)? Why/Why not?

What was easy/challenging about the physical activity plan? What did you like/not like?

How well did the physical activity plan suit your needs? How did the plan change over time?

How much did you use the activity tracker?

How motivated were you to be physically active?

MOOD/PSYCHOLOGICAL FACTORS

#12 Did anything about your mood, and how you felt, contribute to the [lack of improvement/amount of improvement] in pain and function with the PEAK program? (e.g. Stress, anxiety etc.)

Prompts:

Did participating in the exercise program affect how you felt? How?

Did you talk about how you felt with your physiotherapist? How did that help/not help?

Does stress usually affect your knee pain? How so? Why do you think this happens?

LIFESTYLE & OTHER HEALTH PROBLEMS

#13 Do you think anything related to your lifestyle and circumstances contributed to the fact that you [didn’t get improvement/got improvement] in pain and function with the PEAK program?

Prompts:

Sleep? Support from family/friends? Availability of time? Where you live?

#14 To what extent do you think your general health influenced the fact that you [didn’t get improvement/got improvement] in pain and function with the PEAK program?

Prompts:

How would you rate your general health?

How much did other health problems limit from you exercising/being physically active?

Did you/physio have to modify your program to accommodate other health problems/needs?

THERAPEUTIC RELATIONSHIP

#15 How did you feel about your physiotherapist?

Prompts:

Did you like them? Why/why not?

Did you trust them and the advice they gave you? Why/why not?

Did you understand what the physio wanted you to do?

How motivated were you to listen to the physio and follow their advice?

Do you think the physio had a good understanding of your knee problems and your goals?

#16 How did you feel about the number of consultations you had with your physio?

Prompts:

Would you have liked more? Less? Over what timeframe?

Longer consults? Shorter?

CLOSING COMMENTS

#18 Is there anything else you wish to add?

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Running title: Responders & non-responders to exercise

Table 2: Participant characteristics (n=26).

Pseudonym	Gender	Age	Weight ^a	Location ^b	Employment	Co-morbidity ^c	Consult mode	Exercise adherence (3 mths) ^d	Exercise adherence (9 mths) ^d	Physical activity adherence (3 mths) ^e	Physical activity adherence (9 mths) ^e
RESPONDERS (n=12)[†]											
Bill	Male	60-64	Overweight	Major city	Retired		IP	3	3	8	7
Christine	Female	55-59	Obese	Inner regional	Work full-time	Back pain	IP	3	1	8	6
Elizabeth	Female	70-74	Healthy	Major city	Retired	Heart disease	VC	3	3	10	10
Francis	Male	45-49	Overweight	Major city	Work full-time		VC	3	2	9	9
James	Male	50-54	Overweight	Inner regional	Work full-time	Back pain	VC	2	2	10	7
Judith	Female	55-59	Overweight	Major city	Work part-time		VC	4	5	10	9
Lesley	Male	50-54	Healthy	Major city	Work full-time		VC	3	0	9	2
Gregory	Male	55-59	Overweight	Major city	Work full-time	Heart disease	VC	3	2	10	6
						Back pain					
Nancy	Female	60-64	Obese	Major city	Retired	Lung disease	IP	3	4	6	4
						Depression					
						Bradycardia					
Patricia	Female	50-54	Obese	Inner regional	Work part-time	Back pain	VC	4	0	10	2
						Asthma					
Valerie	Female	70-74	Healthy	Major city	Retired	Back pain	VC	3	1	10	8
Melissa	Female	50-54	Overweight	Major city	Work full-time		VC	3	2	10	8
NON-RESPONDERS (n=14)[†]											
Beverley	Female	60-64	Obese	Outer regional	Unable to work due to health	Hypertension	IP	3	0	10	2
						Cancer					
						Back pain					
Edward	Male	75-79	Overweight	Major city	Unable to work due to health	Hypertension	VC	7	4	7	8
						Back pain					
						Gall stones					
Catherine	Female	60-64	Overweight	Major city	Retired	Depression	VC	0	0	8	0
						Back pain					
Joseph	Male	60-64	Obese	Major city	Work full-time	Heart disease	IP	0	0	5	1
						Back pain					

Running title: Responders & non-responders to exercise

Joyce	Female	75-79	Healthy	Major city	Retired	Back pain	IP	2	4	7	6
Kathleen	Female	55-59	Obese	Major city	Retired	Diabetes	VC	3	2	9	3
Patrick	Male	75-79	Overweight	Major city	Retired		VC	1	0	9	1
Matilda	Female	70-74	Overweight	Inner regional	Retired	Hypertension	VC	2	0	10	3
						Back pain					
Lisa	Female	60-64	Obese	Major city	Work part-time		VC	3	3	9	7
Susan	Female	60-64	Obese	Major city	Retired		IP	0	0	9	1
David	Male	80-84	Healthy	Major city	Retired	Hypertension	VC	3	0	9	8
						Back pain					
						Leukemia					
Wendy	Female	55-59	Overweight	Major city	Unemployed		VC	2	2	7	5
Michelle	Female	70-74	Severely obese	Inner regional	Unable to work due to health	Hypertension	IP	3	0	10	8
						Back pain					
						Shortness of breath					
Cynthia	Female	55-59	Obese	Major city	Work full-time		VC	3	0	7	7

[†]Responders=participants who were improved for both pain and function at 3 months and who maintained improvement at 9 months; non-responders=participants who were not improved on both of the pain and function variables at 3 months and remained not improved on both variables at 9 months.

^aClassified according to World Obesity classification system using body mass index calculated from self-reported height and weight.

^bMetropolitan and regional classification, based on residential postcode, in accordance with Australian Standard Geographical Classification.

^cReported using the Self-Administered Comorbidity Questionnaire

^dSelf-reported number of strengthening exercise sessions performed over the prior week (in whole numbers), noting participants were encouraged to perform exercises three times per week.

^eSelf-reported using a numerical rating scale (with terminal descriptors of ‘strongly disagree’ (score=0) and ‘strongly agree’ (score=10)) to the statement “I followed the physical activity plan that my PEAK trial physiotherapist helped me to develop”.

VC=video conferencing

IP= in person

Table 3: Themes, subthemes and exemplary quotes across responders and non-responders.

Themes and subthemes	Responders	Non-responders
Theme 1: Facilitators		
Accountability and monitoring	Bill: <i>"I guess the fact that I suppose I knew somebody was going to be marking my homework so to speak meant that there was that element as well. If I skip a day or whatever, what's [my physiotherapist] going to say?"</i> Lesley: <i>"Just having that consultation and someone working with you along the way, there's a sense of obligation to yourself and to the other person."</i> Gregory: <i>"That was kind of a good little challenge to have your little [activity tracker] on your arm and see how many steps and you know if you need to go for an extra walk, well, I would"</i>	Joyce: <i>"when I was filling out the booklet all the time, that was an incentive to make sure I kept doing the exercises. And I've noticed since I haven't got to fill it out all the time, I'm not doing them three times a week, I've let it slip..... I was using the stepper all the time – yes, I used the stepper every day. Even when I wasn't doing the exercise and that thing, I was putting it on every day and measuring my daily steps. That was good actually, that was a real motivator"</i> Michelle: <i>"I found going to [the physio], it made you do it."</i> David: <i>"Well, it just gave you something to work on. Yeah, look, it was something that I used to do every night before I went to bed, I'd fill it in.. I thought that was good."</i>
Individualisation	Bill: <i>"I guess certainly the physio treatment and the tailoring of the selection of the exercises and the ability to have that reviewed on a regular basis and ratchet it up accordingly [helped achieve results]."</i> Nancy: <i>"I was able to negotiate away from the ones that were awkward or difficult for me, to the ones that were easier or more present or physically possible in my house."</i> Melissa: <i>"You know, I think there was a couple that, they were hard to do and we just adjusted them and then worked towards the harder ones."..." I liked that you could build on it, so you weren't expected to just, you know, do a mammoth effort in the beginning."</i>	David: <i>"With [the physio], we sort of worked on trying to not do it - not go down as far, and so just played that one by ear as to a point where you were continuing to do them, but not to the full degree that it was originally required."</i> Michelle: <i>"when I first started, it hurt a lot; the first lot of exercises. And it made it that every time I took a step it felt like someone stabbed me in the front of the kneecap with a knife; it was that sharp. And then I went back to [the physio] for my next visit and he changed one of the exercises because it was irritating the knee...and when he changed that one, even though we still did the same exercise but minus the band, it was much better..."</i> Kathleen: <i>"She changed a couple of them because I just said to her, "I can't squat down on that chair, it just doesn't happen," and she did change a couple of them around for me..."</i>
Positive therapeutic relationship	Bill: <i>"Certainly if it's anything to do with the knee I'll seek [my PEAK physiotherapist] out again and if it's to do with anything else is a very high probability that I'll seek him out again."</i> Lesley: <i>"I think he was really good. He was very easy to talk to, get along with. I think he explained everything really well."</i> Melissa: <i>"[My physiotherapist] was really good. Really approachable and listened, and really took onboard whatever I said as well."</i>	Patrick: <i>"I thought she was excellent. She was good at looking at what was happening and trying to change the program to fit, and I thought that she had a very positive approach...."</i> David: <i>"I must say, in the past I haven't been all that fussy about physios, because I didn't feel that they were as hands-on as I would like, but he seemed to be - yeah, sort of easy to talk to and understood the problems quite well."</i> Joyce: <i>"I thought she was very good. I thought she was very professional. And, yes, I trusted her with what she was telling me to do."</i>
Theme 2: Personal attitudes and expectations		

Running title: Responders & non-responders to exercise

Nothing to lose	Patricia: "...it was only ever going to do nothing or improve things ... So for me it was just like if you do this and it makes you feel better, that's awesome. If you do this and it doesn't make any difference, well, it's actually still making me get off my arse and do something. So that's good." Melissa: "I guess when I signed up, I didn't have an expectation. I thought, you know, anything's better than nothing." Bill: "I was fairly confident that would give at least some benefit."	Joyce: "I didn't expect great improvements. All I wanted was to either maintain it, get a little bit better, but not get worse." Susan: "I was hopeful but I wasn't unrealistic. So I didn't expect, I did not expect a miracle." Kathleen: "I think there's nothing negative that can happen, even if it didn't get better, it's not a negative thing because you tried."
Acceptance and realism	Christine: "There's always some pain to have a gain [laughs]. So sometimes doing the exercises, yeah, I would find that there'd be some sort of pain...Yes, it hurts, yes, it's uncomfortable but hopefully it will keep it moving and going and whatever." Judith: "And so my aim was to...get back to closer to 15 to 20,000 steps a day – which I achieved. So doing the exercises and strengthening the knee, I was able to get back to all of that again. ..Realistically I knew it was not going to get me back to running." Lesley: "So the exercises were one aspect of it, but the other aspect of it is just understanding my limits, and maybe tapering my expectations a little bit as well."	Patrick: "You ignore pain, that's the thing too. So it comes and goes. You treat it, you get an anti-inflammatory, you get a massage, do what you can and just keep going." Lisa: "Oh look, I've had it for so long, I just, it's just part of life. It's a limiter, but just puts boundaries on things." Susan: "It's just there. It's just part of me now. So, I don't feel necessarily ... oh, I guess, what I feel down about is when I'm with other people and they go for a big long walk, and I say, "I have to sit down, I'll wait for you here." So, that's pretty annoying, but other than that, I just have to accommodate it into my life."
Perceived good health	Lesley: "... so I would say my general health was very good. If I'm giving myself a rating out of 10, I would say my general health was a 8." Elizabeth: "I would say it's certainly above average...I have atrial fibrillation which I manage, and then I've got the osteoarthritis... other people will say we can't believe that you're 70 and your energy and activity and stuff like that."	Wendy: "My general health is fine...I mean, like my knee issues is something that's been there for a long, long time, so I don't think my general health affected that program at all; and I'm in good health, touch wood." Kathleen: "My general health is pretty good. I don't have any major issues." Patrick: "Again, I think my general health is pretty good. The only thing I've got is osteoarthritis in the knees, which I tend to ignore and work around."
Accepting responsibility	NA	Joyce: "I really just think it was – I really think it was because I wasn't doing what I needed to do. I wasn't – it was mainly in the walking and things like that, I just wasn't doing it." Catherine: "Virtually I guess what I'm saying, the problem was probably 100% my lack of 100% commitment rather than any fault of the study." Matilda: "So I think I get – when I say I didn't benefit from it, it's more that I probably didn't adhere to the exercise program well enough to benefit from it. But I think if I did, I probably would. Does that make sense?" Joseph: "I think for me it's more disappointment for not following it through like I should have followed it through I guess....At the end of the day when I did turn up it was really good."

Running title: Responders & non-responders to exercise

Theme 3: Osteoarthritis beliefs		
Exercise is important	Judith: “..It’s the answer. If you can’t strengthen those muscles, you’re not going to see any improvement. Without strengthening those muscles, you’re just going to become a couch potato.” Gregory: “..Increasing the muscle strength helps – I don’t know what the term is but it helps support the knee, helps the function in the knee.” Patricia: “But I’m pretty confident that it was, you know, and it was whatever the damage that I had could only be improved by doing strengthening exercises.”	Catherine: “You just can’t pop a pill for relief. You have to do other things, other logical things like the exercises and strengthen and what have you.” Joseph: “I know exercise is correct. That’s obviously just to strengthen what you have got there and it does work. As far as I don’t know, massage or manipulation or TENS machines, braces and that I don’t know if that makes any difference but I agree with, well, just exercise in general. I know that works.” Matilda: “If you don’t keep your legs stronger – mine aren’t strong enough. I know that, and the more strength you lose in the muscles around – that support your knees, the more limited you become in what your capabilities are and what you can do, and so you lose some. Without the strength in your legs, you lose your life. You lose a desire to go and do things.”
It’s degenerative	James: “...the bones now have become weak at the very end of the leg bones, where they would normally be cushioned on the meniscus, so they’ve become soft. And, yeah, it’s just they’re more tender, that’s my understanding of it.” Lesley: “...there must be a link surely that things have to wear out. Just like your car wears out after a certain amount of kilometres” Gregory: “The right knee was – worn out, wearing away on the inner side of the joint just because of the structure of my legs so that’s what caused it. My knees are plain old worn out.”	Patrick: “And as I said, they’re stuffed anyway. There’s no cartilage in either knee so there’s only so much you can do. So it’s a maintenance – it’s not an improvement program, it’s a maintenance program.” Catherine: “I just think osteoarthritis is just a part of life. It’s incurable, if that’s the word, and you’ve got to live with it and therefore manage it.” Michelle: “.. they’ve worn out. I did 50 years of hairdressing. I’ve done a lot of heavy work in my time like concreting and stuff like that. A lot of gym work which most probably wasn’t real brilliant for them. So I reckon they’re just worn out”
Body weight as contributor	NA	Joseph: “I think that was half my problems with my knee is because I’m overweight so that doesn’t help in the first place.” Cynthia: “I think if I lost 20 kilos, which should be my ultimate game, maybe 30, I suspect my knees would improve out of sight. And I mean, I lost 10 kilos and actually after losing 10, my knees did feel a bit better. So if I lost another 20, I probably think they’d be a lot better.” Michelle: “And then I lost – I can’t remember how much it was now, it was like a fair bit in six months – like 8 kilos or something – and I think nothing else would – well, apart from my physical fitness would have been pretty poor – so I think those two things. If I could have got more weight off more quickly, I reckon I might have seen more benefits, you know?”
Theme 4: Self-efficacy		

Running title: Responders & non-responders to exercise

Exercise adherence	Bill: <i>"I was very, very diligent with the exercise program certainly through the first three months. I didn't miss a single day. Did all the exercises as required and to the level required"</i> Judith: <i>"I felt, as I worked on the exercises – like religiously, doing them every second day"</i> Valerie: <i>"I must admit, towards the end, I did flag off a little bit. Mainly because my knee was feeling so good."</i>	Michelle: <i>"I followed exactly what I had to do. Yes, 100 percent."</i> Catherine: <i>"Probably because I didn't do the exercises. I did some exercises with trepidation for fear of causing my back pain ...There was times that I just didn't do the exercises due to other factors, whatever, at the time."</i> Joseph: <i>"The first time I went back it was I pretty much did them all. And then the second time I went back I did, I don't know, three-quarters. And the third time I went back I did half and sort of dwindled away so by the fifth time I went back it was hardly anything"</i>
Empowered for self-management	Elizabeth: <i>"But we covered the book and it got me to a stage where I was comfortable doing my exercise and there was nothing of concern really"</i> James: <i>"Well, now I understand it is very important, understanding that a little bit of pain is OK and how to deal and manage that pain and understand that some pain to do with any sort of physical activity is OK and I'm not doing any further damage..."</i> Melissa: <i>"It got me where I had a wide variety of different exercises that I could do and I felt supported and I knew what I needed to do, so I didn't really need more [physio consults]."</i>	NA
Theme 5: Barriers		
Comorbid health conditions	NA	Beverley: <i>"I thought it was doing me OK but then no, I just couldn't deal with it anymore...I ended up having to have injections in my hips afterwards. Because I do have bursitis in my hips, so it actually created more problems for me."</i> Catherine: <i>"I have had for some years, quite a long time ago diagnosed with depression and I am on medication for that that works but different issues in life that come up are still very hard to live with and I did have a very severe bout of depression, and that happens."</i> Joyce: <i>"Well I think it was the overriding factor – my general health with my hips and my back and that were the major contributor for me easing up and not doing as much as I should have been."</i>
Stressors & life events	NA	Kathleen: <i>"I persevered with it until a couple of months ago, because I had a lot of bad news in the family and things – stress just took over"</i> Michelle: <i>"Kept it up right up until most probably just before I left. And then I was packing. So it was more a time factor, and I was – the packing – I had to do most of it myself. And I was really struggling...So there really was no thought of, "Oh yes, I must do my exercises," because by the end of the day I could barely move. So yes, I dropped off a fair bit in that few months leading up to moving"</i>

Running title: Responders & non-responders to exercise

		Matilda: <i>"Other things happened in my life that changed as well about the same time. That always complicates outcomes, and they were not something that could be avoided. Just some of my physical activity ceased due to other issues, other people's injuries, actually. So there was a bit of a sudden change in lifestyle."</i>
Theme 6: Outcomes		
Strength gains	Gregory: <i>"It did in terms of resistance and reps and stuff, yes, it progressed a lot. I got a lot stronger, definitely, yeah."</i> Judith: <i>"I felt all the muscles leading into my knee really – so you know my quad, my hammy, I felt all of that starting to build strength, which was taking a bit of pressure off the poor old knee as well."</i> Lesley: <i>"You could just definitely feel the strengthening in the quads and things like that, that were actually taking the load off the knee a little bit."</i>	Joseph: <i>"I must admit at one stage I did feel better. When I was doing the exercises initially I did feel stronger and more flexible and that side of things."</i> David: <i>"Well, I do feel that it did - I got stronger in the legs, and that was a help."</i> Michelle: <i>"I felt so much stronger. I could barely walk, I'd use a walker – inside the house, just to go to the sink. And when I first went there I could barely walk and I was doing just a few hundred steps a day ... And then I worked up to 6,000 and – .. I could walk to the sink without my walker. So I definitely got improvement as far as strength went."</i>
Measurement limitations	NA	Michelle: <i>"When I filled out that final part of that survey, I was just recovering from being really, really sick. ... And yes, but unfortunately that survey asked me how I felt in the last two weeks and I wrote on it that I had been very sick so I didn't think it was really fair to have to write how I felt in that two weeks."</i> Catherine: <i>"But if I'm having to mow a lawn, lift a lawnmower into a car, which I did and ended up with two bulging discs in my back, you're not doing the survey justice at those points in time."</i> Matilda: <i>"I don't think it helped with the pain, put it that way, because that's not – but that wasn't my issue anyway... And so, my knee issue was more learning to live with the dysfunction and how to avoid falling over, learning how to use my legs differently... So that's why, I suppose, the questions, when you do a survey, questions are always limited in terms of how you can answer them because of the way they're worded... they've been worded for a particular answer, and you can't always give that answer."</i>

NA= not applicable as the subtheme did not arise within the subgroup