Individuals' experiences of the consequences of anterior cruciate ligament reconstruction surgery

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ABSTRACT

Anterior cruciate ligament (ACL) injuries have a profound impact on an individual's life. The aim of this study was to explore participants' experiences and perspectives of outcomes of their ACL reconstruction (ACLR) from two to 10 years following surgery, in relation to physical activity, sports, occupation and quality of life. Ten participants completed patient-reported outcome measures (PROM), namely the Tegner Activity Scale, the Knee Outcome and Osteoarthritis Score (KOOS) and the Sports Confidence Scale; and they participated in individual face-to-face semi-structured interviews. The interviews were recorded and transcribed verbatim. The general inductive approach was used for data analysis, and PROMs were analysed descriptively. Two themes were identified from the interviews: "Continuum of fear of re-injury versus confidence" and "Ongoing knee-health related problems and need of health professional advice". Anterior cruciate ligament reconstruction may lead to long-term fear of injury and behavioural manifestations, with fluctuating levels of confidence during sports. Participants had ongoing knee health-related problems and were concerned about the future risk of re-injury or osteoarthritis. Participants reported good knee function, and yet scored low on quality of life scales (KOOS, median 53/100). The Sports Confidence Scale indicated low knee-related confidence levels (median 41.5/80). Health professionals should consider long-term individual-specific maintenance programmes that improve and maintain confidence and self-efficacy for those with ACLR.

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INTRODUCTION

Anterior cruciate ligament (ACL) rupture is one of the most debilitating sports injuries with an annual incidence of 68.6 per 100,000 person-years for isolated ACL tears in the United States of America (Sanders et al., 2016). Individuals undergo anterior cruciate ligament reconstruction (ACLR) to improve knee stability, typically intending to return to their pre-injury level of sports; and to maintain their quality of life (QOL) (Heijne, Axelsson, Werner, & Biguet, 2008). However, the goal to return to their pre-injury level of sports is challenged by participants often experiencing fear of re-injury (Kvist, Ek, Sporrstedt, & Good, 2005). Only 55% of individuals with ACLR have been found to return to competitive sports post-surgery (Ardern, Taylor, Feller, & Webster, 2014).

Different health-related QOL levels have been reported for participants with ACLR. For example, low QOL (based on the Knee Osteoarthritis and Injury Outcome Score, Quality of Life [KOOS-QOL]) was reported at an average of nine years in one cohort (Filbay, Ackerman, Russell, Macri, & Crossley, 2014), while another cohort with an average 11.5 years post-surgery reported similar levels of QOL compared to uninjured controls (Möller, Weidenhielm, & Werner, 2009). Paradoxically, athletes who continue to play competitive sports after ACLR report lower knee-related QOL in the long term than those who have changed to recreational level sports (Filbay, Crossley, & Ackerman, 2016).

Previous qualitative research has focused on participants' experiences related to rehabilitation post-ACLR. Those studies

described the rehabilitation journey as a long and arduous process, often associated with a loss of identity and emotional responses such as frustration and anger (Scott, Perry, & Sole, 2017; Heijne et al., 2008). Further, psychosocial barriers to return to sports post-ACLR have been identified (DiSanti et al., 2018). To improve our understanding of outcomes of ACL injury and reconstruction, the aim of the present study was to explore participants' experiences and perspectives of the outcomes of their ACL injury and surgery from two to 10 years in relation to physical activity, sports, occupation and their QOL. This study is nested within a larger research project exploring long-term outcomes of ACLR.

METHODS

Design

A qualitative study design was used with semi-structured interviews. The Consolidated Criterion for Reporting Qualitative Research (COREQ) checklist was used for reporting the study (Tong, Sainsbury, & Craig, 2007). Prior to the study, researchers bracketed their perceptions and thoughts related to the field of study (Sorsa, Kiikkala, & Åstedt-Kurki, 2015) to mitigate the influence that such preconceptions may have on the research process and data analysis (Tufford & Newman, 2012; Palaganas, Sanchez, Molintas, Visitacion, & Caricativo, 2017; Petty, Thomson, & Stew, 2012). The study was approved by the University of Otago Human Ethics Committee (Health) (ref: H15/034).

Participants

Participants were recruited from the local community via advertisements for a study exploring biomechanical and physical outcomes of ACLR. Participants had provided written informed consent to participate in the larger study and confirmed their willingness to be interviewed. The participants were recruited sequentially based on their response. Those included were men and women between 20 and 50 years old, who underwent a primary ACLR (any type of graft), with or without associated ligamentous, meniscal or chondral injury within the past two to 10 years. Participants were excluded if they had bilateral or revision surgeries; other lower limb, pelvic or low-back musculoskeletal injuries which needed health care over the past 12 months or were limiting their daily function, sports or occupational performance; or had known systemic, neurological or cardiovascular disorders.

Data collection

Prior to the interviews, participants completed a demographic questionnaire; the Tegner Activity Scale (Tegner & Lysholm, 1985); the Sports Confidence Scale (Ardern, Taylor, Feller, & Webster, 2012); and the Knee Injury and Osteoarthritis Outcome Scale (KOOS) (Roos, Roos, Lohmander, Ekdahl, & Beynnon, 1998) via Qualtrics (Provo, UT, USA, 2015). $KOOS_4$ was calculated as an average score of four sub-scales excluding "function during daily activities" due to a high ceiling effect for that sub-scale (Hamrin Senorski et al. 2017). These data were collected to describe the participants as a group. Quantitative data from the patient-reported outcome measures (PROM) provided ratings by participants regarding their symptoms, function, QOL and fear related to their knee health; and their responses were explored in depth during the interviews.

Face-to-face individual interviews were held. Four of the interviews were conducted only by MK, while two interviewers (MK and GS, both women) were present for the remaining interviews. At the time of interviews, MK was a PhD candidate with clinical experience in musculoskeletal rehabilitation and was new to the qualitative research methodology. GS is an established clinical researcher within the field of musculoskeletal physiotherapy, and is experienced in quantitative and qualitative research methods. Participants had met MK during the quantitative data collection sessions prior to the interviews. The participant information sheet clarified that the study contributed towards the PhD thesis of MK and that the co-researchers were physiotherapy academic staff.

All interviews were conducted in the School of Physiotherapy, University of Otago, and took between 20 to 40 minutes. While participants were informed that they could bring a support person, none chose to do this. No interview was repeated. The interview guide had open-ended questions, and was developed and refined by the research team (Appendix 1). While the guide provided structure, the selection and wording of specific questions and their respective order depended on how the interview proceeded. The interviewer also referred to the individually completed PROM, and could ask participants to clarify and explain their ratings. Field notes were made during and after the interview. The interviews were recorded with a digital audio recorder (Sony R- IC Recorder) and transcribed verbatim.

Data analysis

Quantitative and qualitative data were analysed using an Excel spreadsheet (Microsoft Office 2013). Descriptive analyses (median and ranges) were performed for the PROM.

The general inductive method was used for the interview data (Thomas, 2006). The transcriptions were read multiple times, and text segments that reflected the participants' experiences were identified and coded. The codes were categorised and the researchers developed links between these categories and identified themes relevant for the research aims. After the primary analysis of the available data and when no new codes evolved from the next two interviews, it was deemed that data saturation had occurred (Fugard & Potts, 2015); this occurred by the eighth participant.

The primary author (MK) analysed all interviews, while GS analysed every second interview. The codes produced by the researchers were data driven, and were then compared, discussed and negotiated. The categories and emerging themes and sub-themes were discussed and confirmed within the research team. The key themes were cross-referenced back to the original text to ensure that it was an accurate representation of the participants' perceptions of their experiences. Supporting quotes that most accurately reflected the key themes and sub-themes were selected. A summary of the results was sent to the participants for verification and feedback.

RESULTS

Seven women and three men (median age 28.5 years, range 20 to 52 years) participated in the study. One participant declined to take part due to unknown reasons. Three participants were health professionals, three held academic or education positions, and four were students. Three participants underwent reconstruction within five months of incurring their ACL rupture, while the remaining participants had delayed surgery (Appendix 2). Time since reconstruction ranged from three to 10 years, and all participants had been discharged from rehabilitation. Five participants had returned to their preinjury level of sports participation, one had increased their level of sports participation, while the remaining four participants had decreased their level of sports participation by two or more scores (Table 1).

Despite a high median KOOS "function daily living" score (99/100), as a group the participants still experienced "knee-related symptoms" (median 59/100) and slightly impaired "knee function during sports and recreational activities" (median 84/100). The median KOOS4 was 69/100 (Table 1). Overall, they scored low on KOOS "knee-related QOL" (median 53/100). Results from the Sports Confidence Scale (Table 1) indicated that, as a group, these participants still had decreased confidence in their knee (41.5/80).

From the qualitative data, 13 categories were converged into two themes. Themes and subthemes with supporting quotes are described below (Table 2), with additional supporting quotes in Appendix 3.

1. The "fear of re-injury" versus "confidence" continuum

This theme describes a continuum between fear of re-injury and confidence when engaging with physical and sports activities. It consisted of three sub-themes: contributors to fear of re-injury; behavioural manifestations of fear; and confidence.

Contributors to fear of re-injury

Four main contributors to fear of re-injury were defined from the data and were related to the participants' experiences with the injury, surgery and rehabilitation (Figure 1). Contributors included participants' fear of re-experiencing the intense pain associated with the initial injury (Quotes 1, 2 and 3), and the memory of the inciting injury movement (Quote 4). While most participants described being cautious and mindful towards their knee health during physical activity, some of the participants expressed anxiety associated with the knee and were avoiding specific activities (Quote 5). One participant described himself as confident during sports but still cautious with the specific activity that was related to his injury, namely sprinting to catch a ball (Quote 6).

The difficulty of undergoing a long period of rehabilitation accompanied with loss of muscle strength (Quote 7) was the third factor contributing towards the fear of re-injury. Furthermore, the injury and rehabilitation had impacted on family dynamics and commitments. For one participant, knee health hindered her actively engaging with children. Another participant had to take greater day-to-day responsibility for her children as her partner's work now demanded extended periods away from the family (Quote 8). Family responsibilities thus contributed towards the fear of re-injury as participants did not want to impose the inconvenience associated with the commitment to rehabilitation on their family again.

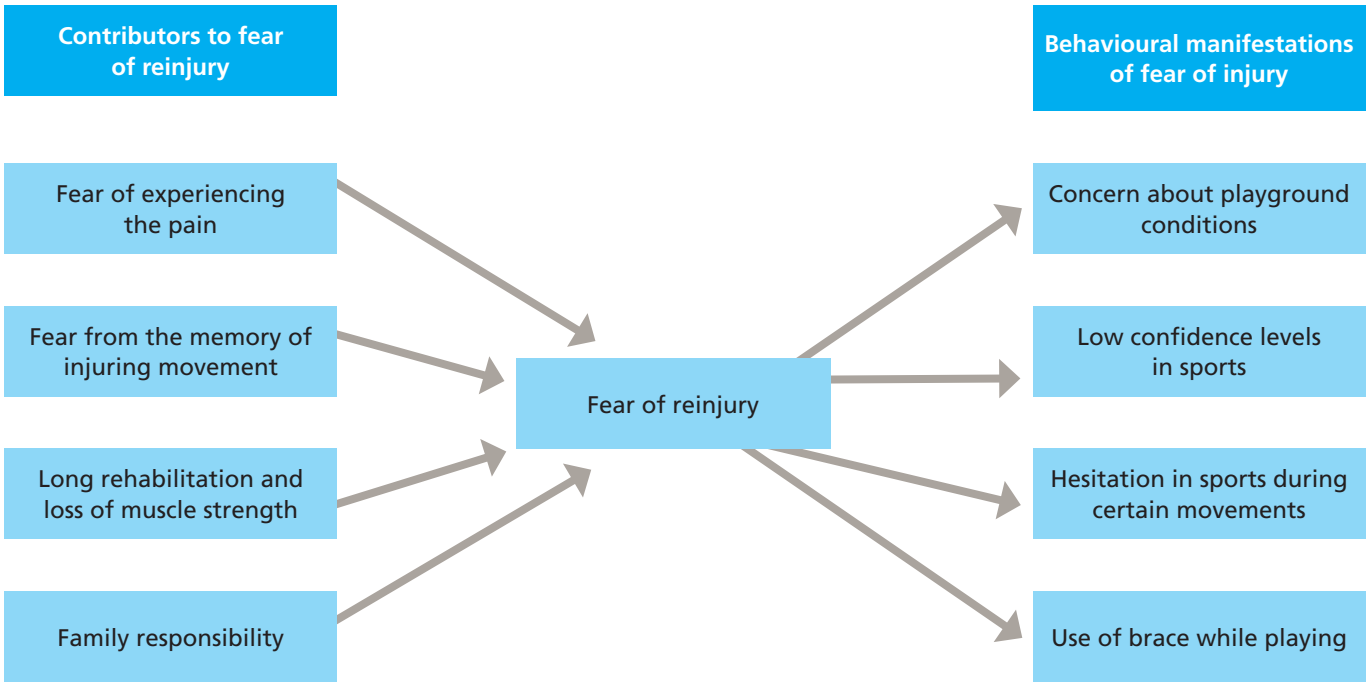

Figure 1: Fear of re-injury and its consequences

Table 1: Participant demographics and patient-reported outcomes

ID/sex	Length of interview (mins)	Time since ACLR (years) / side of injury	Pre-injury Tegner scores	Post-injury Tegner	KOOS-Pain	KOOS-Symptoms	KOOS-ADL function	KOOS Sports/ recreation	KOOS QOL	KOOS4	Confidence during sports
P1 (F)	23.5	9 /left	6	6	97	54	99	90	63	78	41
P2 (F)	27.2	10/right	6	1	67	39	93	80	19	54	51
P3 (F)	20.2	9/right	3	3	78	89	99	40	38	67	64
P4 (F)	19.5	5/right	9	9	97	61	100	90	69	81	37
P5 (M)	41.0	3/left	9	9	100	61	100	85	63	80	39
P6 (M)	32.0	4/left	3	4	94	57	99	70	56	73	47
P7 (F)	39.1	5/right	7	4	94	71	100	80	75	82	45
P8 (F)	38.2	7/left	9	7	72	46	94	50	44	56	52
P9 (F)	20.0	3/left	7	3	86	46	100	75	50	67	37
P10 (M)	30.5	9/right	5	5	97	75	100	100	44	83	32
Median (range)		6 (3-10)	6.5 (3-9)	5.1 (1-9)	94 (67-100)	59 (39-89)	99 (93-100)	80 (40-100)	53 (19-75)	69 (54-83)	41.5 (32-64)

Notes: Tegner activity scale, scale from 0 "sick leave or disability pension because of knee symptoms" to 10 "competitive sports – national or elite" (Tegner & Lysholm, 1985); KOOS, Knee injury and Osteoarthritis Outcome Score: "0" indicates extreme knee problems and "100" indicates no knee problems (Roos et al., 1998); KOOS4: an average of pain, symptoms, function during sports and recreation, and quality of life (Hamrin Senorski et al. 2017); ACLR, anterior cruciate ligament reconstruction; ADL, activities of daily living; QOL, quality of life; Confidence during sports, maximum score 80, higher scores indicate lower levels of fear of injury (Ardern et al., 2012)

Table 2: The key themes and the subthemes

Theme/ subthemes	Categories	Quote number	Participant quote
1. Fear of re-injury versus confidence continuum			
Contributors to fear of injury			
	Fear of experiencing injury pain	1	"I remember just being in a lot of pain, so I don't really want to have to feel it [again]." P4
		2	"I felt really uncomfortable playing when there are lots of people around me, like if people, I was always scared that someone would push me over and twist my knee and I would be in pain. I think I was always more scared of the pain. I didn't want to feel that pain again." P8
		3	"I just would never want to go through it again, I mean I know I could get through it but it's, yeah it messed me up for a bit…." P6
	Memory of inciting injury movement	4	"I wasn't doing anything different, like I've jumped that way 100 times before so it's just kind of … a memory thing, I suppose, and like when I came back, one of the first games I played, I stopped real suddenly to stop myself from going offside and it kind of locked back on me and I just … freaked out a little bit […]….." P7
		5	"I don't jump on the trampoline as much, I do it sometimes but I'm really conscious that it feels, in my head, I think it could go wrong very easily […]." P2
		6	"There is definitely times where I don't trust myself to run […] or to sprint to be able to catch a ball or something so I will just jog because I don't have the confidence because both times that I have done it [the ACL rupture] has been at a sprint so that is the time when I am the least confident." P8
	Long rehabilitation period and loss of muscle strength	7	"It's mostly the weakness that I've got on that side and… yeah the long-term, like …. if I'm fit, then it's fine but I'm not always fit and yeah there's definitely weakness on that side and I don't want to have to repeat all the rehab and everything else again, 'cause it does take a while for it to feel normal." P1
	Impact of the injury and rehabilitation on family responsibility	8	"Main thing probably is the fear, because my husband works [… abroad] and I am here with kids so I can't afford to be injured because I got no family [close by], and will be really difficult […] if I re-injured my knee." P3
Behavioural manifestations of fear of injury			
	Concern about playing conditions	9	"I hate playing on slippery, when it is wet. If we are playing outside I don't like playing it, it is unstable. Wet surfaces are pretty bad. Just the uneven surface makes me feel uncomfortable." P8
	Hesitation in sports during certain movements	10	"I'm just a bit, I think twice when I'm doing a heavy pivotal movement on the right and on the left I will just do it without thinking. Obviously I, actually modified, meaning ...I try to change it to my left if I could." P10
		11	"…I'm not as adventurous anymore, how I used to be […]; I play the safe road now. [….] I've got older brothers and they're go go go, so I do pull back a bit and stay with mum sometimes now instead of going off with them. But other than that I still join in. I still go bike riding and skiing and everything." P9
	Use of brace during playing	12	"I do use a brace when I do snow skiing. I don't think it does anything but it just gives me a little bit more confidence or […] knowing just to protect it as such." P9

Theme/ subthemes	Categories	Quote number	Participant quote
Confidence			
	The fluctuating confidence spectrum	13	"But with the right conditions and knowing that my fitness is in the right place, then it doesn't hold me back." P1
		14	"I'd say most of the time I don't think about it [the knee] too much." P1
		15	"I know that it's never going to be as good as my left but I can live with that but I want to make sure I do everything possible to make that better. For some reason I think I'm actually stronger now than before." P10
		16	"I remember the way I was playing soccer at the start …, I was just tip toeing around, I wasn't really like trying to turn, I was real conscious of the way I was turning … but then, throughout the football season I just learnt that I can actually manage all of those things... I think I am still ...gaining confidence in it…." P5
		17	"I don't feel confident in that knee or either of them now though, so no it's not just the one that had the operation." P2
		18	"I played in the team but I had to pull out of the team because... I don't know if I didn't trust it or if my knee wasn't strong enough, but it wouldn't hold out with my head. I was almost protecting my knee in everything I did, so every time I jumped up I'd land on the other leg. I'd always turn on the other leg, and I was kind of just leaving the injured one behind, or the surgery one behind. Tried again in 2014 and then just decided I'd flag it and just do something else." P9
2. Ongoing knee-health related problems and need of health professional device			
	Ongoing problems	19	I probably walk, like so I used to walk a lot and now I think if I walked to work, for example then how sore am I gonna be for the rest of the day or will my knee be able to cope then walking home, does that make sense 'cause …" P2
		20	"Yeah I don't like to [run on hard surface], well I do run on concrete a bit but I really prefer not to, just 'cause like I get a lot more pain ,.. a little bit more pain, not a lot but definitely the softer surfaces." P7
	Continuing daily struggles	21	"Kneeling gets really uncomfortable. I can do it for a little bit, but I prefer to sit in a low squat than kneel... Pain will be minor and it is not ... too major but then sometimes it will be mainly, from after playing a game or training and it will just ache. Going upstairs is generally fine, it is the going down, if I am walking in bare feet, on like hard concrete it is not very good." P8
		22	"… It ...[reduced physical activity] is the combination of both, part of it would probably be because of my study… but also because I have put on, I guess, quite a lot of weight, and so I am slower and don't feel as comfortable. I can't compete at that same level because I am slower, and a lot of the girls coming through, especially for basketball, are young and fast and… to play at that level, the higher level, it is just hard. Um, it is fine to some extent for short periods of time, but because of my knee, I often feel that I have never been able to get as fit again…"P8
	Maintenance of muscle strength	23	"I pulled it [hamstrings] about three times, and then I just went, I had to sit out of football for about a month or two this season. P5

Theme/ subthemes	Categories	Quote number	Participant quote
		24	"At this stage I feel like I have … got to keep … building or, at least, maintain the leg strength, and I have learnt from earlier in the year I can't neglect the hamstrings especially because if I do, I think it makes [them]… susceptible, so I better get working at that." P5
		25	"I like to walk up stairs wherever I go rather than take the lift, push play, you know that kind of thing…" P6
	Seeking health-professional advice	26	"I think maybe an exercise plan that challenges my head and lets me know that I can do these things. Maybe to know I've got the strength, like physically do a test or something and see that yes, you do have the strength to do these things. It's not going to give way. And then do the activities and realise that it's fine" P9
		27	"I need my specialist to every so often to and have a check up and make sure my knees fine 'cause for me it really helps to reassurance from, for example from the likes of doctor xxx. Because … I have a lot of faith in him and he's a specialist in his area. So if he tells me I'm doing the right thing, then I know I'm doing the right thing." P10
Concern for long-term disabilities			
	Concern for future OA and TKR	28	"I am aware that I might develop osteoarthritis in the knee, and I just take it as it comes." P3
		29	"I'm just worried about when I get old, it's gonna be really sore but immediate future, no issues." P7
		30	"My concern is that people say that if you have ACL surgery you're likely to need a knee replacement in the future." P9

Notes: An em dash (–) was used to indicate a pause; an ellipsis (...) the removal of some text that did not alter the meaning of the quote; and square brackets [ ] to indicate the addition of text to clarify meaning. ACL, anterior cruciate ligament; P, participant

Behavioural manifestations of fear of injury

Fear of re-injury had four main behavioural manifestations. Participants were concerned about the playing surface condition and showed hesitation with specific activities. Five participants expressed concern about wet, frosty or uneven playing surfaces as they felt this increased the chance of slipping and re-injuring their knee (Quote 9). Most participants reported being hesitant, guarded or very conscious of their reconstructed knee during specific sports-related movements, particularly during changing direction while sprinting, turning and pivoting (Quote 10). Three participants with a decrease of ≥ 3 for the Tegner score described continuing to avoid "high-risk" activities, including those considered by them to be for fun or adventurous (Quote 11). It became apparent during the interviews that a fear of re-injury was contributing towards changed behaviour in terms of general physical activity as participants tended to think about their knee safety first. Two participants used braces for their knee during sports to increase confidence, while one participant strapped the knee during weight training in the gym (Quote 12).

Confidence

Participants appeared to be fluctuating between fear of re-injury and confidence, with a spectrum of confidence levels, which was also reflected by the Confidence During Sports Scale (range 32 to 64). The varying confidence spectrum may affect the overall performance of participants in such a way that those with low levels of confidence were unable to perform at maximum effort. Only three participants described themselves as having regained confidence in their injured knee (Quote 13) and could participate in their sport without having to focus on the knee (Quote 14). Some participants had regained trust in their knees, investing much effort to optimise results by strengthening the thigh muscles (Quote 15). One participant described how continuing to train and playing soccer contributed towards steadily improving confidence (Quote 16).

One participant also indicated loss of confidence in the contralateral uninjured knee, (Quote 17) and another participant described her struggle with returning to sport, deciding after a while to quit (Quote 18). These results indicate individual-specific levels of confidence and trust in their reconstructed (and contralateral) knees.

2. Ongoing knee health-related problems and need of health professional advice

Most participants described ongoing knee health-related problems such as pain, stiffness, achiness and pain after running, albeit at different levels. One participant described her concerns for pain, which she experienced after walking to her office (Quote 19). Another participant described avoiding hard surfaces while running as it caused her knee pain and soreness (Quote 20). However, those problems did not always appear to limit their ADL or sports-related knee function (Quote 21). Further, one of the participants attributed other health- and life-related factors to her decline in physical activity levels (Quote 22).

Participants were aware of the need for long-term maintenance of muscle strength, in particular for graft site-related weakness, to maintain confidence and decrease risk of re-injury. Muscle weakness related to the site of the graft was an issue, specifically of the hamstring or quadriceps muscles (quadriceps weakness following a patella tendon graft, and hamstring weakness following a hamstring tendon graft). One participant described having recurrent hamstring strains following his hamstring tendon graft (Quote 23). Maintenance and improvement of muscle strength was perceived to be critical to manage the fear of re-injury and improve confidence (Quote 24). One participant also indicated positive changes in daily behaviour following the surgery specifically to maintain and increase knee-related physical performance, for example taking stairs instead of the lift (Quote 25).

Participants indicated the need for ongoing health professional advice to manage the fear of injury, and to improve muscle strength and movement control (Quote 26). For some participants, contact with their health professional provided reassurance (Quote 27). Six of the participants were concerned about the long-term risk of knee osteoarthritis and pain (Quote 28 and 29), and one mentioned concern about the possibility of the future need for knee replacement (Quote 30).

DISCUSSION

This study explored individuals' experiences of outcomes and consequences of their ACL injury up to 10 years post-reconstruction. Two main themes relating to the research question were "fear of re-injury versus confidence continuum", and "ongoing knee health-related problems". Overall, a range of experiences were described, with different strategies to adapt to the influences of injury on their lives. Positive experiences and outcomes were evident by some participants describing slowly regaining confidence during sports, returning to a pre-injury level of sports or even increasing the level of physical activities post-surgery compared to their pre-injury level. Such participants were making a conscious effort to engage in physical activity (e.g. preferring to walk up the stairs rather than using the lift) and to improve or maintain knee health. They described that they had been more aware of their knee when returning to physical activities and sports, but in a "mindful" and "caring" way, instead of worrying about the future of the knee. In contrast, a more pronounced fear of injury and avoidance of specific activities were described by other participants. Such participants also appeared to have more anxiety and fear related to the future of the knee, and seemed to prefer activities associated with low levels of physical exertion (e.g. driving rather than walking).

Fear of re-injury was present, irrespective of participants' level of physical activity or time since surgery (up to 10 years). The fear was primarily driven by experiences of the pain associated with the ACL injury and surgery. The fear also appeared to be influenced by the commitments the long post-surgical rehabilitation period had required, frequently conflicting with family commitments. Such conflicting commitments (rehabilitation versus family roles) have been described previously (Burland et al., 2018; Ross, Clifford, & Louw, 2017; Scott et al., 2017; Tjong, Murnaghan, Nyhof-Young, & Ogilvie-Harris, 2014). The fear influenced return to sports such that one participant was unable to return to the preinjury sport, changing to alternative sports. Previous studies showed that fear of re-injury was present up to two years post-surgery (Heijne et al., 2008), decreasing at around three years post-surgery (Gignac et al., 2015). In a previous study from our centre, participants (<3 years post-surgery) suggested that maintaining physical activity and confidence in the knee would require vigilance for life to decrease risk of a knee re-injury (Scott et al., 2017). Our current findings also indicate that fear or anxiety of re-injury can persist for a longer period than is usually expected.

Fear of re-injury may be a subconscious protective response, particularly when considering the relatively high incidence of re-injury (Lai, Ardern, Feller, & Webster, 2018). Heightened awareness of the knee during various activities has also been described in a recent study with 12 participants with ACLR (Burland et al., 2018), and by participants who had undergone non-surgical management for ACL rupture (Takata et al., 2017). Fear may thus also be considered a rational response to the ACL injury.

In the second theme emanating from this study, participants discussed their concerns about ongoing knee health-related problems such as pain, soreness and potential risks of future osteoarthritis. These concerns are realistic. For example, higher rates of anterior knee pain and pain during kneeling have been reported previously in literature in those with bone patellar tendon bone grafts (Poehling-Monaghan et al., 2017). Risk of osteoarthritis within 10 years following injury has also been reported previously and is known to affect QOL in the long term (Lohmander, Englund, Dahl, & Roos, 2007). Besides a high risk of re-injury of the injured and the contralateral knee when returning to sports (Paterno, Rauh, Schmitt, Ford, & Hewett, 2012), a sevenfold increase in odds has also been reported for undergoing a total knee replacement after having an ACL injury, compared to those without such injury (Khan et al., 2018). Thus, the participants' concerns, as found in this study, should not be minimised; rather, health professionals should provide opportunity for open discussion to allay potentially excessive concerns while still acknowledging the risks.

Changed priorities in terms of sports, physical activity and behaviour modifications since ACL injury were described by most of the participants; however, such changes were not entirely due to consequences of the knee injury and surgery. In our previous study with individuals less than three years following ACLR, the participants highlighted their family's support towards their rehabilitation and recovery. In contrast, for some participants (two to 10 years post-ACLR) in the current study, their focus was on responsibilities towards family support, mainly their children. Two participants attributed the changed physical activity levels to commitment to university study. Such changed life responsibilities influencing decision-making for return to sports and activity choices have been described for individuals post-ACLR (Burland et al., 2018). Thus, besides fear of re-injury and residual knee impairments, changed life priorities and responsibilities contributed towards decision-making for return to physical activity and sports.

Overall, participants suggested a need for access to long-term health professional advice, either to improve their knee health or for reassurance related to their knee, such as graft site-related weakness, minor pain, soreness in the knee and maintenance of muscle strength. Patients with ACLR should be informed by health professionals about the implications of such risks before surgery, along with providing individual-specific strategies to minimise such risks. Considerations should include the individual's specific sports-, recreation- or work-related goals and life priorities. Overall, this demands considering the physical and psychological responses to the injury (Burland et al., 2018). Discussions may also be needed as to whether changes in physical activities or types of sports are recommended, particularly those sports that may have a lower risk of re-injury of the knee. Thus, physiotherapists should continue monitoring the individual's goals and ability to accept or control fear, anxiety or concerns related to re-injury and long-term knee health.

Health professionals involved in rehabilitation are increasingly aware of their role in identifying emotional or psychological responses to ACL injuries (Ardern, Taylor, Feller, Whitehead, & Webster, 2013; Scott et al., 2017; von Aesch, Perry, & Sole, 2016). Our earlier study with participants who had undergone ACLR less than three years earlier (Scott et al., 2017), described participants' emotional responses as loss of their identity due to the injury, and feeling out of control, depressed and frustrated at various stages of their rehabilitation. While those responses were not described in detail by the current participants up to 10 years following ACLR, the fear of re-injury and the loss of confidence during specific tasks were still evident. This study, thus, highlights the importance of identifying the individuals at-risk of long-term fear of re-injury, loss of confidence and low self-efficacy. Questionnaires such as the Tampa Scale of Kinesiophobia (Kvist et al., 2005) or the ACL Return to Sports Index (Webster & Feller, 2018) may be useful to identify patients at risk of excessive fear-related movement-avoidance behaviours. Principles of motivational interviewing may be helpful to establish the individual's concerns and goals for the future, and develop an individual-specific plan (Coronado et al., 2018).

Self-management strategies may be considered post-ACLR to address fear of re-injury. In a previous study from our centre, physiotherapists reported using a biopsychosocial approach as part of the care they provided for the rehabilitation of patients with ACLR in New Zealand (von Aesch et al., 2016). Collectively, past studies (Burland et al., 2018; Coronado et al., 2018; Sonesson, Kvist, Ardern, Österberg, & Silbernagel, 2017; Ardern et al., 2013) highlight the importance of addressing the psychosocial needs of the patients during rehabilitation following ACL injury. Such strategies may include self-management of lingering symptoms, enhancement of self-efficacy, and encouragement of changes in sporting goals and activities where necessary.

The quantitative data for this research project was collected prior to the interviews, allowing the interviewer to refer to them during the interview and to establish rapport with the participant. The participants' perspectives about the influence of ACLR on their lives appeared to be in agreement with the results of PROM. Credibility of the results of this study was ensured by: (1) development of the interview guide by the research team through review and reflection; (2) the audio recordings and verbatim transcriptions of the interview, open atmosphere during the interviews, the researchers bracketing prior experiences and thoughts, and member checks of the study results with the participants; (3) peer debriefing of the overall results by three of the authors.

Trustworthiness and dependability of data were established by the parallel coding of every alternative interview by a second researcher and by providing additional quotes (Appendix 3) (Thomas, 2006). All interviews were face to face and employed the same method of data collection for all the participants. Confirmability of the study findings was ensured by the open discussion in the research team following the analysis.

The current study included a small sample size, and selection bias may have influenced our data, whereby individuals with residual impairments may be most likely to volunteer to participate in research studies. However, we suggest that the group of participants had a wide range of physical activity levels, ages and family responsibilities. Three participants were health professionals, which may have influenced their perspectives and experiences. Overall, the study provided insights into experiences of individuals typically attending community-based physiotherapy practices in the New Zealand healthcare context. The KOOS scores for participants were within the "acceptable range" (Muller et al., 2016), with the exception of lower KOOS QOL scores (Table 1). The KOOS QOL (median = 53) and symptoms (median = 59) of our participants appeared to be lower compared to other groups (MOON consortium: KOOS QOL = 75, symptoms = 85) (MOON Knee Group, 2018), and a Scandinavian group: KOOS QOL = 69, symptoms = 86 (Granan, Forssblad, Lind, & Engebretsen, 2009)). The experiences and perspectives may not apply to individuals who considered themselves fully recovered post-surgery.

CONCLUSION

Up to 10 years post-surgery, the participants reported long-term fear of injury and behavioural manifestations, with fluctuating levels of confidence, and variable levels of QOL. Maintaining thigh muscle strength and continuing with sports was seen to enhance confidence. Participants raised concern for long-term risk of re-injury and of developing knee osteoarthritis. Health professionals should consider long-term individual-specific maintenance programmes that improve and maintain confidence and self-efficacy, and promote physical activity in those that have undergone ACLR.

KEY POINTS

1. Participants with ACLR had fluctuating levels of confidence during sports while striving to live life as normally as possible.
2. Physiotherapists need to consider long-term fear of injury and behavioural manifestations which may persist long-term following ACLR surgery.
3. A rehabilitation maintenance plan may need to be considered for overall knee health, reassurance and strategies to improve self-confidence and self-efficacy.

DISCLOSURES

No funding was obtained for this study. There are no conflicts of interest which may be perceived to interfere with or bias this study.

PERMISSIONS

This study was approved by the University of Otago Human Ethics Committee Health (ref: H15/034).

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Appendix 1

INTERVIEW GUIDE

Section 1 – General information about the knee

1. Please could you give me some background information about yourself in terms of your occupation and sports background?
2. Please could you describe to me how your knee injury happened, and what happened with the knee since then?
3. How do you feel about your reconstructed knee at the moment?

Section 2 – Level of sports and recreational activities

4. Please tell me more about your level of physical activities for recreational purposes and exercise in the past year.
    a. Prompt: Do you think your reconstructed knee still influences the physical activity levels?
    b. How does your current physical activity or sports level compare to before injury?
    c. If there are still differences in the level of activity before and after the injury, can you explain why you have not returned to the same level?
    d. Prompt: Are there factors that make you feel more hesitant? If so, why do you feel hesitant or fear re-injury during sport?

Section 3 – Health-related quality of life

5. How would you describe your confidence in your knee during sports and recreational activities?
    a. Prompt: How much are you troubled by lack of confidence in your knee?
6. How have you modified your lifestyle in terms of your sports, occupation and recreation to accommodate your reconstructed knee?
7. How do you think pain and other problems related to your knee interfere with your normal work?
8. In hindsight, what other choices may you have made in terms of surgery and rehabilitation?
9. In hindsight, what worked very well for you during surgery and rehabilitation?
    a. What didn't work well for you?
10 Overall, how is your knee health these days? What works well for you in terms of physical activities and sports, and what does not?

Section 4 – Recommendations and advice for ACLR participants

11. What are your concerns for the future in terms of any activities related to your knee?
    a. Prompt: Would you be able to maintain your current exercise level in the future?
    b. Expectations? Challenges?
    c. Knee function? Activity level?
    d. How likely are you to recommend anterior cruciate ligament reconstruction surgery to patients with anterior cruciate ligament injury?
12. What will be your overall advice for people who have had an anterior cruciate ligament reconstruction?

Appendix 2

SURGICAL DETAILS OF PARTICIPANTS

Participant ID	Time between injury and surgery	Type of graft	Surgical details	Additional surgeries
P1	6 months	PT	Primary ACLR, partial lateral meniscectomy	–
P2	8 years	PT	#	–
P3	6 months	Allograft	Reconstruction of right knee, meniscectomy	–
P4	#	HT	Primary ACLR	–
P5	3 months	HT	Arthroscopic ACLR left knee, single bundle with meniscal repair	–
P6	7 months	HT	Primary ACLR	–
P7	2 months	HT	Primary ACLR	Second surgery: Scar tissue removal; third surgery: screw removal
P8	12 months	PT	Primary ACLR with meniscal repair	–
P9	13 months	HT	Primary ACLR	–
P10	5 months	PT	Primary ACLR, meniscectomy	Cyst removal surgery 2 years post primary ACLR

Notes: ACLR, anterior cruciate ligament reconstruction; PT, patellar tendon; HT, hamstring tendon; P, participant; #, missing data; **–**, no subsequent surgeries; All participants had guided rehabilitation

Appendix 3

ADDITIONAL QUOTES FROM PARTICIPANTS

Themes/Subthemes	Categories	Quotes
1. Fear of re-injury versus confidence continuum		
Contributors of fear of injury		
	Fear of experiencing injury pain	"I don't like running, I don't like high impact sports, too scared to go back to skiing because I know several people who had the operation and they re-injured their knee when they had a crash, so I am quite happy the way my knee is there, I don't want to re-injure it. I keep away from contact sports and skiing which is a shame but I am happy the way it is. It's partly the fear that I will re-injure my knee. I am just worried that I will fall on my knee, that's all…you know." P3
	Memory of inciting injury movement	"… It kind of scares you 'cause you know exactly how you've done it and how you could do it again so like just trying to avoid doing a similar movement to what I did at the time I guess." P4
		"I've got no control whatsoever ice skating and I just feel like I would be at too much of a risk of doing something to myself. I was a good enough skier beforehand that I've got the control to do it whereas I've got no control whatsoever ice skating and I just feel like I would be at too much of a risk of doing something to myself and it's that knowing that yes, it is a possibility to do again whether it would be the same knee or the other knee and I don't want to do it again." P1
	Long rehabilitation period and loss of muscle strength	"So it's definitely less weight on the leg with the reconstruction when it comes to anything using my quads." P1
	Impact of the injury and rehabilitation on family responsibilities	"… I don't do stuff with the kids which I would, like I'd probably run around and kick a ball around outside with them." P2
Behavioral manifestations of fear of re-injury		
	Concern about playing conditions	"Yeah [playground conditions] that sort of plays a role, definitely when it is [a] muddy surface and [a] wet surface, which we quite often get in Dunedin …, Yeah you do think about it." 'P5
		Slippery surfaces are one that I am concerned about in the Winter especially, icy stuff …" P9
		"Yeah wet muddy surface, I don't know, I worry about, you know, your foot getting lost and it twisting … yeah so pretty cautious about surface." P5
		"Just the uneven surface makes me feel uncomfortable." P8
		"I wouldn't play football on the hard concrete with the kids." P6
		"I can't do the same weights on that leg, but otherwise it doesn't really stop me from doing anything that I want to." P1
		"Cos that's how I did it when I was turning on my foot. 'Cos I wore like studded shoes so just be like when I have to do quick turns playing sport would be one I'd be a bit more cautious and probably like run around it rather than pivoting." P4
		"It's just… turning. Turning, pivoting on my foot is, on that leg is what scares me. I don't know why it doesn't scare me on my left but, yeah, I'm a bit guarded trying to turn on it because that's how I've done it. Probably just because I do guard my knee a little bit so it's more just a protective sort of means. But I'm still guarded." P4
		I do guard my knee a little bit, so it's more just a protective sort of means. P4

Themes/Subthemes	Categories	Quotes
		"Yeah it's good. It's fine. I don't worry about that too much. The only direction thing I worry about now is with water-skiing. So if I have my left foot forward and my right foot back, I'm fine turning, no I'm fine turning left, problems turning right. And, again, I don't know if it's strength or mind." P9
	Hesitation in sports during certain movements	"Yeah definitely with like lunges, like I'll do walking lunges but I won't do the jumping lunges just because I know at all the time. I spent a lot of time in front of the mirror like watching my knee, you know, making sure that it was in line and 'cause gym doesn't have any mirrors, it's like I don't want to… but lunges, I just, yeah I'm just a bit wary of technique, my techniques not very good so especially if I don't have a mirror where I can correct it." P7
		"I think I can give 100% …, but it is probably not, you know, I don't do it, I have got to think about it a little bit and […] convince myself, no I am fine to go all out here, and I have done that through this last part of the season and have realised that I can handle it, and it withstands all that effort." P5
		"I was pretty reckless then and fearless, and now I think about it a bit more and go, ok I might sort of hold out of that tackle; might not lunge for that ball." P5
		"I was a bit afraid, like for the sort of turning and twisting and kicking stuff because I'm not, soccer's not one of the sports I've played a lot, that I might do something to myself." P1
		"I make sure …. that every turn I take is done well." P9
		"Downhill, putting pressure forward, so if I was jumping down a slope, I'd be quite nervous." P9
		"I think twice if I'm changing my direction very quickly on that, on my right knee." P10
		"I probably am just a little bit more careful […] I never really was into high- risk stuff anyway but […] I've got flatmates that go long boarding and [...] sliding down [the street] on food trays and stuff. I don't know whether I would think differently but my reason was sort of […] I won't do that 'cause my knee's not better so I don't know whether I use it as an excuse to not do something I already don't wanna do, or whether if I felt really strong and more invincible than I do feel, maybe I would, I dunno but it's probably a good thing ..." P7
	Use of brace while playing	"[Strapping] usually if I'm on a mountain that I'm less familiar with." P1
		I don't know if it [brace] was doing anything or if it just gave me confidence in my mind but I seemed to have. It doesn't seem to make a difference to how I actually ski whether I wear it or not but I certainly don't wear it for any other activities anymore." P1
		"Only on the heavier weights [during gym training]. Because on the heavy lifts as you mentioned before, sometimes when fatigue kicks in there's a bit of wobble on your joints." P10
Confidence		
	The fluctuating confidence spectrum	"I think it is that, it is still that lack of confidence, you know." P5
		"It's pretty fine. Like I don't really notice it." P4
		"Probably a lot more disability is in my head, I can recognise it now and I probably could run; it might need just take pain killers." P3
		"I'm like an old lady knees, aye." P2

Themes/Subthemes	Categories	Quotes
		"I said I won't do any less but I won't do any more, so whatever the physio told me to, whatever the rehab people said, I did exactly that and I hit all the marks, so when he said when you're gonna be walking, I was walking and when he said you can start going out in the morning and I still remember that … , it was a great day to be able to run for a minute, and then it was just a sliding scale and then just kept going… and here I am now, …" P6
		I'm just mindful of OK this is probably one of those times where you can either button off or you just take it a wee bit easy; you know, better to be cautious than to go oh bother …" P6
2. Ongoing knee health-related problems and need of health professional advice		
Ongoing knee health-related problems		
	Ongoing problems	"Yeah, yeah, so like sitting, if I, I have to sit on the ground quite a bit, like with the kids or with my work sometimes we do and getting up's sore, like sitting down." P2
		"I can't kneel for example, or just, if I even have to kneel down to get something, it hurts and sometimes if I kneel on something, where the scar is, it's shocking, so yeah, and driving after a while, it gets sore." P2
		"… it's not that I don't actually like doing it, and once I do it the trouble I have is getting down 'cause generally, like I'm usually someone who moves really fast and from position to position but I can't, I have to get myself in one place that I can then reach everything." P2
		"Yes, I have got [on] with daily activities,… If I run it hurts, if I rise upstairs, it clicks a lot then." P3.
		Yeah ... like sitting. If I, I have to sit on the ground quite a bit, like with the kids or with my work sometimes we do, and getting up's sore, like sitting down ... I can't kneel for example, or just, if I even have to kneel down to get something, it hurts and sometimes if I kneel on something where the scar is, it's shocking ..., and driving after a while, it gets sore…" P9
		"… No, not really, mmm, I don't need to do much physically, like the idea of having a standing desk is quite appealing but I wouldn't, I'm concerned that if I was to do that, I couldn't handle it, like standing for too much might be worse" P2
		"Yeah I don't like to. Well I do run on concrete a bit but I really prefer not to, just 'cause like I get a lot more pain, yeah a little bit more pain, not a lot but definitely the softer surfaces, so it's just a little bit tender for like that real hard impact kind of stuff." P7.
		"Because I think that is where I would lock my knee out, and then that is the kind of feeling I don't like, so sprinting is hard and it is quite scary. I guess that is how I perceive going hard out and going full on in sport is being able to sprint and that is the one thing that I haven't been able to do. Changing direction is fine, I am able to change direction, I am able to jump, it is just the sprinting." P8
		"It [pain] would be less than that probably. It would be behind my kneecap. It would be more after sport than during. So like if I've worked pretty particularly hard on that leg... it might get a bit sore but even then I'd say it's less than every month. It'd be like every three or four months and it wouldn't last more than a day." P8

Themes/Subthemes	Categories	Quotes
		"Yeah, but it's this, it's like a flow-on effect aye. I've had the most trouble with my hip, which we think is resultant from the knee … you know how your body compensates … and I've had it looked at by physios and osteos and all that kind of stuff and it's linked to the knee." P9 "… it still gives me pain, and it wasn't sore when I had the operation done." P9
		" I'm just worried about when I get old, it's gonna be really sore, but immediate future, no issues." P7
		"Yea, I expect to have knee replacement in future at some point, may be hip replacement too." P3
		"I do take two Panadol, two Ibuprofen in the morning because if I don't, by the end of day it hurts ... yep every day, and I find if I forget to take those pills in the morning by it hurts bit, if I take it is fine, and you sort 18 hours of the day, 10 hours of the day pain free, and the days if no pills during the day, when I have forgotten them by lunch time." P3
		"Cause I know that when I say problem, its I know for a fact, I know that this is not as good as my left, and I still have this fear in my head that my knee is going into valgus. That's my biggest fear currently. I had to do 200kg squat or whatever, I had to reach failure by eight and I reached it by eight with that weight so, and I thought it was appropriate weight. But because its heavy, I sometimes I feel my knee wobble a little bit and going, I don't know maybe it didn't go out but I thought it was going valgus, which I did notice my left leg was completely stable." P10
		"Sometimes if it, you know, if it pops really hard there's a bit of discomfort but nothing major." P10
		"I can't do the same weights on that leg, but otherwise it doesn't really stop me from doing anything that I want to. So it's definitely less weight on the leg with the reconstruction when it comes to anything using my quads." P1
		"Not enough that I avoid stairs. It's just that, it only happened last year that one day I was going up some stairs and there was a big click and it hurt briefly and then since then I've noticed it make more noise as I go up and down stairs, and it's just, it's not even pain, it's just there's a little bit of discomfort." P1
	Continuing daily struggles	"I can't kneel on a hard surface for very long at all, I usually transfer all the weight over to the other knee straight away. If there's a cushion or something soft, then yes, but not like on the floor." P1
		"My knee like locked at the start so I just had to think about ok, I just need to … change what I'm doing, so ... I can sit on my knee a lot but it doesn't stop me from doing stuff, it's more like I just have to re-think how I'm gonna like do stuff..." P7
		"I don't know maybe I won't like kneel on it for a while, something like that will be about the only thing that affects me in every day." P5
		"… With my kids if, you know 'cause that's another thing, they're a bit bigger now, but until quite recently, I was holding my little one a lot and …, now I have to say to them, just don't climb on me, don't, because it's just too, too hard..." P2
		"Achiness after running, I'm not sure what that's caused to, and achiness when it's really cold in the winter, in the morning. Now and then downstairs I'm conscious of it. I don't jump around and leap from things how I used to. I'm definitely cautious with it." P9

Themes/Subthemes	Categories	Quotes
		"Yeah … like sitting, if I, I have to sit on the ground quite a bit, like with the kids or with my work sometimes we do and getting up's sore, like sitting down, … I can't kneel for example or just, if I even have to kneel down to get something, it hurts and sometimes if I kneel on something, where the scar is, it's shocking … and driving after a while, it gets sore…" P9
		"Yeah,… just continual care … you know like when you get switched around to too many people, they just don't, you can't get that continuity and so having that is like the best thing I reckon, yeah." P7
	Maintenance of muscle strength	"My left leg is considerably stronger than my right which is quite annoying as that is my dominant leg. On a day-to-day basis it's not very noticeable because the strength of the right leg is more than enough for my activities." P10
		"Yes, I did afterwards, but I tried to get, I tried to get, um in recovery, get back to everything too quickly. I had a bit of a strain in [my hamstring] there." P9
		"… yet the main [hamstring] injuries I got were training for the marathon because it was repetitive." P6
		"Yeah I think probably my fear of injury is less when I'm stronger so I just remember. Like. when I was going through my rehab, I was … was supposed to jump onto this box, it was … this high, not even 30cm … and you had to jump and that scared me so much but like as I got stronger, I was like yep, no this is alright, like I can, so like the stronger I get, the less worried I am about injury and then I get weak again, I'm like oh it could go but I know that's not true 'cause it's a ligament and you know like, but it's just the feeling of being strong and yeah and knowing that you've got a lot of support around my knee, just yeah that would make me a lot more confident, yeah." P7.
	Seeking health-professional advice	"… I could approach them and say, hey I need some exercises because I feel like I am getting quite weak, or something like that, but otherwise, no, I don't think. They could probably do a follow-up maybe; I guess that could be quite good." P8
Concern for long-term disabilities		
	Concern for osteoarthritis and knee replacement	"I guess I do have the vague wondering if I'm going to end up with osteoarthritis or not in the knee." P1
		"Ah well maybe if I stop being so mobile, will it stiffen up more, I don't know, I mean not." P6

Notes: ACL, anterior cruciate ligament; OA, osteoarthritis; P, participant; TKR, total knee replacement; An em dash (–) was used to indicate a pause; an ellipsis (…) the removal of some text that did not alter the meaning of the quote; and square brackets [ ] to indicate the addition of text to clarify meaning