Rehabilitation characteristics and patient barriers to and facilitators of ACL reconstruction rehabilitation: A cross-sectional survey

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ABSTRACT

Objectives To investigate patient-reported rehabilitation characteristics and barriers to and facilitators of ACL reconstruction rehabilitation.

Design Survey-based study.

Setting Online survey platform.

Participants Adults 1-20 years post ACL reconstruction (n=304).

Main Outcome Measures 1) rehabilitation characteristics, 2) barriers to and facilitators of rehabilitation.

Results Fear of re-injury (43.8%) was the highest rating barrier to rehabilitation adherence, while a good relationship with your rehabilitation provider was regarded as the most important factor (83.6%) in facilitating rehabilitation. Rehabilitation frequency reduced across the duration of rehabilitation from most commonly 1 x week (38.2%) in the first three months to once every month (26%) from 6-9 months. Almost all participants (95.7%) consulted a rehabilitation provider for the first six months. Only 43.4% of respondents returned to their previous level of sport. The exploratory analysis identified that low barriers to rehabilitation and a longer duration of supervised rehabilitation are associated with a faster return to sport, greater likelihood of return to previous level of sport and fewer reported ongoing problems with the knee.

Conclusions This cross-sectional survey provides insight into the patient's experience of rehabilitation practices and a patient's perspective on the key barriers to and facilitators of ACL rehabilitation adherence and participation.

Keywords physiotherapy, return to sport, adherence, compliance

INTRODUCTION

In a sporting context, one in 29 female athletes and one in 50 male athletes will rupture their anterior cruciate ligament (ACL) (1). Reconstruction and subsequent rehabilitation following injury is still considered the primary treatment method (2). Unfortunately, outcomes following ACL reconstruction are still reported as sub-optimal (3) as many athletes fail to return to their previous level of sport (4), have ongoing pain and disability (5) or reinjure the same or contralateral knee upon return to sport (6).

Incomplete rehabilitation has been reported to be one of the main factors contributing to suboptimal outcomes after ACL reconstruction (7). Research shows that only 30% of patients complete rehabilitation beyond three months, with only 5% following evidence-based recommendations (8). Recent evidence has demonstrated an increased likelihood of returning to sport and meeting discharge criteria with a longer duration of supervised physiotherapy (8, 9). Furthermore, patients that return to sport have been shown to have a greater long-term quality of life (10) and are less likely to reinjure if they meet discharge criteria (11).

ACL rehabilitation is a long-term commitment, and there can be a host of reasons why patients may not complete rehabilitation or return to sport. A recent scoping review identified personal, environmental and treatment-related factors which the individual may encounter throughout their rehabilitation, highlighting the need for patient involvement in the rehabilitation process to identify, manage and optimise care (12). As such, it is pertinent to seek the opinion of our patients as to what they find most challenging and most important during the rehabilitation process.

The objective of this study is to investigate patient-reported rehabilitation characteristics, barriers to and facilitators of rehabilitation participation and adherence in an adult population

within the context of key patient outcomes. We aim to provide guidance to practitioners to improve rehabilitation delivery and gain information to guide future research.

METHODS

Survey Development

The design followed a seven-step process for survey scale design (13), supported by literature on recommended practices for the conduct and reporting of survey research (14). The primary author (AW) developed a 36-item web-based survey guided by the results from a recent scoping review evaluating the influence, barriers to and facilitators of adherence and participation to ACL rehabilitation completed by the authors (12) and collaboration with the research team and clinical physiotherapists who have an interest in ACL rehabilitation.

The preliminary questions were tested by the authors and three external researchers and clinicians for clarity, format and usability. The survey was piloted with five patients in the form of cognitive interviews (13) with the lead author for immediate feedback resulting in modifications. The second round of pilot testing was completed with six participants and final modifications made to the survey. It was determined that the survey took approximately 10 minutes to complete.

Survey Instrument

The voluntary, anonymous survey was conducted on the secure online program Qualtrics XM (www.qualtrics.com). Participants were initially presented with the 'Participant Information' section detailing the background, purpose, risks and data usage. Access to the survey was granted after the participant answered 'yes' to informed consent and two subsequent questions to ensure participant eligibility. It was stated that the survey had been developed

only for participants 18 years and older who were at least 12 months post ACL operation but not more than 20 years ago. Participants were ineligible after 20 years as it was deemed that rehabilitation practices significantly changed since the year 2000 (15). It was clearly stated that those who had suffered an ACL injury but did not have a reconstruction were ineligible.

Respondents were asked to answer questions based on their experience of rehabilitation since the time of most recent injury. The survey contained five sections; (1) demographics (Q5-8), (2) injury and surgery (Q9-14), (3) barriers to and facilitators of rehabilitation (Q15-18), (4) rehabilitation (Q19-23) and (5) return to sport (Q24-36). The complete survey instrument is available in appendix 1.

The survey utilised display logic which facilitated only the display of questions which were relevant to the respondents based on their previous responses. This ensured accurate completion of the survey and time efficiency. The total number of questions may vary between respondents. Only one question was displayed per page, and participants had to enter a response before proceeding. Respondents were permitted to go back and edit prior responses and could enter multiple answers for questions 13, 20, 35 and 36. Questions 16 and 18 provided the opportunity for respondents to enter a text response, and a 5-point Likert scale was utilised in questions 15, 17, 19, 23 and 34 (13).

Survey distribution

The survey was distributed by email to local physiotherapy practices, surgical and physiotherapy patient databases, state and regional sporting clubs and associations, news articles, and through social media profiles of the authors. The email contained a summary poster, a brief overview of the study, eligibility criteria and a custom link to complete the survey instrument on Qualtrics. Anybody who received the email was free to and encouraged to share the poster and information with their contacts to increase survey reach. Survey

responses were collected between 6 March and 15 July 2020. The study was approved by the Bond University Human Research Ethics Committee (AW02850).

Data Synthesis

The reporting of data followed the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement. Following the closure of the survey, the data were screened, and responses excluded if it was incomplete, deemed to be not consistent with a valid response (submitted in less than four minutes) or was not a unique response (duplicate IP addresses). Data were then exported to the software package SPSS Statistics for Windows, version 26.0 (SPSS Inc., Armonk, NY, USA) where the data could be analysed. All responses were equally weighted.

Descriptive statistics were used to summarise the distributions for continuous variables, and the frequencies and percentages for categorical responses. Cronbach's alpha test was performed on the multi-item questions 15 and 17 to ensure internal consistency reliability. Prior to further exploratory analyses, selected variables with either multiple ordinal responses or on a continuous scale were re-categorised into binary variables, including the main variables of interest: barriers to rehabilitation adherence (high/low), frequency of supervised rehabilitation (high/low) and duration of rehabilitation duration (long/short). The chi-square test was used to test for associations or differences in proportions of responses between pairs of categorical variables. Analyses were carried out in SPSS version 26, and significance values were set at $p < 0.05$.

RESULTS

A total of 413 participants responded to the survey; 304 responses were deemed eligible for inclusion in the analysis. Responses were excluded for the following reasons: 81 responses were incomplete, and 28 did not meet eligibility criteria. The completion rate of the survey was 79%.

Respondent demographics

Table 1 details the demographics of the respondents. The median participant age was 25 years old at the time of most recent reconstruction, 58.6% ($n=178$) were female, 91.4% ($n=278$) resided in Australia, and 70.4% lived in a metropolitan area.

One in five respondents (21.4%) reported a second injury. A contralateral injury (67.7%) was twice as likely as a second injury to the ipsilateral limb (32.3%). A concomitant meniscus injury was the most common (56.3%) associated injury, and most patients had a hamstring graft (82.2%).

Table 1 – Respondent demographics ($N=304$)

Participant characteristic	<i>n</i> (%)	Injury characteristic	<i>n</i> (%)
Age, median (IQR)		Second injury	65 (21.4)
At time of survey	32 (26.0-40.0)	Ipsilateral injury	21 (32.3)
At time of reconstruction	25 (21.0-32.8)	Contralateral injury	44 (67.7)
Gender		Associated injuries	225 (74.0)
Male	126 (41.4)	Meniscus injury	171 (56.3)
Female	178 (58.6)	Medial collateral ligament	81 (26.6)
Country		Lateral collateral ligament	26 (8.6)
Australia	278 (91.4)	Posterior cruciate ligament	31 (10.2)
International	26 (8.6)	Cartilage injury	58 (19.1)
Area profile		Fracture	23 (7.6)
Metropolitan	214 (70.4)	Graft	
Regional/Rural	90 (29.6)	Hamstring tendon	261 (82.2)
		Patella tendon	35 (11.1)
		Quadriceps tendon	13 (4.1)
		Allograft	3 (0.9)
		Synthetic	1 (0.3)

Data are reported as n (%) unless otherwise specified.

Rehabilitation characteristics and satisfaction

Table 2 details the responses to questions in the survey relating to the respondent's rehabilitation. Respondents were most likely to participate in rehabilitation with a physiotherapist (97.4%) in a private clinic (83.9%), and rehabilitation was deemed essential by 87.8% of participants. The majority of participants were extremely satisfied (38.8%) or quite satisfied (37.2%) with the care delivered by their rehabilitation provider. Only 3.6% of participants reported being not at all satisfied with their care. These results were in line with overall satisfaction after ACL reconstruction with 34.5% stating they are extremely satisfied and 36.5% quite satisfied, despite 79.6% of respondents reporting ongoing problems with their knee.

Table 2 Rehabilitation characteristics and satisfaction

Characteristic	n (%)	Characteristic	n (%)
Rehabilitation providers		Rehabilitation provider satisfaction	
Physiotherapist	296 (97.4)	Extremely satisfied	118 (38.8)
I did my own rehabilitation	64 (21.2)	Quite satisfied	113 (37.2)
Strength and Conditioning Coach	42 (13.8)	Moderately satisfied	50 (16.4)
Personal Trainer	31 (10.2)	Slightly satisfied	12 (3.9)
Exercise Physiologist	28 (9.5)	Not at all satisfied	11 (3.6)
Athletic Trainer	11 (3.6)	Outcome satisfaction	
Rehabilitation environment		Extremely satisfied	105 (34.5)
Private clinic	255 (83.9)	Quite satisfied	111 (36.5)
Gym or fitness facility	94 (30.9)	Moderately satisfied	60 (19.7)
Hospital clinic	62 (20.4)	Slightly satisfied	16 (5.3)
Sports team	41 (13.5)	Not at all satisfied	12 (3.9)
School	7 (2.3)	Ongoing knee problems	
Rehabilitation importance		Significant problems	16 (5.3)
Essential	267 (87.8)	Moderate problems	43 (14.1)
Quite important	31 (10.2)	Minor problems	183 (60.2)
Moderately important	3 (1.0)	No problems	62 (20.4)
Slightly important	2 (0.7)		
Not important	1 (0.3)		

Barriers to rehabilitation

Figure 1 presents which factors the respondents deemed affected their ability to fully participate in their recommended rehabilitation. Cronbach's alpha was acceptable (0.79) demonstrating adequate internal consistency of the question. Fear of re-injury (43.4%) was the highest rating barrier while not having access to facilities or equipment (9.5%) and not enough time to complete rehabilitation exercises (8.9%) were not regarded as substantial barriers to rehabilitation participation.

Figure 1. Barriers to completing recommended rehabilitation ordered from most to least affecting rehabilitation, using the percentage of negative responses 'Quite a lot' and 'A lot'. Note: The percentage for each response can be approximated using the percent of total bars at the top or bottom of the figure.

Facilitators of rehabilitation

Figure 2 presents which factors the respondents deemed important in facilitating their rehabilitation. Cronbach's alpha (0.80) demonstrated good internal consistency of the question. The majority of factors presented to the participants were rated as important to rehabilitation. A good relationship with your rehabilitation provider was regarded as the most

important factor (83.6%) followed by regular assessment of progress and function (76.3%). Fewer than one in three participants rated being given a choice in their rehabilitation (29.3%) and interacting with others with the same injury as important (28.3%).

Figure 2. Facilitators to completing recommended rehabilitation, ordered from most to least important, using the percentage of 'Quite important' and 'Essential' responses. Note: The percentage for each response can be approximated using the percent of total bars at the top or bottom of the figure.

Rehabilitation frequency and duration

Figure 3 presents the most common frequency of consultation with a rehabilitation provider per post-operative time period. A clear trend can be seen of reducing rehabilitation frequency across the duration of rehabilitation from most commonly once a week (38.2%) in the first three months, every two weeks (29.9%) at 3-6 months and once every month (26%) at 6-9 months. Almost all participants (95.7%) consulted a rehabilitation provider for the first six

months following which dropout rates increased to 21.1% at six months, 39.1% at nine months and 63.2% from 12 months.

		Rehabilitation frequency						
		>2 times/week	2 times/week	Once a week	Every 2 weeks	Once every month	Less than once a month	I did not see anyone
Post operative time period	First 3 months	13.5%	20.4%	38.2%	21.4%	3.6%	1.6%	1.3%
	3-6 months	5.9%	9.5%	21.7%	29.9%	22.0%	6.6%	4.3%
	6-9 months	4.3%	3.6%	9.9%	17.4%	26.0%	17.8%	21.1%
	9-12 months	3.0%	1.6%	7.2%	8.2%	18.1%	22.7%	39.1%
	12 months+	1.6%	0.7%	4.6%	2.6%	8.2%	19.1%	63.2%

Figure 3. Heat map of reported rehabilitation frequency per post-operative time frame. Note: the darkest cells have the highest percentages per row, representing the most commonly reported responses; aggregate percentages equate to 100 in each row.

Sports participation and outcomes

Table 3 details the responses to questions in the survey relating to the respondent's sports participation pre and post-injury or surgery. Prior to surgery, 86.5% of respondents aimed to return to their previous level of sport, however, only 43.4% of respondents achieved this post-surgery, and 14.2% did not return to any knee strenuous sport. Both the level, as defined by Grindem et al. (2014) (16), and the frequency of knee-strenuous sport also decreased post-surgery.

Respondents expectations of when they would be able to return to their previous level of sport and when they did return to sport were consistent with each other. Over 70% of respondents returned to sport between 9-12 months (33.5%) and 12-18 months (37.6%) post-surgery. Only 12% of respondents returned to sport prior to 9 months. Knee related problems were the major reason respondents either returned to a lower level of competition (67.0%) or changed sports (78.0%).

When deciding to return to sport, the rehabilitation provider (70.4%) and the individual (77%) were the most involved people. When asked who should be involved, the participants reported the rehabilitation provider as the most common (91.1%). The coach and family and friends play a small role in return to sport decision making.

Table 3 Sports participation and outcomes

Characteristic	n (%)	n (%)
Return to competitive level of sport	Pre-surgery aim	Post-surgery
Previous competitive level	263 (86.5)	132 (43.4)
Lower level of competition	-	88 (28.9)
Changed sports	-	41 (13.5)
Did not return to sport	-	43 (14.2)
Level of knee strenuous sport	Pre-injury	Post-surgery
Level 1 – Jumping, hard pivoting and cutting	270 (88.8)	197 (64.8)
Level 2 – Running twisting and turning	25 (8.2)	36 (11.8)
Level 3 – No twisting, turning or jumping	4 (1.3)	28 (9.2)
Level 4 – No knee strenuous sport / Did not return to sport	5 (1.6)	43 (14.2)
Sport participation frequency per week	Pre-injury	Post-injury
>5	48 (15.8)	23 (7.6)
4-5	91 (29.9)	64 (21.1)
2-3	136 (44.7)	136 (44.7)
0-1	24 (7.9)	38 (12.5)
Return to sport timeframe	Pre-surgery expectation	Post-surgery
3-6 months	7 (2.3)	8 (3.0)
6-9 months	41 (13.5)	24 (9.0)
9-12 months	124 (40.8)	89 (33.5)
12-18 months	106 (34.9)	100 (37.6)
18-24 months	7 (2.3)	24 (9.0)
2 years or longer	19 (6.3)	21 (7.9)
Reason for change in post-surgery sports competition level	Non-knee related problems	Knee related problems
Lower level of competition	29 (33.0)	59 (67.0)
Changed sports	9 (22.0)	32 (78.0)
Return to sport decision making	Who was involved	Who should be involved
Rehabilitation provider	214 (70.4)	277 (91.1)
The individual	234 (77)	233 (76.6)
Surgeon	145 (47.7)	198 (65.1)
Family and friends	70 (23)	67 (22)
Coach	37 (12.2)	58 (19.1)

Exploratory Analyses

Exploratory chi-square analyses were performed to evaluate any difference in the distribution of responses across various variables which include binary variables as presented in Table 4. Significant differences in the distribution of responses were demonstrated between the three key variables of interest (barriers to, frequency and duration of supervised rehabilitation) and ACL reconstruction outcomes (Table 5). Participants' geographical location and age were associated with perceived barriers to, frequency and duration of supervised rehabilitation (Table 5).

Table 4. Summary statistics for variables re-categorised into binary variables before chi-square analyses

Variable	<i>n</i> (%)
Barriers to rehabilitation adherence	
High (average 'some' or higher)	191 (62.8)
Low (average 'a little' or less)	113 (37.2)
Frequency of supervised rehabilitation	
Low (<every 2 weeks)	200 (34.2)
High (≥every 2 weeks)	104 (65.8)
Duration of supervised rehabilitation	
< 9 months	119 (39.1)
≥ 9 months	185 (60.9)
Age at reconstruction	
<30 yrs	205 (67.4)
≥30 yrs	99 (32.6)

Barriers to rehabilitation adherence

In the group who experienced a low level of barriers to rehabilitation adherence compared to high, a higher percentage of people returned to sport before 12 months (47.1% v 27.5%), returned to their previous level of competition (66.9% v 44.9%), had no ongoing problems with

their knee (26.7% v 9.7%), and were extremely satisfied with their rehabilitation provider (47.6% v 23.9%) and their overall outcome (44.0% v 18.6%).

There was no association between high or low barriers to rehabilitation and frequency or duration of rehabilitation.

Frequency and duration of supervised rehabilitation

A higher percentage of respondents were extremely satisfied with their rehabilitation provider (50.0% v 33.0%) in the group who had a high frequency of supervised rehabilitation compared to low.

In the group who attended supervised rehabilitation for greater than nine months compared to less than nine months, a higher percentage of people returned to sport (91.8% v 82.4%), returned to their previous level of competition (65.5% v 47.4%), were extremely satisfied with their rehabilitation provider (49.7% v 21.8%) and their overall outcome (40.5% v 25.2%) and fewer reported significant or moderate ongoing problems with their knee (14.1% v 27.8%)

Influencing demographic factors to barriers to, frequency and duration of supervised rehabilitation

Participants who lived in a metropolitan area as opposed to living in a regional or rural location reported a higher frequency of supervised rehabilitation (37.9% v 25.6%, $p=0.039$) and supervised rehabilitation duration greater than nine months (64.5% v 52.2%, $p=0.046$).

In the group aged < 30 years compared to ≥ 30 years a higher percentage of patients reported high barriers to rehabilitation adherence (76.1% v 23.9%, $p=0.013$), high frequency of supervised rehabilitation (80.8% v 19.2%, $p<0.001$) and supervised rehabilitation duration greater than 9 months (75.7% v 32.6%, $p<0.001$).

There was no association between gender, re-injury, or associated injuries and any of the key variables.

Table 5. Results of exploratory chi-square analyses to determine significant relationships between categorical variables

Outcome variable	Barriers to rehabilitation adherence		Frequency of supervised rehabilitation		Duration of supervised rehabilitation	
	Chi-square	p-value	Chi-square	p-value	Chi-square	p-value
Time to return to sport	$\chi^2_6=14.86$	0.021*	$\chi^2_6=11.61$	0.071	$\chi^2_6=16.10$	0.013*
Return to previous level of sport	$\chi^2_2=24.16$	<0.001*	$\chi^2_2=5.00$	0.084	$\chi^2_2=7.40$	0.025*
Ongoing knee problems	$\chi^2_3=14.50$	0.020*	$\chi^2_3=3.05$	0.384	$\chi^2_3=14.50$	0.020*
Rehabilitation provider satisfaction	$\chi^2_4=32.05$	<0.001*	$\chi^2_4=12.24$	0.016*	$\chi^2_4=31.74$	<0.001*
Overall outcome satisfaction	$\chi^2_4=33.28$	<0.001*	$\chi^2_4=2.71$	0.608	$\chi^2_4=19.78$	0.001*
Interaction						
Barriers	-		$\chi^2_1=0.17$	0.678	$\chi^2_1=1.97$	0.161
Influencing variable						
Geographical location	$\chi^2_1=0.162$	0.088	$\chi^2_1=4.255$	0.039*	$\chi^2_1=4.00$	0.046*
Age at reconstruction	$\chi^2_1=6.16$	0.013*	$\chi^2_1=12.80$	<0.001*	$\chi^2_1=14.62$	<0.001*
Gender	$\chi^2_1=0.002$	0.968	$\chi^2_1=0.581$	0.446	$\chi^2_1=0.770$	0.380
Re-injury	$\chi^2_1=0.837$	0.360	$\chi^2_1=1.231$	0.267	$\chi^2_1=1.622$	0.203
Associated injuries	$\chi^2_1=0.829$	0.362	$\chi^2_1=1.232$	0.267	$\chi^2_1=0.614$	0.433

* statistically significant result $p<0.05$

DISCUSSION

The results of this survey provide insight into the state of rehabilitation practices and the adult patients perspective on the key barriers to and facilitators of ACL rehabilitation adherence and their relationship to patient outcomes. The most important findings of this survey are that fear of re-injury, and the therapeutic relationship was the strongest factors reported by patients which influence their ability to complete rehabilitation as recommended. Most respondents (78.9%) completed supervised rehabilitation through to 9 months post-operative, with a consistent trend of reduced supervision as rehabilitation progressed. We also reported a low

return to previous level of sport rate of 43.4%, despite 86.5% of respondents aiming to return to their previous level of sport prior to surgery.

The exploratory analyses provided further insights into associations between the level of barriers experienced by respondents, supervised rehabilitation frequency and duration and a variety of clinically important outcomes following ACL reconstruction. We also explored the demographic factors which may influence these variables.

Rehabilitation characteristics

Our results demonstrated that patients strongly believe that appropriate rehabilitation is essential in their recovery from surgery and return to sport. Physiotherapists were reported as the primary provider of rehabilitation services, and overall satisfaction of patients following ACL reconstruction was closely related to satisfaction with the care delivered by their rehabilitation provider. Patients have previously described the physiotherapist's role as the coordinator, motivator and guide in the delivery of high-value evidence-based care to facilitate patient return to sport goals (17).

The severity of ongoing knee problems requires further investigation, as only 20% of respondents reported having no ongoing problems with their knee, with 20% reporting moderate or severe problems. While patient-reported outcome measures are often used in the assessment of outcome following reconstruction (18), it can be hard to ascertain the presence of ongoing pain from these studies. Further research into the presence of ongoing pain, often despite a return to sport, should be considered in the evaluation of a successful outcome after ACL reconstruction.

Rehabilitation providers need to consider the risk of re-injury on the contralateral limb following return to sport. The second ACL injury rate in this cohort of patients was approximately 20%, which is consistent with previous evidence (19); however, the risk of

injuring the contralateral leg was twice that of the reconstructed leg (20). Contralateral injury risk needs to be a consideration throughout rehabilitation to ensure sufficient overall function bilaterally as limb symmetry index alone can underestimate function (21), and the contralateral limb has been shown to detract from one to five years after reconstruction (22).

Barriers and facilitators of rehabilitation

Fear of re-injury was reported as a main limiting factor in an individual's ability to complete their rehabilitation as recommended. Ardern et al. (2014) identified fear of re-injury as a main determinant of a successful return to sport (4). Fear of re-injury was also the most commonly reported barrier to rehabilitation in a review of qualitative studies on ACL rehabilitation (18).

The design of appropriate rehabilitation programs to facilitate a graded exposure to activities to reduce the fear associated with athletic movements should be a key focus for rehabilitation providers (23). Appropriate exercise exposure has demonstrated an improvement in psychological readiness (24), while it has also been shown that there is no link between physical function and psychological readiness (25) and therefore needs to be assessed independently.

The length and commitment of rehabilitation were also reported as a significant barrier by one in five respondents. This highlights the importance of rehabilitation providers setting realistic expectations early in rehabilitation to prepare the patient adequately for the long rehabilitation journey ahead (26, 27). Interestingly, motivation to complete rehabilitation was not consistently reported as a main barrier despite previous research demonstrating it as a major limiting factor for patients (12). This may be due to a selection bias as participants who were motivated to complete the survey may be naturally more motivated to invest time in rehabilitation. The majority of respondents had ongoing symptoms, which they reported as a reason they found it hard to complete their rehabilitation as prescribed.

Consistent with previous literature, the results demonstrated the importance of the rehabilitation provider in facilitating rehabilitation (12). This includes a strong therapeutic alliance, regular assessments and goal setting, providing sports specific enjoyable rehabilitation and supportive information with consideration of financial limitations such as insurance coverage, to guide the patient throughout the rehabilitation journey.

Rehabilitation duration and frequency

The effect of a higher frequency of supervised rehabilitation, particularly in the later phases of rehabilitation is a particular area of note. Respondents reported a gradual reduction in rehabilitation frequency as rehabilitation progressed. From six months post-operation patients are rarely seeing or not seeing their rehabilitation provider, despite it being the optimal time to address post-operative deficits before return to sport (28-30). A decrease in contact between patient and physiotherapist as function improves has been reported in a survey of 223 Australian physiotherapists (31) indicating decreased contact may not have been patient-driven. A recent scoping review reported that the effect of frequency on rehabilitation outcome was unclear; therefore, further investigation into the effects of decreasing contact is warranted (12).

The reported duration of supervised rehabilitation is very encouraging, as a longer duration of supervised rehabilitation is associated with a greater likelihood to meet discharge criteria, improved functional capacity and return to sport (12). In this cohort, 95.7% of respondents attended rehabilitation over the first six months, and 78.9% of respondents completed rehabilitation through to nine months post-operative.

While we did not evaluate the quality of the rehabilitation such as that reported by Edwards et al. (2018) (8), this seems essential, as rehabilitation in line with evidence-based guidelines has been reported to improve outcomes (8). It is likely that if patients attend rehabilitation

sessions but are not provided rehabilitation of sufficient intensity to address post-operative deficits, then the frequency and duration of rehabilitation would be less important than the quality of the rehabilitation provided (32).

Sports participation and outcomes

Only 43.4% of respondents returned to their previous level of sport, which is substantially lower than previous research (4). This is despite 86.5% of respondents reporting they aimed to return to their previous level of sport prior to surgery. Return to sport (86%) was consistent with Ardern et al. (2014), who reported 81% return to some form of knee strenuous sport in a similar population. A transition to a lower level of knee strenuous sport and frequency of participation was seen across the cohort mostly attributable to those performing the most strenuous sports, reducing their sports participation.

Knee related issues were provided as the reason for not returning to previous level of sport in 67-78% of respondents, which links to the reported high levels of fear of re-injury and ongoing symptoms post-reconstruction in this cohort. This may also be the reason for the transition to a lower level of knee strenuous sport and frequency of participation. Further investigation into the reasons why individuals do not return to sport can provide further insight into the true return to sport rates by adjusting values to account for those that reduce or cease participation due to reasons not associated with their knee (22-33% in this cohort).

Increased research and opinion suggest that delaying return to sport for 9-12 months post-operation is necessary to decrease re-injury rates (33). Only 12% of respondents returned prior to 9 months. Expectations set before surgery were consistent with respondent's eventual return to sport dates. Therefore, it may be that worries regarding returning too early are less of a concern if the appropriate advice is provided to patients. Focusing on achieving return to sport criteria in a symptom free knee should be the major focus for clinicians (2). A shared

decision-making model is advocated in return to sport decision making (34) and supported by responses in this study. As the physiotherapist reportedly plays a key role in the decision, they can help the individual facilitate the appropriate discussions with other members of the multidisciplinary team.

Exploratory Analysis

The exploratory analysis provided preliminary evidence that patients who reported fewer barriers to rehabilitation and a longer duration of supervised rehabilitation are more likely to achieve a faster return to sport, have a greater likelihood to return to their previous level of sport, have fewer ongoing problems with the knee and have a higher rehabilitation and outcome satisfaction. If the rehabilitation provider can facilitate a rehabilitation environment to address barriers (such as fear of re-injury), encourage a longer duration of supervised rehabilitation, build a strong relationship with their patient, and support the patient through the long rehabilitation process by performing ongoing reassessments of function and goal setting, then they may be more likely to achieve favourable outcomes.

The results also support current uncertainty as to whether there is an optimal frequency of supervised rehabilitation visits and if this varies between stages of rehabilitation (12). Furthermore, patients who are experiencing high barriers will not necessarily attend rehabilitation more or less frequently or for a longer or shorter duration. It may be likely that rehabilitation providers do not vary patient attendance in response to patients' individual circumstances or barriers encountered.

Younger patients and those who live in a metropolitan area appeared to attend rehabilitation more frequently and for a longer duration. Younger patients also reported a higher degree of barriers to rehabilitation. It can be hypothesised that those that live in metropolitan areas have greater access to physiotherapist care. Younger patients may experience more barriers to

access due to cost and a bigger insult to their athletic identity (35). It may also be likely that younger individuals attend more frequently and longer due to factors not associated with their knee, such as fewer family and work commitments.

Limitations

This study has several limitations. The survey itself had not been previously validated but was created using an established methodology (13). The reliability of key questions in the survey was tested through the use of the Cronbach Alpha score. The respondents of the survey were predominately from Australia, which limits the applicability of results to other countries due to variations in the delivery of health care services. The survey was completed by adults only so results cannot be generalised to the paediatric or adolescent population. While we reported on characteristics of rehabilitation and return to sport outcomes, we did not include any questions on the content of the rehabilitation or the level of competition of the participants. Future research studies may also benefit from adding injury mechanism to see if fear of re-injury is greater if the injury occurred while participating in the individuals preferred sport. The link to access the survey did not require a respondent specific login; therefore leaving the survey open to invalid responses. Through IP address screening and time to completion, check the risk of invalid response should have been reduced. The responses are influenced by recall or reporting bias and the individual's interpretation of terms and questions within the survey. The 6-step process in the development of the survey aimed to mitigate this as much as feasible (13). Responses were collected between March and July 2020 during the Covid-19 pandemic when sport participation ceased. Due to the demographics of the participants in the survey, inclusion criteria and the majority of questions pertaining to the rehabilitation experience we believe that the pandemic was unlikely to have a significant effect on the responses given. Finally, the exploratory nature of the analyses provides interesting insights into associations between various categorical variables, but they do not provide evidence of any causation.

However, the results do provide scope for further research into the factors which influence rehabilitation adherence and participation and the link to achieving a successful outcome for patients.

CONCLUSION

This survey provides insight into the state of rehabilitation practices and adult patient's perspective on the key barriers to and facilitators of ACL rehabilitation adherence and participation and their relationship to patient outcomes. The most important findings of this survey are that fear of re-injury, and the therapeutic relationship was the strongest factors reported by patients which influence their ability to complete rehabilitation as recommended. Further, 78.9% of respondents completed rehabilitation through to 9 months post-operative while supervised rehabilitation frequency consistently reduced across the course of the rehabilitation. We also reported a low return to previous level of sport rate of 43.4%, despite 86.5% of respondents aiming to return to their previous level of sport prior to surgery.

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