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

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1 ABSTRACT

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

4 Design Survey-based study.

5 Setting Online survey platform.

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

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

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

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

22 Keywords physiotherapy, return to sport, adherence, compliance

INTRODUCTION

23

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

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

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

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

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

48

49 METHODS

50 Survey Development

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

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

63 Survey Instrument

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

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

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

78 The survey utilised display logic which facilitated only the display of questions which were
79 relevant to the respondents based on their previous responses. This ensured accurate
80 completion of the survey and time efficiency. The total number of questions may vary
81 between respondents. Only one question was displayed per page, and participants had to
82 enter a response before proceeding. Respondents were permitted to go back and edit prior
83 responses and could enter multiple answers for questions 13, 20, 35 and 36. Questions 16 and
84 18 provided the opportunity for respondents to enter a text response, and a 5-point Likert
85 scale was utilised in questions 15, 17, 19, 23 and 34 (13).

86 Survey distribution

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

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

95 Data Synthesis

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

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

114

115 RESULTS

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

120 *Respondent demographics*

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

124 One in five respondents (21.4%) reported a second injury. A contralateral injury (67.7%) was
 125 twice as likely as a second injury to the ipsilateral limb (32.3%). A concomitant meniscus injury
 126 was the most common (56.3%) associated injury, and most patients had a hamstring graft
 127 (82.2%).

128

129 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)

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

131 *Rehabilitation characteristics and satisfaction*

132 Table 2 details the responses to questions in the survey relating to the respondent's
 133 rehabilitation. Respondents were most likely to participate in rehabilitation with a
 134 physiotherapist (97.4%) in a private clinic (83.9%), and rehabilitation was deemed essential by
 135 87.8% of participants. The majority of participants were extremely satisfied (38.8%) or quite
 136 satisfied (37.2%) with the care delivered by their rehabilitation provider. Only 3.6% of
 137 participants reported being not at all satisfied with their care. These results were in line with
 138 overall satisfaction after ACL reconstruction with 34.5% stating they are extremely satisfied
 139 and 36.5% quite satisfied, despite 79.6% of respondents reporting ongoing problems with their
 140 knee.

141

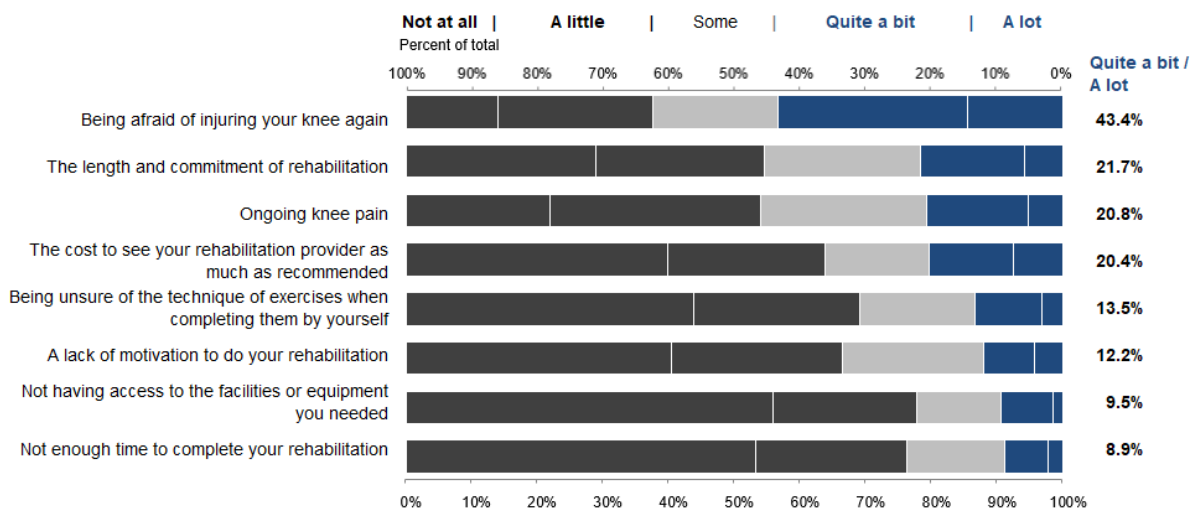
142 Table 2 Rehabilitation characteristics and satisfaction

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)		

143

144 *Barriers to rehabilitation*

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



151

152 Figure 1. Barriers to completing recommended rehabilitation ordered from most to least
 153 affecting rehabilitation, using the percentage of negative responses 'Quite a lot' and 'A lot'.

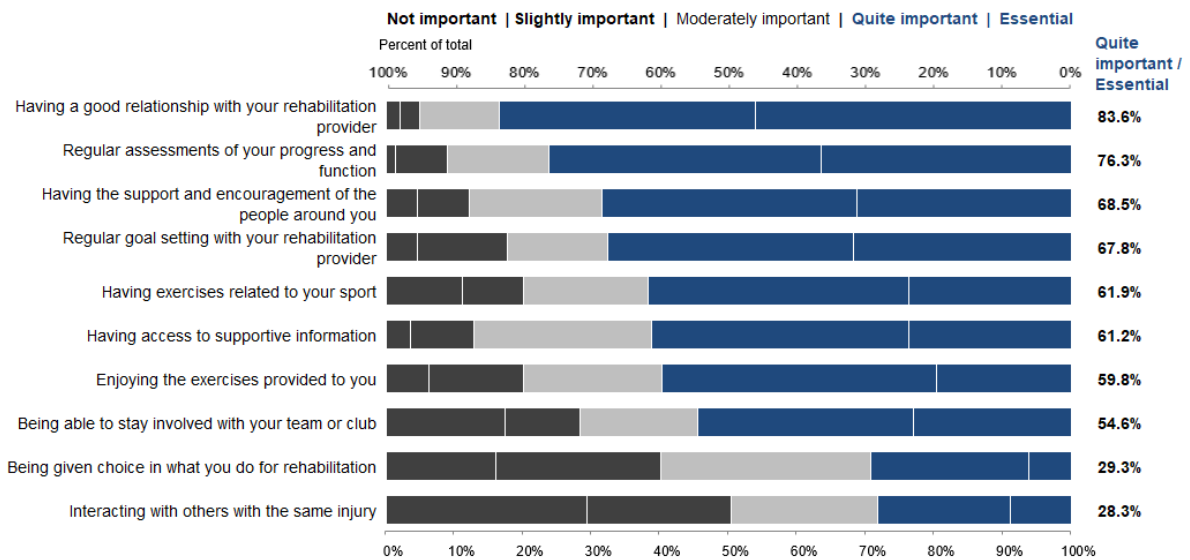
154 Note: The percentage for each response can be approximated using the percent of total bars
 155 at the top or bottom of the figure.

156

157 *Facilitators of rehabilitation*

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

162 important factor (83.6%) followed by regular assessment of progress and function (76.3%).
 163 Fewer than one in three participants rated being given a choice in their rehabilitation (29.3%)
 164 and interacting with others with the same injury as important (28.3%).
 165



166
 167 Figure 2. Facilitators to completing recommended rehabilitation, ordered from most to least
 168 important, using the percentage of 'Quite important' and 'Essential' responses. Note: The
 169 percentage for each response can be approximated using the percent of total bars at the top
 170 or bottom of the figure.

171
 172 *Rehabilitation frequency and duration*

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

178 months following which dropout rates increased to 21.1% at six months, 39.1% at nine months
 179 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%

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

184

185 *Sports participation and outcomes*

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

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

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

202

203 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)

204

205 Exploratory Analyses

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

213

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

Variable	n (%)
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)

216

217 *Barriers to rehabilitation adherence*

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

221 their knee (26.7% v 9.7%), and were extremely satisfied with their rehabilitation provider
222 (47.6% v 23.9%) and their overall outcome (44.0% v 18.6%).

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

225 *Frequency and duration of supervised rehabilitation*

226 A higher percentage of respondents were extremely satisfied with their rehabilitation provider
227 (50.0% v 33.0%) in the group who had a high frequency of supervised rehabilitation compared
228 to low.

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

234 *Influencing demographic factors to barriers to, frequency and duration of supervised* 235 *rehabilitation*

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

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

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

245

246 Table 5. Results of exploratory chi-square analyses to determine significant relationships
 247 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

248 * statistically significant result $p < 0.05$

249

DISCUSSION

250 The results of this survey provide insight into the state of rehabilitation practices and the adult
 251 patients perspective on the key barriers to and facilitators of ACL rehabilitation adherence and
 252 their relationship to patient outcomes. The most important findings of this survey are that fear
 253 of re-injury, and the therapeutic relationship was the strongest factors reported by patients
 254 which influence their ability to complete rehabilitation as recommended. Most respondents
 255 (78.9%) completed supervised rehabilitation through to 9 months post-operative, with a
 256 consistent trend of reduced supervision as rehabilitation progressed. We also reported a low

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

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

263 Rehabilitation characteristics

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

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

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

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

285 Barriers and facilitators of rehabilitation

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

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

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

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

310 Rehabilitation duration and frequency

311 The effect of a higher frequency of supervised rehabilitation, particularly in the later phases of
312 rehabilitation is a particular area of note. Respondents reported a gradual reduction in
313 rehabilitation frequency as rehabilitation progressed. From six months post-operation patients
314 are rarely seeing or not seeing their rehabilitation provider, despite it being the optimal time
315 to address post-operative deficits before return to sport (28-30). A decrease in contact
316 between patient and physiotherapist as function improves has been reported in a survey of
317 223 Australian physiotherapists (31) indicating decreased contact may not have been patient-
318 driven. A recent scoping review reported that the effect of frequency on rehabilitation
319 outcome was unclear; therefore, further investigation into the effects of decreasing contact is
320 warranted (12).

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

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

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

332 Sports participation and outcomes

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

340 Knee related issues were provided as the reason for not returning to previous level of sport in
341 67-78% of respondents, which links to the reported high levels of fear of re-injury and ongoing
342 symptoms post-reconstruction in this cohort. This may also be the reason for the transition to
343 a lower level of knee strenuous sport and frequency of participation. Further investigation into
344 the reasons why individuals do not return to sport can provide further insight into the true
345 return to sport rates by adjusting values to account for those that reduce or cease
346 participation due to reasons not associated with their knee (22-33% in this cohort).

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

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

357 Exploratory Analysis

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

367 The results also support current uncertainty as to whether there is an optimal frequency of
368 supervised rehabilitation visits and if this varies between stages of rehabilitation (12).

369 Furthermore, patients who are experiencing high barriers will not necessarily attend
370 rehabilitation more or less frequently or for a longer or shorter duration. It may be likely that
371 rehabilitation providers do not vary patient attendance in response to patients' individual
372 circumstances or barriers encountered.

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

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

380 Limitations

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

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

405

406 CONCLUSION

407 This survey provides insight into the state of rehabilitation practices and adult patient's
408 perspective on the key barriers to and facilitators of ACL rehabilitation adherence and
409 participation and their relationship to patient outcomes. The most important findings of this
410 survey are that fear of re-injury, and the therapeutic relationship was the strongest factors
411 reported by patients which influence their ability to complete rehabilitation as recommended.
412 Further, 78.9% of respondents completed rehabilitation through to 9 months post-operative
413 while supervised rehabilitation frequency consistently reduced across the course of the
414 rehabilitation. We also reported a low return to previous level of sport rate of 43.4%, despite
415 86.5% of respondents aiming to return to their previous level of sport prior to surgery.

416

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