Patient Acceptance of Knee Symptoms and Function after Anterior Cruciate Ligament Reconstruction Improves with Physiotherapy Treatment

Wayne Fausett *MHPrac*
Faculty of Health and Environmental Sciences, Auckland University of Technology, Auckland, New Zealand

Duncan Reid *DHSc*
School of Clinical Sciences, Auckland University of Technology, Auckland, New Zealand

Peter Larmer *DHSc*
Centre for Health and Social Practice, Waikato Institute of Technology, New Zealand; School of Clinical Sciences, Auckland University of Technology, Auckland, New Zealand

Nick Garrett *PhD*
Biostatistics and Epidemiology, Auckland University of Technology, Auckland, New Zealand

ABSTRACT

Physiotherapy is considered an important component of rehabilitation following anterior cruciate ligament reconstruction (ACLR). The relationship between physiotherapy treatment and patient-reported outcomes following ACLR in New Zealand (NZ) is not clear. We used repeated measures logistic regression to examine the relationship between patient-reported outcome data from the NZ ACL Registry and physiotherapy treatment data from the Accident Compensation Corporation (ACC). Outcome measures utilised were the patient acceptable symptom state (PASS) on the Knee Injury Osteoarthritis and Outcome Score (KOOS[4]) and a normative score on the Marx Activity Rating Scale (MARS) within 24 months of ACLR. Data from 5,345 individuals were included in the final analysis, with a mean (*SD*) of 11.7 (10.5) (range 0–91) physiotherapy treatments received, over an average (*SD*) of 185 (153) (range 0–725) days, in the two years following ACLR. Physiotherapy treatment post-ACLR increased the likelihood of achieving a KOOS[4] PASS score at 6 and 12 months, but not at 24 months, following surgery. Physiotherapy did not increase the likelihood of achieving a normative MARS score in the 24 months after ACLR. Multiple factors likely contribute to people who have had an ACLR in NZ receiving a low dosage of physiotherapy treatment following surgery. Physiotherapy treatment after ACLR may increase patient acceptance of any post-surgical symptoms and functional limitations, but the effect on post-operative activity levels is less clear.

Fausett, W., Reid, D, Larmer, P., & Garrett, N. (2023). Patient acceptance of knee symptoms and function after anterior cruciate ligament reconstruction improves with physiotherapy treatment. *New Zealand Journal of Physiotherapy, 51*(1), 53–69. https://doi.org/10.15619/NZJP/51.1.07

Key Words: ACL Reconstruction, Physiotherapy, Rehabilitation, Outcomes

INTRODUCTION

Functional rehabilitation following anterior cruciate ligament reconstruction (ACLR) is considered an effective intervention to increase the likelihood of a patient achieving their post-surgical goals (Lobb et al., 2012). In New Zealand (NZ), physiotherapists typically oversee rehabilitation following ACLR (Fausett et al., 2019). Therefore, the quantity and duration of post-operative physiotherapy treatment likely provides an accurate estimation of the dosage of rehabilitation received following ACLR in NZ. There remains no consensus on the optimal quantity and duration of post-ACLR physiotherapy treatment (Walker et al., 2020), with equivocal evidence as to whether the dosage of physiotherapy treatment following ACLR significantly influences patient-reported outcome scores, knee strength, functional ability, and graft re-rupture rates (Beynnon et al., 2011; Grant et al., 2005; Hohmann et al., 2011; Przybylak et al., 2019; Rhim et al., 2021; Vincent et al., 2017).

The dosage of treatment received by patients receiving community-based physiotherapy following ACLR can vary widely. Retrospective studies show patients post-ACLR receive between 15 and 50+ physiotherapy treatments following surgery (Burroughs et al., 2021; Christensen et al., 2017; Dempsey et al., 2019; Miller et al., 2017). The number of treatments physiotherapists report using following ACLR ranges from 20 to 60 but can exceed 100 (Dingenen et al., 2021; Ebert et al., 2019a; Korakakis et al., 2021). The reported duration of post-ACLR rehabilitation for community-based patients ranges between 127–175 days (Christensen et al., 2017; Dempsey et al., 2019; Miller et al., 2017), with the duration rarely exceeding 6 months (Dunphy & Gardner, 2020; Ebert et al., 2018; Edwards et al., 2018).

Outcomes following ACLR are typically evaluated with a combination of functional measures and patient-reported outcomes measures (PROMs) (Filbay & Grindem, 2019). There are over 50 PROMs related to the anterior cruciate ligament (ACL) deficient knee (Johnson & Smith, 2001). The Knee Injury Osteoarthritis and Outcome Score (KOOS) and the Marx Activity Rating Scale (MARS) are two PROMs consistently utilised in

ACL research and by ACL registries (Kanakamedala et al., 2016; Senorski, Svantesson, Engebretson, et al., 2019). As discrepancies can exist between post-operative PROM scores and patient satisfaction levels, the concept of a patient acceptable symptom state (PASS) may better facilitate interpretation of a PROM (Cristiani et al., 2020; Wright et al., 2015). The PASS is defined as the PROM score beyond which patients consider themselves well (Tubach et al., 2005). PASS thresholds have been developed for each subscale of the KOOS (Muller et al., 2016), and measurement of the PASS is a valuable complement to the KOOS in ACL injury (Svantesson et al., 2020). PASS thresholds, which are derived from a population with the condition of interest, differ from normative scores, which are derived from people who have never had the condition.

The Accident Compensation Corporation (ACC) of NZ is a government-funded no-fault insurance scheme, which funds treatment and rehabilitation costs for personal injuries caused by an accident, as defined by the ACC Act of 2001 (Todd, 2011). An injury claim is lodged on behalf of the patient by their treatment provider and, if accepted, treatment costs are funded under that specific claim (Bismark & Paterson, 2006). As ACL injuries in NZ are typically the result of an accident (Gianotti et al., 2009), treatment and rehabilitation costs for ACL injuries in NZ are usually met by ACC. ACC is the primary funder of private physiotherapy services in NZ (Reid & Larmer, 2007). Patients receiving treatment from private physiotherapists are typically charged a co-payment, as ACC funding does not usually cover the full cost of the treatment (New Zealand Government, 2007). ACC requires physiotherapy providers to collect visual analogue scale (VAS) pain scores and patient specific functional scale (PSFS) scores from patients; however, ACC does not collect this data from providers. Therefore, although ACC has visibility regarding the dosage of rehabilitation provided following ACLR, it has no knowledge of the specific outcome, or effectiveness, of that rehabilitation. ACC has also historically placed limits on the number of physiotherapy treatments it would fund following a musculoskeletal injury, with the maximum number of treatments following ACL injury being sixteen. Once the treatment number limit has been reached, the physiotherapist must apply to ACC for funding of additional treatments.

ACL registries provide a unique opportunity to understand and interpret factors affecting patient-reported outcomes after ACLR (Prentice et al., 2018). The NZ ACL Registry has been collecting PROM data for NZ ACLR patients since 2014, with almost 90% of ACLRs performed in 2020 enrolled by the registry (New Zealand ACL Registry, 2021). To date, it has not been possible to correlate these patient outcomes with the rehabilitation received, as the NZ ACL Registry does not collect data related to post-surgical physiotherapy treatment. Therefore, the purpose of this study was to explore the quantity and duration of physiotherapy treatment following primary, unilateral ACLR in NZ, and to determine the relationship between that dosage of physiotherapy treatment and patient-reported outcomes in the two years following surgery.

METHODS

Data sources

This retrospective study used outcome data from November 2014 to 1 December 2019 from the NZ ACL Registry. The data included pre-ACL injury MARS score, pre-ACLR KOOS/MARS scores, and post-ACLR KOOS/MARS scores at 6, 12, and 24 months. The data was forwarded to ACC's Analytics and Research department in a password-protected Microsoft Excel spreadsheet. As outcome data were collected independent of the physiotherapy provider, all individuals had the opportunity to complete PROMs at all data collection points, even if the individual was not engaged in physiotherapy treatment at the time of PROM data collection.

Using individual identifiers – National Health Index (NHI) number, and/or date of birth, and/or date of ACL injury – outcome data was matched to the ACC claim under which the ACLR was funded. Once individual outcome data and the ACC claim were matched, the following variables were extracted from the ACC claims management software system (Fineos) into a password-protected Microsoft Excel spreadsheet:

- Age at date of ACLR.
- Gender.
- Date of ACLR.
- Number of days between ACL injury and ACLR.
- Number of physiotherapy treatments in the 12 months prior to ACLR.
- Number of physiotherapy treatments between 0–6, 7–12, and 13–24 months post-ACLR.
- Date of first and last physiotherapy treatment after ACLR.
- Whether the individual had received vocational rehabilitation following ACLR.

Once extracted, patient data were de-identified and forwarded to the primary investigator for analysis. Individuals were excluded if patient-reported outcome data was either missing or unavailable from more than one post-ACLR time point. Unavailable data was defined as data yet to be collected, as that time point after ACLR had not yet been reached. Other exclusion criteria included ACLR revision, as subjective outcomes for this population are typically worse than for primary surgery (Lind et al., 2012; Wright et al., 2012), or non-ACC funded ACLR, as ACC would not hold physiotherapy treatment data for these individuals.

Outcome measures

The primary outcomes were the achievement of a KOOS[4] PASS score or a normative MARS score. The KOOS is composed of five subscales: pain, knee-related symptoms, activities of daily living (ADL), function in sport and recreation, and quality of life (Roos et al., 1998). Items on the KOOS are scored from 0 (no problem) to 4 (extreme problem) on a 5-point Likert scale. Scores from each subscale are transformed to a 0–100 scale, with 0 representing "extreme knee problems" and 100 representing "no knee problems". The KOOS[4] is an average of four subscales, where the ADL subscale is excluded to avoid a ceiling effect, as younger, more active patients rarely have difficulties with activities of daily living (Frobell et al., 2010). Excluding the ADL subscale mitigates the risk of a high score on the ADL subscale artificially inflating the KOOS[4] score.

The achievement of a KOOS[4] PASS score was based on individual KOOS subscale threshold values established by Muller et al. (2016), who asked ACLR patients: "Taking account of all the activity you have during your daily life, your level of pain, and also your activity limitations and participation restrictions, do you consider the current state of your knee satisfactory?" (p. 2821). Corresponding PASS values for the KOOS subscales were Pain > 88.9, Symptoms > 57.1, Sport and Recreation > 75.0, Quality of Life > 62.5, which equates to a KOOS[4] PASS score of 70.9. Individuals were not required to achieve a PASS score on each of the four subscales.

The MARS is a knee-specific questionnaire that evaluates activity level in people with various knee disorders (Marx et al., 2001). The MARS assesses the ability to perform four functional activities: running, cutting, decelerating, and pivoting. Participants record how often they perform these activities on a 0–4 scale, with 4 being most active. The maximum possible MARS score is 16. We used a MARS score of 11 for females and 12 for males as normative values (Cameron et al., 2015).

Statistical analysis

Initial descriptive analysis examined the distributions of the outcome and explanatory measures. The available confounding factors were identified as gender, age group, received vocational rehabilitation post-ACLR, and number of days between ACL injury. A repeated measures logistic regression with unstructured correlation was used to examine the association between dichotomous outcome measures and physiotherapy treatment, adjusting for the confounders and time varying effects.

RESULTS

Outcome data for 9,562 individuals was received from the NZ ACL registry (Figure 1). Outcome data was unable to be matched to an ACC claim for 4% of individuals due to a missing NHI number, date of birth, or date of ACL injury. Physiotherapy treatment data was not recorded for 7%. Two out of the possible three post-ACLR outcome data points were either missing or unavailable for 33%. Sufficient outcome data was available and able to be matched to the corresponding ACC claim, from which physiotherapy treatment data was able to be extracted, for 56% of individuals.

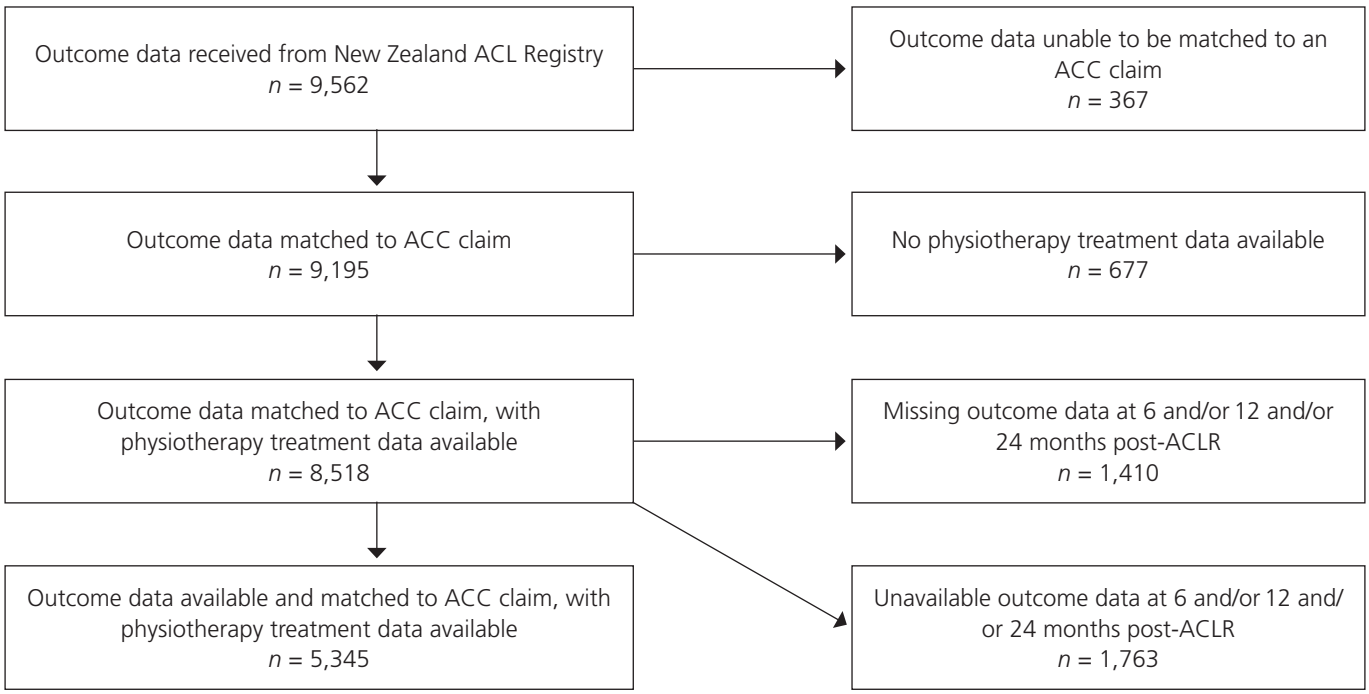
Descriptive analysis of the groups included and excluded from the final data set revealed the percentage of males differed across all groups, with males more likely to have missing physiotherapy treatment data and missing outcome data (Table 1). Individuals with missing outcome data were more likely to be younger at the time of ACLR but less likely to have received vocational rehabilitation. Those with missing physiotherapy treatment data had a longer delay to ACLR and were less likely to have received vocational rehabilitation.

Physiotherapy treatment following ACLR

The average (*SD*) number of physiotherapy treatments in the 12 months prior to ACLR was 5.5 (5.2) (range 0–39) (Figure 2). The average (with *SD* in parentheses) number of physiotherapy treatments 0–6 months post-ACLR was 9.2 (7.2) (range 0–67), 7–12 months post-ACLR was 1.9 (3.7) (range 0–54), and 13–24 months post-ACLR was 0.6 (2.4) (range 0–35). The average (*SD*)

Figure 1

Flow Chart Showing Derivation of Final Data Set



Note. ACC = Accident Compensation Corporation; ACL = anterior cruciate ligament; ACLR = anterior cruciate ligament reconstruction.

Table 1

Descriptive Covariate Values for Individuals Included and Excluded From the Final Data Set

Variable		Outcome data received from NZ ACL Registry (*n* = 9,562)	Outcome data unmatched to ACC claim (*n* = 367)	Physiotherapy treatment data missing (*n* = 677)	Outcome data missing (*n* = 1,410)	Outcome data unavailable (*n* = 1,763)	Physiotherapy treatment data and outcome data available and matched (*n* = 5,345)	*p* [b]
					% [a]			
Gender	Male	57.6	63.2	69.4	70.7	54.3	53.3	< 0.0001
Age at ACLR, *M* (*SD*), range, years		27.8 (11.1), 8–70	28.8 (10.5), 11–64	29.4 (10.9), 9–70	25.6 (9.3), 10–63	28.7 (10.8), 10–69	29.4 (11.2), 8–69	
Age at ACLR, years	8–20	29	20	23	36	26	24	< 0.0001
	21–30	38	47	38	40	38	37	
	31–40	18	18	22	15	20	20	
	41–69	15	15	17	9	16	19	
Days from ACL injury to ACLR, *M* (*SD*), range, years		289 (723), 12–16,025	290 (928), 14–15,418	422 (975), 17–8,801	252 (637), 16–14,406	234 (605), 12–16,025	287 (708), 14–12,163	
Days from ACL injury to ACLR	14–79	26	29	22	27	26	25	< 0.0001
	80–126	24	20	24	23	24	25	
	127–230	25	23	23	25	29	25	
	231+	25	23	31	25	21	25	
	Missing	–	5	–	–	–	–	
Had vocational rehabilitation	Yes	33.4	–	22.2	40.1	32.3	35.6	< 0.0001
	No	66.6	–	77.8	59.9	67.7	64.4	
Pre-injury MARS score, *M* (*SD*)		11.4 (4.9)	11.4 (5.0)	10.4 (5.3)	11.2 (5.2)	11.6 (4.8)	11.7 (4.8)	

Note. ACC = Accident Compensation Corporation; ACL = anterior cruciate ligament; ACLR = anterior cruciate ligament reconstruction; NZ = New Zealand.

[a] Except where indicated. [b] Chi-square test.

total number of physiotherapy treatments in the 24 months post-ACLR was 11.7 (10.5) (range 0–91). The percentage of individuals who did not receive physiotherapy treatment pre-ACLR, and 0–6, 7–12, and 13–24 months post-ACLR, was 22%, 12%, 57%, and 88% respectively (Figure 2).

The duration of post-ACLR physiotherapy treatment was less than 6 months for 57% of individuals, while post-ACLR physiotherapy treatment lasted longer than 9 months for 25% of individuals (Figure 3). The average (*SD*) number of days from the first post-ACLR physiotherapy treatment to the last treatment was 185 (153) days (range 0–725).

Patient-reported outcomes following ACLR

KOOS[4]

The likelihood of an individual achieving a KOOS[4] PASS score following ACLR increased significantly over time ($p < 0.0001$) (Table 2). The percentage of individuals achieving a KOOS[4] PASS score pre-ACLR, and at 6, 12, and 24 months post-ACLR, was 17%, 53%, 70%, and 75% respectively (Figure 4).

MARS

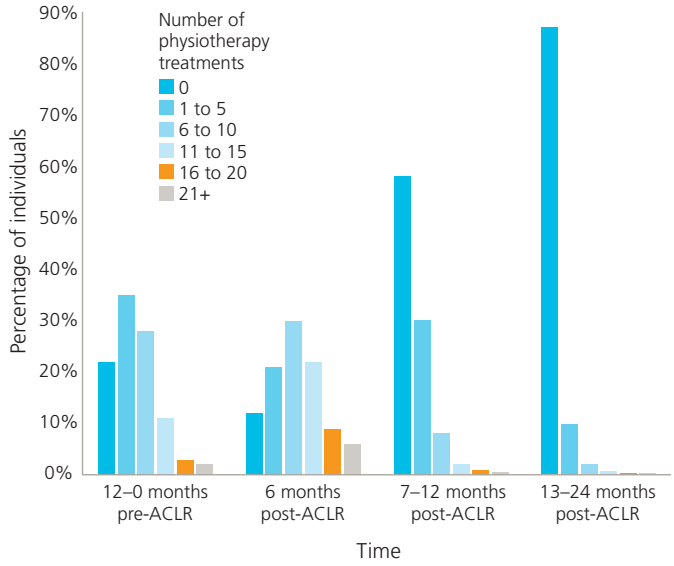
The likelihood of an individual achieving a normative MARS score following ACLR increased significantly over time ($p < 0.0001$) (Table 3). The percentage of individuals achieving a normative MARS score pre-ACLR, and at 6, 12, and 24 months post-ACLR, was 5%, 11%, 23%, and 28% respectively (Figure 5).

Relationship between physiotherapy treatment and patient-reported outcomes – univariate analysis

Post-ACLR physiotherapy treatment was initially grouped into 0, 1, 2–4, and 5+ treatments, as these treatment numbers approximated quartile divisions within the complete data set. Initial analyses showed a statistically significant increase in the likelihood of achieving a KOOS[4] PASS score for one physiotherapy treatment over no physiotherapy treatments 0–6 and 7–12 months post-ACLR ($p = 0.04$), with lesser non-significant increases for 2–4 and 5+ treatments (Table 4). There was no effect of different quantities of post-ACLR physiotherapy

Figure 2

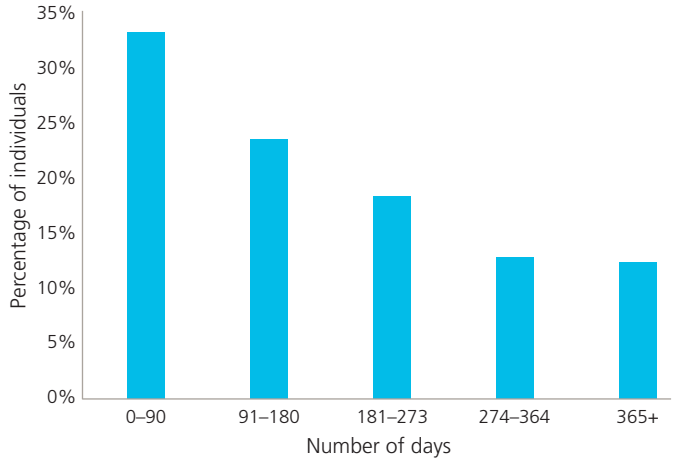
Average Number of Physiotherapy Treatments Per Individual



Note. ACLR = anterior cruciate ligament reconstruction.

Figure 3

Number of Days Between First and Last Physiotherapy Treatment Following ACLR



Note. ACLR = anterior cruciate ligament repair.

Table 2

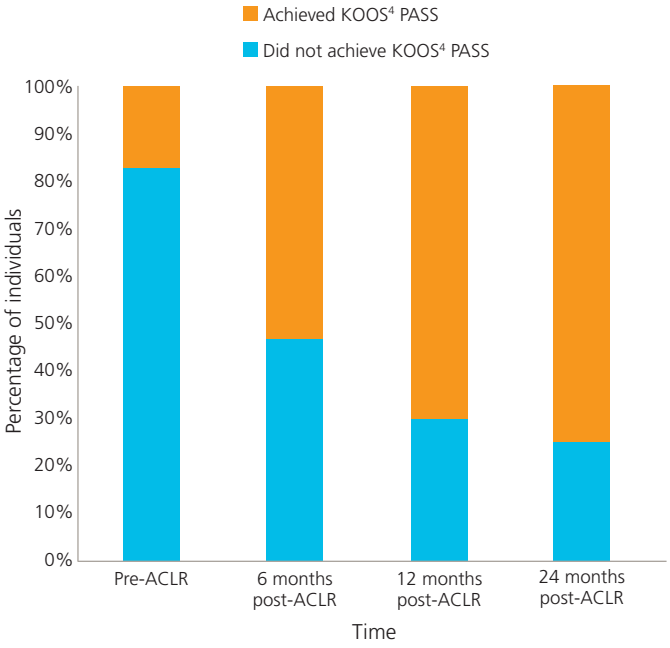
Unadjusted Odds Ratios For the Likelihood of Achieving a KOOS⁴ PASS Score Following ACLR

Time since ACLR	*OR*	95% CI		*p*
		LL	*UL*	
Pre-ACLR	1.00	–	–	
6 months	5.34	4.92	5.79	
12 months	10.87	9.96	11.86	
24 months	13.99	12.64	15.49	< 0.0001

Note. ACLR = anterior cruciate ligament reconstruction; CI = confidence interval; KOOS⁴ PASS = Knee Injury Osteoarthritis and Outcome Score, patient acceptable symptom state; *LL* = lower limit; *UL* = upper limit.

Figure 4

Individuals Achieving a KOOS⁴ PASS Score Over Time



Note . ACLR = anterior cruciate ligament reconstruction; KOOS⁴ PASS = Knee Injury Osteoarthritis and Outcome Score, patient acceptable symptom state.

treatment on the likelihood of achieving a normative MARS score. Therefore, the physiotherapy treatment groups were collapsed into whether or not physiotherapy treatment was present.

KOOS⁴

The percentage of individuals who achieved a KOOS⁴ PASS score at each time point, based on whether they received physiotherapy treatment, is shown in Figure 6. Overall, there was a significant association between receiving physiotherapy treatment and the likelihood of achieving a KOOS⁴ PASS score following ACLR (p = 0.0024), with physiotherapy treatment at 7–12 months associated with an increased likelihood of achieving a KOOS⁴ PASS score at 12 months post-ACLR (Table 5).

MARS

The percentage of individuals who achieved a normative MARS score at each time point, based on whether they received physiotherapy treatment, is shown in Figure 7. Overall, there was a significant association between receiving physiotherapy treatment and the likelihood of achieving a normative MARS score following ACLR (p = 0.0003), with physiotherapy treatment between 7–12 and 13–24 months associated with an

Table 3

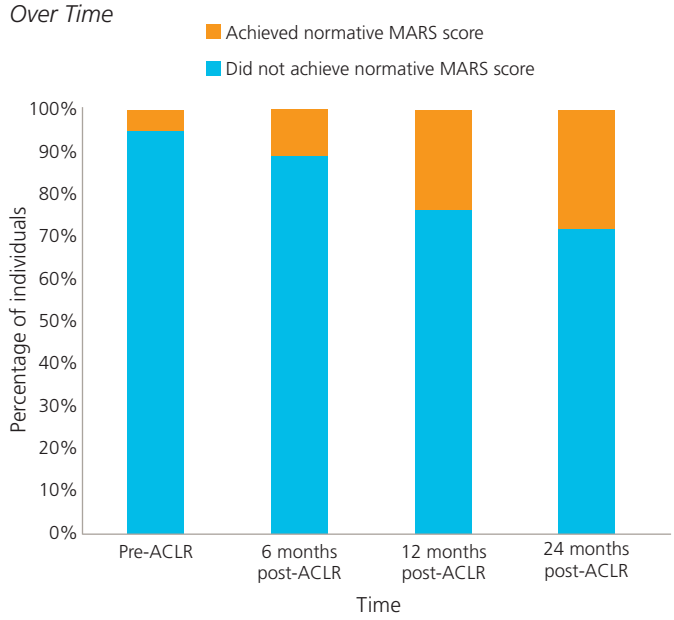
Unadjusted Odds Ratios for the Likelihood of Achieving a Normative Marx Activity Rating Scale Score Following ACLR

Time since ACLR	*OR*	95% CI		*p*
		LL	*UL*	
Pre-ACLR	1.00	–	–	
6 months	2.20	1.90	2.55	
12 months	5.86	5.10	6.73	
24 months	7.53	6.52	8.70	< 0.0001

Note. ACLR = anterior cruciate ligament reconstruction; CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

Figure 5

Individuals Achieving a Normative Marx Activity Rating Scale Over Time



Note. ACLR = anterior cruciate ligament reconstruction; MARS = Marx Activity Rating Scale.

increased likelihood of achieving a normative MARS score at 12 and 24 months after surgery respectively (Table 6).

Relationship between physiotherapy treatment and patient-reported outcomes – multivariate analysis

When adjusted for confounding variables, there was a significant relationship between physiotherapy treatment and likelihood of achieving a KOOS[4] PASS score following ACLR ($p = 0.0035$) (Table 7). Physiotherapy treatment between 0–6 months and 7–12 months increased the likelihood of achieving a KOOS[4] PASS score at 6 and 12 months respectively. However, when adjusted for confounders, the relationship between physiotherapy treatment and the likelihood of achieving a normative MARS score following ACLR did not reach significance ($p = 0.15$). Physiotherapy treatment during all post-operative time periods was not associated with an increased likelihood of achieving a normative MARS score at any post-operative time point. Unadjusted and adjusted odds ratios for KOOS[4] PASS scores and normative MARS scores for all variables are presented in Appendices A and B.

Table 4

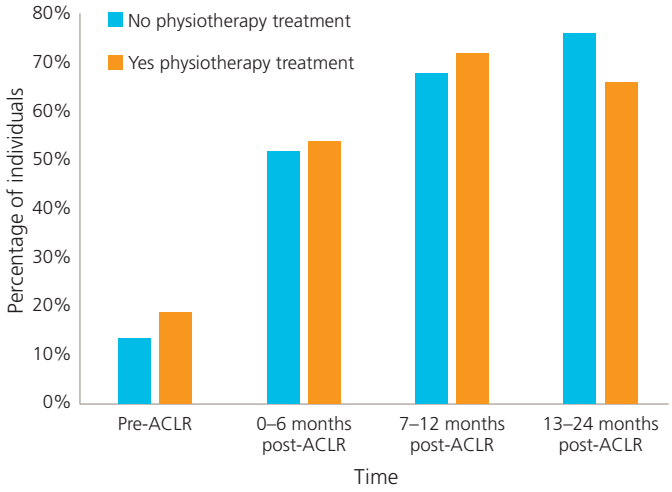
Unadjusted Odds Ratios for Physiotherapy Treatment and the Likelihood of Achieving a KOOS[4] PASS Score Following ACLR

Time since ACLR	Number of physiotherapy treatments	*OR*	95% CI	
			LL	*UL*
0–6 months	0	1.00	–	–
	1	1.45	1.01	2.09
	2–4	1.20	0.96	1.49
	5+	1.18	0.99	1.39
7–12 months	0	1.00	–	–
	1	1.31	1.08	1.59
	2–4	1.12	0.96	1.31
	5+	1.17	0.99	1.39
13–24 months	0	1.00	–	–
	1	0.90	0.62	1.33
	2–4	0.88	0.60	1.27
	5+	0.77	0.50	1.17

Note. ACLR = anterior cruciate ligament reconstruction; CI = confidence interval; KOOS[4] PASS = Knee Injury Osteoarthritis and Outcome Score, patient acceptable symptom state; *LL* = lower limit; *UL* = upper limit.

Figure 6

Individuals Achieving a KOOS[4] PASS Score and If They Received Physiotherapy Treatment



Note . ACLR = anterior cruciate ligament reconstruction; KOOS[4] PASS = Knee Injury Osteoarthritis and Outcome Score, patient acceptable symptom state.

Table 5

Unadjusted Odds Ratios for Individuals Receiving Physiotherapy Treatment and the Likelihood of Achieving a KOOS[4] PASS Score Following ACLR

Time since ACLR	Physiotherapy treatment	*OR*	95% CI	
			LL	*UL*
0–6 months	No	1.00		
	Yes	1.12	0.95	1.31
7–12 months	No	1.00		
	Yes	1.21	1.08	1.36
13–24 months	No	1.00		
	Yes	0.86	0.68	1.09

Note. ACLR = anterior cruciate ligament reconstruction; CI = confidence interval; KOOS[4] PASS = Knee Injury Osteoarthritis and Outcome Score, patient acceptable symptom state; *LL* = lower limit; *UL* = upper limit.

Figure 7

Individuals Achieving a Normative Marx Activity Rating Scale and If They Received Physiotherapy Treatment

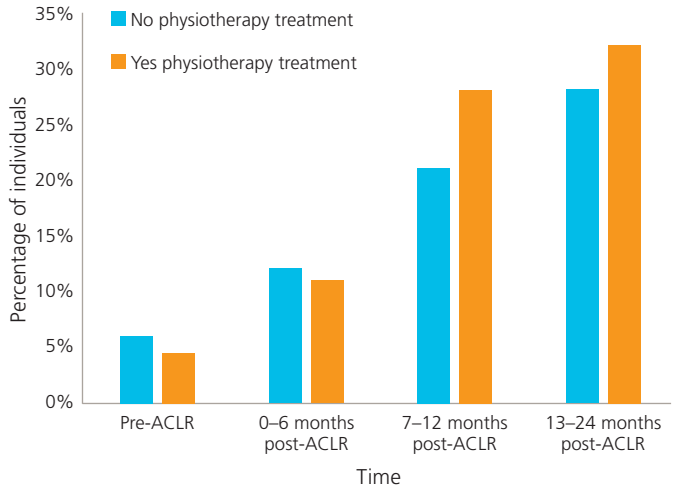


Table 6

Unadjusted Odds Ratios for Individuals Receiving Physiotherapy Treatment and the Likelihood of Achieving a Normative Marx Activity Rating Scale Score Following ACLR

Time since ACLR	Physiotherapy treatment	*OR*	95% CI	
			LL	*UL*
0–6 months	No	1.00		
	Yes	0.95	0.71	1.27
7–12 months	No	1.00		
	Yes	1.27	1.12	1.46
13–24 months	No	1.00		
	Yes	1.40	1.12	1.75

Note. ACLR = anterior cruciate ligament reconstruction; CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

Table 7

Adjusted Odds Ratios for Receiving Physiotherapy Treatment and the Likelihood of Achieving a KOOS[4] PASS Score and a Normative Marx Activity Rating Scale Score Following ACLR

Variable	Time since ACLR	Physiotherapy treatment	*OR*	95% CI	
				LL	*UL*
KOOS[4]	0–6 months	No	1.00		
		Yes	1.19	1.01	1.41
	7–12 months	No	1.00		
		Yes	1.18	1.05	1.33
	13–24 months	No	1.00		
		Yes	0.84	0.67	1.07
MARS	0–6 months	No	1.00		
		Yes	0.91	0.68	1.23
	7–12 months	No	1.00		
		Yes	1.13	0.97	1.31
	13–24 months	No	1.00		
		Yes	1.24	0.97	1.58

Note. ACLR = anterior cruciate ligament reconstruction; CI = confidence interval; KOOS[4] PASS = Knee Injury Osteoarthritis and Outcome Score, patient acceptable symptom state; LL = lower limit; MARS = Marx Activity Rating Scale; UL = upper limit.

DISCUSSION

The aim of this study was to explore the dosage of physiotherapy treatment following ACLR in NZ, and to determine the relationship between the quantity of physiotherapy treatment and patient-reported outcomes in the 2 years following surgery. Our results showed physiotherapy treatment in the first 12 months following ACLR was associated with an increased likelihood of achieving a KOOS[4] PASS score. Physiotherapy treatment in the 24 months following ACLR was not associated with an increased likelihood of achieving a normative MARS score. A greater number of physiotherapy treatments following ACLR was not associated with an increased likelihood of achieving a KOOS[4] PASS score or a normative MARS score in the 24 months following surgery. Overall, individuals received a low dosage of physiotherapy treatment following ACLR in NZ.

This is the first study to show a relationship between physiotherapy treatment and the achievement of a KOOS[4] PASS score following ACLR. Other factors associated with achieving a KOOS[4] PASS score after an ACLR include the absence of a concomitant medial collateral ligament injury and receiving a hamstring tendon graft (Senorski et al., 2018). Age, gender, quadriceps symmetry, absence of concomitant cartilage and meniscal injuries, and hop test performance are also associated with achieving PASS scores on subscales of the KOOS following ACLR (Cristiani et al., 2020; Senorski et al., 2018). Of these factors, only quadriceps symmetry and hop test performance

can be modified by rehabilitation, i.e., physiotherapy treatment. Physiotherapy treatment following ACLR has been shown to improve quadriceps and hamstring strength (Dempsey et al., 2019; Rhim et al., 2021; Walston & Barillas, 2021) and lower limb function (Ebert et al., 2018; Lim et al., 2019). Therefore, physiotherapy treatment potentially contributes to the positive correlation between functional performance and KOOS scores following ACLR (Reinke et al., 2011).

Physiotherapy treatment between 13 and 24 months after ACLR was associated with decreased likelihood of achieving a KOOS[4] PASS score, both in the univariate and multivariate analyses, although results did not reach statistical significance. A lower percentage of individuals who received physiotherapy treatment from 13 to 24 months achieved a KOOS[4] PASS score at 24 months. Physiotherapy treatment after ACLR is recommended to last up to 12 months (van Melick et al., 2016). Therefore, if physiotherapy treatment is required after 12 months, there have potentially been post-operative complications (Eckenrode et al., 2017; Lord et al., 2020), which necessitated prolonged physiotherapy treatment and likely contributed to a worse outcome.

In the univariate analysis, physiotherapy treatment between 7–12 and 13–24 months after ACLR was associated with a significantly increased likelihood of achieving a normative MARS score. When considered with other confounding variables, there was a trend for physiotherapy treatment between 7 and 24 months to be associated with an increased likelihood of achieving a normative MARS score, but significance was not reached. The relationship between physiotherapy treatment and MARS scores following ACLR has not been previously reported. However, physiotherapy treatment following ACLR has been associated with higher scores on the Tegner Activity Scale (Przybylak et al., 2019; Revenäs et al., 2009), which, as with the MARS, quantifies activity level following knee injury (Collins et al., 2011).

Not unexpectedly, the percentage of individuals achieving KOOS[4] PASS scores and normative MARS scores improved over time following ACLR. Our results show 75% of patients post-ACLR perceive their symptoms as acceptable at 2 years post-surgery, which is consistent with previous research (Ingelsrud et al., 2015). Only 28% of individuals had achieved a normative MARS score at 2 years post-ACLR. Although the percentage achieving a normative MARS score increased over time, the average MARS score at 24 months post-ACLR was only 61% of the average pre-injury score, suggesting a low rate of return to pre-injury activity levels after 24 months. Previous research, using MARS data from the same population, reported only 11.1% and 15.5% of patients in NZ have returned to pre-injury activity levels at 12 and 24 months respectively following ACLR (Rahardja et al., 2021). Our study therefore adds to the body of work showing a significant number of people do not achieve pre-injury activity levels 2 years after ACLR (Antosh et al., 2018; Cox et al., 2014; Dunn et al., 2010).

Preliminary analysis of the KOOS[4] data used a normative score as the dependent variable in the statistical model. However, the number of individuals achieving a normative KOOS[4] score at each time point was so low the statistical model failed. Previous research has shown most people do not achieve normative KOOS scores within 2 years of ACLR (Herrington, 2013). As a significant number of patients achieve a PASS score on four out of the five KOOS subscales at 12 months after ACLR (Senorski et al., 2018), a KOOS[4] PASS score was therefore selected as a dependent variable. A normative MARS score was selected as a dependent variable in the current study, as, to date, no PASS scores have been published for the MARS.

Normative values need to be considered in the context of the population from which they were derived. The normative MARS values used in the current study were derived from a cohort of United States military academy recruits, with an average (*SD*) age of 18.8 (0.9) years for males and 18.7 (0.7) years for females (Cameron et al., 2015); the only published normative MARS scores to date. In the current study, average age of individuals at time of ACLR was 29.5 years for males and 29.3 years for females, with an age range from 8 to 69 years. Only 11% of individuals were aged 17–19 years. Younger people have higher participation rates in ACL-dependent activities (Eime et al., 2016), which would be reflected in higher MARS scores. Following ACLR, MARS scores decline with increasing age (Randsborg et al., 2022; Spindler et al., 2018). Therefore, the average age of individuals in the current study likely contributed to the low percentage achieving a normative MARS score following ACLR.

Patient-reported outcome measures are not routinely utilised by physiotherapists in clinical practice (Jette et al., 2009). Although there is no data on the general utilisation of PROMs by NZ physiotherapists, only 52% of NZ physiotherapists report using PROMs when considering a return to sport after ACLR (Fausett et al., 2022). Patient-reported outcome data following ACLR in NZ is collected by an ACL Registry. This is an ACC-funded organisation set up by the Knee and Sports Society, which is a branch of the NZ Orthopaedic Association (New Zealand ACL Registry, 2021). The NZ ACL Registry has no links to physiotherapy providers in NZ. Therefore, the collection of PROM data following ACLR is independent of the providers delivering the post-surgical rehabilitation, arguably independence that eliminates any bias the physiotherapist may introduce by their collection of the PROM data. However, collection of the PROM data is not correlated specifically to a particular stage of rehabilitation and the physiotherapist has no visibility of the PROM scores. PROM data is collected by the NZ ACL Registry at 6, 12, and 24 month intervals following ACLR. More frequent collection of PROM data by the physiotherapist may offer greater insights into the patient's rehabilitation progress, with the rehabilitation plan able to be adjusted or modified if required.

Our results show individuals in NZ receive a low dosage of physiotherapy treatment following ACLR, with less than 12 treatments over 185 days. Previous retrospective studies have shown community-based patients can receive 15–58 treatments over 127–175 days following ACLR (Christensen et al., 2017; Dempsey et al., 2019; Miller et al., 2017). This large range reflects the lack of a consensus regarding an optimal number of physiotherapy treatments following ACLR (Walker et al., 2020). While no optimal number of physiotherapy treatment sessions exists that can be applied to all patients, the number of treatments required by each patient will be a product of

their post-operative goals and individual progress through their rehabilitation programme. Following ACLR, a fortnightly review with the treating physiotherapist is suggested as the minimum requirement (Filbay & Grindem, 2019), and if rehabilitation lasts the recommended 9–12 months (van Melick et al., 2016), then the minimum number of post-ACLR physiotherapy treatments would be 18–24. Ultimately, the optimal number of physiotherapy treatments for each individual will be the number of treatments they require to achieve their post-operative goals.

The temporal utilisation of a limited number of physiotherapy treatments following ACLR could also influence the duration of rehabilitation. Individuals in the current study received 79% of post-ACLR physiotherapy treatments within 6 months of surgery – a finding consistent with a recent database analysis of over 11,000 ACLR patients that reported 90% of post-ACLR physiotherapy treatments were received within 4 months of surgery (Burroughs et al., 2021). If the majority of allocated treatments are utilised within a short timeframe after surgery, then the premature cessation of rehabilitation may be decided by the allocated number of treatments rather than the achievement of patient goals.

For almost 60% of individuals in the current study, post-ACLR physiotherapy treatment lasted less than 6 months, with physiotherapy lasting at least 9 months for only a quarter of individuals. Although time-based rehabilitation following ACLR has now been succeeded by criterion-based rehabilitation (Meredith et al., 2020), time from surgery is still the most considered factor when assessing a return to sport (Burgi et al., 2019). Few patients achieve recommended criteria to resume pre-injury activities within 9 months of ACLR surgery (Herbst et al., 2015; Toole et al., 2017; Welling et al., 2018), and a return to pre-injury activities before 9 months significantly increases the risk of re-injury (Beischer et al., 2020; Bodkin et al., 2022; Grindem et al., 2016). The risk of re-injury following ACLR is also highest in the first 6–12 months of a return to pre-injury activities (Paterno et al., 2012; Webster & Feller, 2016). Therefore, physiotherapist treatment and oversight of rehabilitation 7–12 months after ACLR may help reduce the risk of ACL re-injury at a time when most patients are considering returning to pre-injury activities.

The final phase of ACLR rehabilitation typically involves a resumption of functional activities, sport-specific training, and a graduated return to pre-injury sports (Buckthorpe, 2019), with most patients expecting a return to pre-injury activities 6–12 months after surgery (Armento et al., 2020; Feucht et al., 2016). Individuals in the current study received on average less than two physiotherapy treatments 7–12 months after ACLR, with 58% receiving no physiotherapy treatment during this time. Therefore, our results suggest NZ ACLR patients are undertaking end-stage rehabilitation without adequate professional oversight (Ebert et al., 2019a; Filbay & Grindem, 2019). Low numbers of physiotherapy treatments at 7–12 months could reflect increased self-management (Ebert et al., 2019a), decreased patient compliance (Risberg et al., 2016), a lack of physiotherapist skill and knowledge to manage a patient through the return to sport phase following ACLR (Walker et al., 2020), or the use of non-physiotherapy providers for rehabilitation guidance (Walker et al., 2021).

Multiple factors likely contribute to patients receiving a low dosage of physiotherapy treatment following ACLR, including low motivation to complete rehabilitation (Thorstensson et al., 2009), a lack of patient education regarding post-ACLR rehabilitation (Cailliez et al., 2012), or a lack of surgeon endorsement of rehabilitation (Ebert et al., 2019b). Patients also report frustration and disappointment with a physiotherapist's ability to manage late-stage ACLR rehabilitation (Walker et al., 2022), which could lead to patients prematurely disengaging in physiotherapy, resulting in a low number of treatments.

From a NZ-specific perspective, the provider co-payment, which can be up to $50 per treatment, for a private physiotherapy treatment, likely represents a significant barrier to a patient receiving the recommended dosage of physiotherapy following ACLR. The limits placed on the number of physiotherapy treatments for an ACL injury by ACC have also potentially contributed to low numbers of treatments being used in the current study. The physiotherapist has to submit a request to ACC for funding of additional treatments by providing their clinical records and a completed ACC32 form, which includes details regarding the patient's current condition, how the current condition is linked to the covered injury, and a plan for the additional treatments. The request is then clinically assessed by ACC, with a subsequent decision issued to either approve or decline the request. This prior approval process represents a barrier to receiving additional physiotherapy treatments, as a decision to decline additional funding results in the patient being liable for the full cost of any further physiotherapy treatment, further compounding any financial burden on the patient. Other potential factors preventing engagement in physiotherapy following ACLR include patient-specific barriers (health literacy/understanding of the condition, cultural beliefs, socioeconomic status), provider-specific barriers (patient interactions), and healthcare system barriers (waiting times, location of services, involvement of multiple providers) (Fausett et al., 2019).

A strength of the current study is the large number of individuals, which provides a level of statistical robustness. However, large cohorts increase the likelihood of significant results, even if those results may not be clinically relevant (Senorski, Svantesson, Baldari, et al., 2019). We used deterministic linkage to match two large, separate data sets, which can produce false negative links due to missing data and erroneous entries (Zhu et al., 2015). The retrospective design, while allowing a large cohort, prevents any causal links being established. ACC clients with an ACL injury may have more than one knee claim related to their ACL injury. Therefore, we cannot rule out the possibility of individuals receiving post-ACLR physiotherapy treatment under a knee claim that the ACLR was not funded under. However, this scenario is unlikely to apply to a large number of individuals, as ACC processes are designed to ensure all entitlements are funded under the correct claim. By choosing to use PROM data from the NZ ACL Registry, there was no control over the outcome measures used, and other PROMs may be more appropriate measures to assess patient outcomes within 2 years of ACLR. The International Knee Documentation Committee form is a more useful tool to evaluate patients in the first year after ACLR (van Meer et al., 2013) and the Tegner

activity scale (TAS) is recommended when assessing activity levels in ACLR patients, particularly in conjunction with the International Knee Documentation Committee (Wera et al., 2014).

CONCLUSION

Physiotherapy treatment improves subjective patient-reported outcomes following ACLR, although the effect of physiotherapy treatment on activity levels is less certain. The majority of individuals report acceptable symptoms and function at 2 years following ACLR, which is in contradiction to a low rate of return to pre-injury activity levels. Individuals undergoing ACLR in NZ receive a low dosage of physiotherapy treatment following surgery. The optimal number of physiotherapy treatments following ACLR remains unclear and is likely dependent on multiple factors. A well-controlled prognostic study examining the effects of various quantities of physiotherapy treatment on outcomes following ACLR is warranted. However, ethical issues would likely render the undertaking of such a study challenging. Future prospective research on outcomes following ACLR should consider the appropriateness of the outcome measures used and how the demographics of the cohort might influence any findings.

KEY POINTS

1. In the first 12 months following ACLR, physiotherapy treatment increases the likelihood of an individual accepting any ongoing symptoms or functional limitations; however, in the 24 months following ACLR, the effect of physiotherapy on activity levels is less clear.
2. The dosage of physiotherapy treatment received by NZ patients following ACLR is less than previous research suggests is required.
3. Multiple factors potentially influence the dosage of post-ACLR physiotherapy treatment in NZ, including financial barriers and health system requirements.
4. Regular assessment of the patient's status during ACLR rehabilitation, using both functional and patient-reported outcomes, will likely have multiple benefits, including providing an objective basis for the progression and modification of rehabilitation, and increasing and maintaining patient motivation.

DISCLOSURES

No funding was obtained for this research. At the time of this study, WF was employed by ACC as a clinical advisor, but this research was not undertaken in his capacity as an ACC employee. Although ACC provided the physiotherapy treatment data for analysis, ACC did not commission this research and was not involved in the planning and conducting of this research. ACC was made aware of the study prior to its commencement and was fully supportive of the research. All other authors report no conflict of interest.

PERMISSIONS

Ethical approval for this research was granted by the Auckland University of Technology Ethics Committee (reference number 19/293).

ACKNOWLEDGEMENTS

The authors thank the NZ ACL Registry for sharing their outcome data. The authors also thank Joe Hedditch at ACC for his assistance with data matching.

CONTRIBUTIONS OF AUTHORS

Conceptualisation, design, and methodology, WF, DR, and PL; Formal analysis, NG and WF; Writing – original draft preparation, WF; Writing – review & editing, WF, DR and PL.

ADDRESS FOR CORRESPONDENCE

Wayne Fausett, 94 Grey St, Tauranga, New Zealand.

Email: wayne.fausett@autuni.ac.nz

REFERENCES

Antosh, I. J., Svoboda, S. J., Peck, K. Y., Garcia, E. S. J., & Cameron, K. L. (2018). Change in KOOS and WOMAC scores in a young athletic population with and without anterior cruciate ligament injury. *The American Journal of Sports Medicine 46*(7), 1606–1616. https://doi.org/10.1177/0363546518768753

Armento, A., Albright, J., Gagliardi, A., Daoud, A. K., Howell, D., & Mayer, S. (2020). Patient expectations and perceived social support related to return to sport after anterior cruciate ligament reconstruction in adolescent athletes. *Physical Therapy in Sport*, *47*, 72–77. https://doi.org/10.1016/j.ptsp.2020.10.011

Beischer, S., Gustavsson, L., Senorski, E. H., Karlsson, J., Thomeé, C., Samuelsson, K., & Thomeé, R. (2020). Young athletes who return to sport before 9 months after anterior cruciate ligament reconstruction have a rate of new injury 7 times that of those who delay return. *Journal of Orthopaedic and Sports Physical Therapy*, *50*(2), 83–90. https://doi.org/10.2519/jospt.2020.9071

Beynnon, B. D., Johnson, R. J., Naud, S., Fleming, B. C., Abate, J. A., Brattbakk, B., & Nichols, C. E. (2011). Accelerated versus nonaccelerated rehabilitation after anterior cruciate ligament reconstruction: A prospective, randomized, double-blind investigation evaluating knee joint laxity using roentgen stereophotogrammetric analysis. *The American Journal of Sports Medicine 39*(12), 2536–2548. https://doi.org/10.1177/0363546511422349

Bismark, M., & Paterson, R. (2006). No-fault compensation in New Zealand: Harmonizing injury compensation, provider accountability, and patient safety. *Health Affairs*, *25*(1), 278–283. https://doi.org/10.1377/hlthaff.25.1.278

Bodkin, S. G., Hertel, J., Diduch, D. R., Saliba, S. A., Novicoff, W. M., Brockmeier, S. F., Miller, M. D., Gwathmey, W., Werner, B. C., & Hart, J. M. (2022). Predicting anterior cruciate ligament reinjury from return-to-activity assessments at 6 months postsurgery: A prospective cohort study. *Journal of Athletic Training*, *57*(4), 325–333. https://doi.org/10.4085/1062-6050-0407.20

Buckthorpe, M. (2019). Optimising the late-stage rehabilitation and return-to-sport training and testing process after ACL reconstruction. *Sports Medicine*, *49*, 1043–1058. https://doi.org/10.1007/s40279-019-01102-z

Burgi, C. R., Peters, S., Ardern, C. L., Magill, J. R., Gomez, C. D., Sylvain, J., & Reiman, M. P. (2019). Which criteria are used to clear patients to return to sport after primary ACL reconstruction? A scoping review. *British Journal of Sports Medicine 53*(18), 1154–1161. https://doi.org/10.1136/bjsports-2018-099982

Burroughs, P. J., Kahan, J. B., Moore, H. G., Grauer, J. N., & Gardner, E. C. (2021). Temporal utilization of physical therapy visits after anterior cruciate ligament reconstruction. *The Orthopaedic Journal of Sports Medicine*, *9*(2), 2325967120982293. https://doi.org/10.1177/2325967120982293

Cailliez, J., Reina, N., Molinier, F., Chaminade, B., Chiron, P., & Laffosse, J.-M. (2012). Patient information ahead of anterior cruciate ligament reconstruction: Experience in a university hospital center. *Orthopaedics & Traumatology: Surgery & Research*, *98*(5), 491–498. https://doi.org/10.1016/j.otsr.2012.03.007

Cameron, K. L., Peck, K. Y., Thompson, B. S., Svoboda, S. J., Owens, B. D., & Marshall, S. W. (2015). Reference values for the Marx Activity Rating Scale in a young athletic population: History of knee ligament injury is associated with higher scores. *Sports Health*, *7*(5), 403–408. https://doi.org/10.1177/1941738115576121

Christensen, J. C., Miller, C. J., Burns, R. D., & West, H. S. (2017). Effect of physical therapy visits on clinical outcomes following anterior cruciate ligament reconstruction with and without concurrent meniscal repair. *Journal of Sport Rehabilitation*, *28*(1), 24–32. https://doi.org/10.1123/jsr.2017-0088

Collins, N., Misra, D., Felson, D. T., Crossley, K. M., & Roos, E. M. (2011). Measures of knee function: International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form, Knee Injury and Osteoarthritis Outcome Score (KOOS), Knee Injury and Osteoarthritis Outcome Score Physical Function Short Form (KOOS-PS), Knee Outcome Survey Activities of Daily Living Scale (KOS-ADL), Lysholm Knee Scoring Scale, Oxford Knee Score (OKS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Activity Rating Scale (ARS), and Teger Activity Score (TAS). *Arthritis Care & Research*, *63*(S11), S208–S228. https://doi.org/10.1002/acr.20632

Cox, C. L., Huston, L. J., Dunn, W. R., Reinke, E. K., Nwosu, S. K., Parker, R. D., Wright, R. W., Kaeding, C. C., Marx, R. G., Amendola, A., McCarty, E. C., Wolf, B. R., Harrell, F. E., & Spindler, K. P. (2014). Are articular cartilage lesions and meniscus tears predictive of IKDC, KOOS, and Marx activity level outcomes after anterior cruciate ligament reconstruction? A 6-year multicenter cohort study. *The American Journal of Sports Medicine 42*(5), 1058–1067. https://doi.org/10.1177/0363546514525910

Cristiani, R., Mikkelsen, C., Edman, G., Forssblad, M., Engström, B., & Stålman, A. (2020). Age, gender, quadriceps strength and hop test performance are the most important factors affecting the achievement of a patient-acceptable symptom state after ACL reconstruction. *Knee Surgery, Sports Traumatology, Arthroscopy*, *28*(2), 369–380. https://doi.org/10.1007/s00167-019-05576-2

Dempsey, I. J., Norte, G. E., Hall, M., Goetschius, J., Slater, L. V., Cancienne, J. M., Werner, B. C., Diduch, D. R., & Hart, J. M. (2019). Relationship between physical therapy characteristics, surgical procedure, and clinical outcomes in patients after ACL reconstruction. *Journal of Sport Rehabilitation*, *28*(2), 171–179. https://doi.org/10.1123/jsr.2017-0176

Dingenen, B., Billiet, B., de Baets, L., Bellemans, J., Truijen, J., & Gokeler, A. (2021). Rehabilitation strategies of Flemish physical therapists before and after anterior cruciate ligament reconstruction: An online survey. *Physical Therapy in Sport*, *49*, 68–76. https://doi.org/10.1016/j.ptsp.2021.02.003.

Dunn, W. R., Spindler, K. P., & MOON Consortium. (2010). Predictors of activity level two years after ACL reconstruction: MOON ACLR cohort study. *The American Journal of Sports Medicine, 38*(10), 2040–2050. https://doi.org/10.1177/0363546510370280.

Dunphy, E., & Gardner, E. C. (2020). Telerehabilitation to address the rehabilitation gap in anterior cruciate ligament care: Survey of patients. *JMIR Formative Research*, *4*(9), e19296. https://doi.org/10.2196/19296

Ebert, J., Edwards, P., Yi, L., Joss, B., Ackland, T., Carey-Smith, R., Buelow, J.-U., & Hewitt, B. (2018). Strength and functional symmetry is associated with post-operative rehabilitation in patients following anterior cruciate ligament reconstruction. *Knee Surgery, Sports Traumatology, Arthroscopy*, *26*(8), 2353–2361. https://doi.org/10.1007/s00167-017-4712-6

Ebert, J., Webster, K., Edwards, P., Joss, B., D'Alessandro, P., Janes, G., & Annear, P. (2019a). Current perspectives of Australian therapists on rehabilitation and return to sport after anterior cruciate ligament reconstruction: A survey. *Physical Therapy in Sport*, *35*, 139–145. https://doi.org/10.1016/j.ptsp.2018.12.004

Ebert, J., Webster, K. E., Edwards, P. K., Joss, B. K., D'Alessandro, P., Janes, G., & Annear, P. (2019b). Current perspectives of the Australian Knee Society on rehabilitation and return to sport after anterior cruciate ligament reconstruction. *Journal of Sport Rehabilitation*, *29*(7), 970–975. https://doi.org/10.1123/jsr.2019-0291

Eckenrode, B. J., Carey, J. L., Sennett, B. J., & Zgonis, M. H. (2017). Prevention and management of post-operative complications following ACL reconstruction. *Current Reviews in Musculoskeletal Medicine*, *10*(3), 315–321. https://doi.org/10.1007/s12178-017-9427-2

Edwards, P., Ebert, J., Joss, B., Ackland, T., Annear, P., Buelow, J., & Hewitt, B. (2018). Patient characteristics and predictors of return to sport at 12 months after anterior cruciate ligament reconstruction: The importance of patient age and postoperative rehabilitation. *Orthopaedic Journal of Sports Medicine*, *6*(9), 2325967118797575 https://doi.org/10.1177/2325967118797575

Eime, R. M., Harvey, J. T., Charity, M. J., Casey, M. M., Westerbeek, H., & Payne, W. R. (2016). Age profiles of sport participants. *BMC Sports Science, Medicine and Rehabilitation*, *8*, 6. https://doi.org/10.1186/s13102-016-0031-3

Fausett, W., Reid, D. A., & Larmer, P. J. (2022). Current perspectives of New Zealand physiotherapists on rehabilitation and return to sport following anterior cruciate ligament reconstruction: A survey. *Physical Therapy in Sport*, *53*, 166–172. https://doi.org/10.1016/j.ptsp.2021.10.012

Fausett, W., Wilkins, F., Reid, D., Larmer, P., & Potts, G. (2019). Physiotherapy treatment and rehabilitation following anterior cruciate ligament injury in New Zealand: Are we doing enough? *New Zealand Journal of Physiotherapy*, *47*(3), 139–149. https://doi.org/10.15619/NZJP/47.3.02

Feucht, M. J., Cotic, M., Saier, T., Minzlaff, P., Plath, J. E., Imhoff, A. B., & Hinterwimmer, S. (2016). Patient expectations of primary and revision anterior cruciate ligament reconstruction. *Knee Surgery, Sports Traumatology, Arthroscopy*, *24*(1), 201–207. https://doi.org/10.1007/s00167-014-3364-z

Filbay, S., & Grindem, H. (2019). Evidence-based recommendations for the management of anterior cruciate ligament (ACL) rupture. *Best Practice & Research Clinical Rheumatology*, *33*(1), 33–47. https://doi.org/10.1016/j.berh.2019.01.018

Frobell, R. B., Roos, E. M., Roos, H. P., Ranstam, J., & Lohmander, L. S. (2010). A randomized trial of treatment for acute anterior cruciate ligament tears. *The New England Journal of Medicine*, *363*(4), 331–342. https://doi.org/10.1056/NEJMoa0907797

Gianotti, S. M., Marshall, S. W., Hume, P. A., & Bunt, L. (2009). Incidence of anterior cruciate ligament injury and other knee ligament injuries: A national population-based study. *Journal of Science and Medicine in Sport*, *12*(6), 622–627. https://doi.org/10.1016/j.jsams.2008.07.005

Grant, J. A., Mohtadi, N. G., Maitland, M. E., & Zernicke, R. F. (2005). Comparison of home versus physical therapy-supervised rehabilitation programs after anterior cruciate ligament reconstruction: A randomized clinical trial. *The American Journal of Sports Medicine 33*(9), 1288–1297. https://doi.org/10.1177/0363546504273051

Grindem, H., Snyder-Mackler, L., Moksnes, H., Engebretsen, L., & Risberg, M. A. (2016). Simple decision rules can reduce reinjury risk by 84% after ACL reconstruction: The Delaware-Oslo ACL cohort study. *British Journal of Sports Medicine 50*(13), 804–808. https://doi.org/10.1136/bjsports-2016-096031

Herbst, E., Hoser, C., Hildebrandt, C., Raschner, C., Hepperger, C., Pointner, H., & Fink, C. (2015). Functional assessments for decision-making regarding return to sports following ACL reconstruction. Part II: clinical application of a new test battery. *Knee Surgery, Sports Traumatology, Arthroscopy*, *23*(5), 1283–1291. https://doi.org/10.1007/s00167-015-3546-3

Herrington, L. (2013). Functional outcome from anterior cruciate ligament surgery: A review. *OA Orthopaedics*, *1*(2), 12–19.

Hohmann, E., Tetsworth, K., & Bryant, A. (2011). Physiotherapy-guided versus home-based, unsupervised rehabilitation in isolated anterior cruciate injuries following surgical reconstruction. *Knee Surgery, Sports Traumatology, Arthroscopy*, *19*(7), 1158–1167.

Ingelsrud, L. H., Granan, L.-P., Terwee, C. B., Engebretsen, L., & Roos, E. M. (2015). Proportion of patients reporting acceptable symptoms or treatment failure and their associated KOOS values at 6 to 24 months after anterior cruciate ligament reconstruction: A study from the Norwegian Knee Ligament Registry. *The American Journal of Sports Medicine 43*(8), 1902–1907. https://doi.org/10.1177/0363546515584041

Jette, D. U., Halbert, J., Iverson, C., Miceli, E., & Shah, P. (2009). Use of standardized outcome measures in physical therapist practice: Perceptions and applications. *Physical Therapy*, *89*(2), 125–135. https://doi.org/10.2522/ptj.20080234

Johnson, D. S., & Smith, R. B. (2001). Outcome measurement in the ACL deficient knee—What's the score? *The Knee*, *8*(1), 51–57. https://doi.org/10.1016/S0968-0160(01)00068-0

Kanakamedala, A. C., Anderson, A. F., & Irrgang, J. J. (2016). IKDC Subjective Knee Form and Marx Activity Rating Scale are suitable to evaluate all orthopaedic sports medicine knee conditions: A systematic review. *Journal of ISAKOS, 1*(1), 25–31. https://doi.org/10.1136/jisakos-2015-000014

Korakakis, V., Kotsifaki, A., Korakaki, A., Karanasios, S., & Whiteley, R. (2021). Current perspectives and clinical practice of physiotherapists on assessment, rehabilitation, and return to sport criteria after anterior cruciate ligament injury and reconstruction. An online survey of 538 physiotherapists. *Physical Therapy in Sport*, *52*, 103–114. https://doi.org/10.1016/j.ptsp.2021.08.012

Lim, J.-M., Cho, J.-J., Kim, T.-Y., & Yoon, B.-C. (2019). Isokinetic knee strength and proprioception before and after anterior cruciate ligament reconstruction: A comparison between home-based and supervised rehabilitation. *Journal of Back and Musculoskeletal Rehabilitation*, *32*(3), 421–429. https://doi.org/10.3233/BMR-181237

Lind, M., Menhert, F., & Pedersen, A. B. (2012). Incidence and outcome after revision anterior cruciate ligament reconstruction: Results from the Danish registry for knee ligament reconstructions. *The American Journal of Sports Medicine 40*(7), 1551–1557. https://doi.org/10.1177/0363546512446000

Lobb, R., Tumilty, S., & Claydon, L. S. (2012). A review of systematic reviews on anterior cruciate ligament reconstruction rehabilitation. *Physical Therapy in Sport*, *13*(4), 270–278. https://doi.org/10.1016/j.ptsp.2012.05.001

Lord, L., Cristiani, R., Edman, G., Forssblad, M., & Stålman, A. (2020). One sixth of primary anterior cruciate ligament reconstructions may undergo reoperation due to complications or new injuries within 2 years. *Knee Surgery, Sports Traumatology, Arthroscopy*, *28*, 2478–2485. https://doi.org/10.1007/s00167-020-06127-w

Marx, R. G., Stump, T. J., Jones, E. C., Wickiewicz, T. L., & Warren, R. F. (2001). Development and evaluation of an activity rating scale for disorders of the knee. *The American Journal of Sports Medicine 29*(2), 213–218. https://doi.org/10.1177/03635465010290021601

Meredith, S. J., Rauer, T., Chmielewski, T. L., Fink, C., Diermeier, T., Rothrauff, B. B., Svantesson, E., Hamrin Senorski, E., Hewett, T. E., Sherman, S. L., Lesniak, B. P., & Panther Symposium ACL Injury Return to Sport Consensus Group. (2020). Return to sport after anterior cruciate ligament injury: Panther Symposium ACL Injury Return to Sport Consensus Group. *Knee Surgery, Sports Traumatology, Arthroscopy*, *28*, 2403–2414. https://doi.org/10.1007/s00167-020-06009-1

Miller, C. J., Christensen, J. C., & Burns, R. D. (2017). Influence of demographics and utilization of physical therapy interventions on clinical outcomes and revision rates following anterior cruciate ligament reconstruction. *Journal of Orthopaedic and Sports Physical Therapy*, *47*(11), 834–844. https://doi.org/10.2519/jospt.2017.7048

Muller, B., Yabroudi, M. A., Lynch, A., Lai, C.-L., van Dijk, C. N., Fu, F. H., & Irrgang, J. J. (2016). Defining thresholds for the patient acceptable symptom state for the IKDC subjective knee form and KOOS for patients who underwent ACL reconstruction. *The American Journal of Sports Medicine 44*(11), 2820–2826. https://doi.org/10.1177/0363546516652888

New Zealand ACL Registry. (2021). *Annual report 2021*. https://www.aclregistry.nz/reports/

New Zealand Government. (2007, November 16). *Physiotherapy services report released* [press release]. http://www.scoop.co.nz/stories/PA0711/S00323/physiotherapy-services-report-released.htm

Paterno, M. V., Rauh, M. J., Schmitt, L. C., Ford, K. R., & Hewett, T. E. (2012). Incidence of contralateral and ipsilateral anterior cruciate ligament (ACL) injury after primary ACL reconstruction and return to sport. *Clinical Journal of Sport Medicine*, *22*(2), 116–121. https://doi.org/10.1097/JSM.0b013e318246ef9e.

Prentice, H. A., Lind, M., Mouton, C., Persson, A., Magnusson, H., Gabr, A., Seil, R., Engebretsen. L., Samuelsson, K., Karlsson, J., Forssblad, M., Haddad, F. S., Spalding ,T., Funahashi, T. T., Paxton, L. W., & Maletis G. B. (2018). Patient demographic and surgical characteristics in anterior cruciate ligament reconstruction: A description of registries from six countries. *British Journal of Sports Medicine 52*(11), 716–722. https://doi.org/10.1136/bjsports-2017-098674

Przybylak, K., Sibiński, M., Domżalski, M., Kwapisz, A., Momaya, A. M., & Zielińska, M. (2019). Supervised physiotherapy leads to a better return to physical activity after anterior cruciate ligament reconstruction. *The Journal of Sports Medicine and Physical Fitness*, *59*(9), 1551–1557. https://doi.org/10.23736/s0022-4707.18.08692-9

Rahardja, R., Love, H., Clatworthy, M. G., Monk, A. P., & Young, S. W. (2021). Higher rate of return to preinjury activity levels after anterior cruciate ligament reconstruction with a bone-patellar tendon-bone versus hamstring tendon autograft in high-activity patients: Results from the New Zealand ACL Registry. *The American Journal of Sports Medicine*, *49*(13), 3488–3494. https://doi.org/10.1177/03635465211044142

Randsborg, P.-H., Cepeda, N., Adamec, D., Rodeo, S. A., Ranawat, A., & Pearle, A. D. (2022). Patient-reported outcome, return to sport, and revision rates 7–9 years after anterior cruciate ligament reconstruction: Results from a cohort of 2042 patients. *The American Journal of Sports Medicine*, *50*(2), 423–432. https://doi.org/10.1177/03635465211060333

Reid, D., & Larmer, P. (2007). The New Zealand health priorities: Where do New Zealand private practice physiotherapists fit? *New Zealand Journal of Physiotherapy*, *35*(2), 42–47.

Reinke, E. K., Spindler, K. P., Lorring, D., Jones, M. H., Schmitz, L., Flanigan, D. C., An, A. Q., Quiram, A. R., Preston, E., Martin, M., Schroeder, B., Parker, R. D., Kaeding, C. C., Borzi, L., Pedroza, A., Huston, L. J., Harrell, F. E., & Dunn, W. R. (2011). Hop tests correlate with IKDC and KOOS at minimum of 2 years after primary ACL reconstruction. *Knee Surgery, Sports Traumatology, Arthroscopy*, *19*(11), 1806–1816. https://doi.org/10.1007/s00167-011-1473-5.

Revenäs, Å., Johansson, A., & Leppert, J. (2009). A randomized study of two physiotherapeutic approaches after knee ligament reconstruction. *Advances in Physiotherapy*, *11*(1), 30–41. https://doi.org/10.1080/14038190801999497

Rhim, H. C., Lee, J. H., Lee, S. J., Jeon, J. S., Kim, G., Lee, K. Y., & Jang, K.-M. (2021). Supervised rehabilitation may lead to better outcome than home-based rehabilitation up to 1 year after anterior cruciate ligament reconstruction. *Medicina*, *57*(1), 19. https://doi.org/10.3390/medicina57010019

Risberg, M. A., Grindem, H., & Øiestad, B. E. (2016). We need to implement current evidence in early rehabilitation programs to improve long-term outcome after anterior cruciate ligament injury. *Journal of Orthopaedic and Sports Physical Therapy*, *46*(9), 710–713. https://doi.org/10.2519/jospt.2016.0608

Roos, E. M., Roos, H. P., Lohmander, L. S., Ekdahl, C., & Beynnon, B. D. (1998). Knee Injury and Osteoarthritis Outcome Score (KOOS)—Development of a self-administered outcome measure. *Journal of Orthopaedic and Sports Physical Therapy*, *28*(2), 88–96. https://doi.org/10.2519/jospt.1998.28.2.88

Senorski, E., Svantesson, E., Baldari, A., Ayeni, O. R., Engebretsen, L., Franceschi, F., Karlsson, J., & Samuelsson, K. (2019). Factors that affect patient reported outcome after anterior cruciate ligament reconstruction–A systematic review of the Scandinavian knee ligament registers. *British Journal of Sports Medicine 53*(7), 410-417. https://doi.org/10.1136/bjsports-2017-098191

Senorski, E., Svantesson, E., Beischer, S., Grassi, A., Krupic, F., Thomee, R., & Samuelsson, K. (2018). Factors affecting the achievement of a patient-acceptable symptom state 1 year after anterior cruciate ligament reconstruction: A cohort study of 343 patients from 2 registries. *The Orthopaedic Journal of Sports Medicine*, *6*(4). https://doi.org/10.1177/2325967118764317

Senorski, E., Svantesson, E., Engebretsen, L., Lind, M., Forssblad, M., Karlsson, J., & Samuelsson, K. (2019). 15 years of the Scandinavian knee ligament registries: Lessons, limitations and likely prospects. *British Journal of Sports Medicine 53*, 1259–1260. https://doi.org/10.1136/bjsports-2018-100024

Spindler, K. P., Huston, L. J., Chagin, K. M., Kattan, M. W., Reinke, E. K., Amendola, A., Andrish, J. T., Brophy, R. H., Cox, C. L., Dunn W. R., Flanigan, D. C., Jones, M. H., Kaeding, C. C., Magnussen, R. A., Marx, R. G., Matava, M. J., McCarty, E. C., Parker, R. D., Pedrosa, A. D. . . . MOON Knee Group. (2018). Ten-year outcomes and risk factors after anterior cruciate ligament reconstruction: A MOON longitudinal prospective cohort study. *The American Journal of Sports Medicine 46*(4), 815–825. https://doi.org/10.1177/0363546517749850

Svantesson, E., Hamrin Senorski, E., Webster, K. E., Karlsson, J., Diermeier, T., Rothrauff, B. B., Meredith S. J., Rauer, T., Irrgang, J. J., Spindler, K. P. Ma, C. B., Musahi, V., & Panther Symposium ACL Injury Return to Sport Consensus Group. (2020). Clinical outcomes after anterior cruciate ligament injury: Panther symposium ACL injury clinical outcomes consensus group. *The Orthopaedic Journal of Sports Medicine*, *8*(7). https://doi.org/10.1177/2325967120934751

Thorstensson, C. A., Lohmander, L. S., Frobell, R. B., Roos, E. M., & Gooberman-Hill, R. (2009). Choosing surgery: Patients' preferences within a trial of treatments for anterior cruciate ligament injury. A qualitative study. *BMC Musculoskeletal Disorders*, *10,* 100. https://doi.org/10.1186/1471-2474-10-100

Todd, S. (2011). Forty years of Accident Compensation in New Zealand. *Thomas M. Cooley Law Review*, *28*(2), 189–218.

Toole, A. R., Ithurburn, M. P., Rauh, M. J., Hewett, T. E., Paterno, M. V., & Schmitt, L. C. (2017). Young athletes cleared for sports participation after anterior cruciate ligament reconstruction: How many actually meet recommended return-to-sport criterion cutoffs? *Journal of Orthopaedic and Sports Physical Therapy*, *47*(11), 825–833. https://doi.org/10.2519/jospt.2017.7227

Tubach, F., Wells, G. A., Ravaud, P., & Dougados, M. (2005). Minimal clinically important difference, low disease activity state, and patient acceptable symptom state: Methodological issues. *The Journal of Rheumatology*, *32*(10), 2025–2029.

van Meer, B. L., Meuffels, D. E., Vissers, M. M., Bierma-Zeinstra, S. M., Verhaar, J. A., Terwee, C. B., & Reijman, M. (2013). Knee injury and Osteoarthritis Outcome Score or International Knee Documentation Committee Subjective Knee Form: Which questionnaire is most useful to monitor patients with an anterior cruciate ligament rupture in the short term? *Arthroscopy*, *29*(4), 701–715. https://doi.org/10.1016/j.arthro.2012.12.015

van Melick, N., van Cingel, R. E. H., Brooijmans, F., Neeter, C., van Tienen, T., Hullegie, W., & Nijhuis-van der Sanden, M. W. G. (2016). Evidence-based clinical practice update: Practice guidelines for anterior cruciate ligament rehabilitation based on a systematic review and multidisciplinary consensus. *British Journal of Sports Medicine 50*(24), 1506–1515. https://doi.org/10.1136/bjsports-2015-095898

Vincent, Y. P., Yiu-chung, W., & Patrick, Y. S. (2017). Role of physiotherapy in preventing failure of primary anterior cruciate ligament reconstruction. *Journal of Orthopaedics, Trauma and Rehabilitation*, *22*(1), 6–12. https://doi.org/10.1016/j.jotr.2015.12.003

Walker, A., Hing, W., Gough, S., & Lorimer, A. (2022). 'Such a massive part of rehab is between the ears'; Barriers to and facilitators of anterior cruciate ligament reconstruction rehabilitation: A qualitative focus group analysis. *BMC Sports Science, Medicine and Rehabilitation*, *14*, 106. https://doi.org/10.1186/s13102-022-00499-x

Walker, A., Hing, W., & Lorimer, A. (2020). The influence, barriers to and facilitators of anterior cruciate ligament rehabilitation adherence and participation: A scoping review. *Sports Medicine – Open*, *6*, 32. https://doi.org/10.1186/s40798-020-00258-7

Walker, A., Hing, W., Lorimer, A., & Rathbone, E. (2021). Rehabilitation characteristics and patient barriers to and facilitators of ACL reconstruction rehabilitation: A cross-sectional survey. *Physical Therapy in Sport*, *48*, 169–176. https://doi.org/10.1016/j.ptsp.2021.01.001

Walston, Z., & Barillas, R. B. (2021). The impact of graft type on rehabilitation outcomes following ACL reconstruction: Bone patellar tendon bone versus quadriceps tendon grafts. *Physical Therapy in Sport*, *52*, 234–238. https://doi.org/10.1016/j.ptsp.2021.10.004

Webster, K. E., & Feller, J. A. (2016). Exploring the high reinjury rate in younger patients undergoing anterior cruciate ligament reconstruction. *The American Journal of Sports Medicine, 44*(11), 2827–2832. https://doi.org/10.1177/0363546516651845

Welling, W., Benjaminse, A., Seil, R., Lemmink, K., Zaffagnini, S., & Gokeler, A. (2018). Low rates of patients meeting return to sport criteria 9 months after anterior cruciate ligament reconstruction: A prospective longitudinal study. *Knee Surgery, Sports Traumatology, Arthroscopy*, *26*(12), 3636–3644. https://doi.org/10.1007/s00167-018-4916-4

Wera, J. C., Nyland, J., Ghazi, C., MacKinlay, K. G., Henzman, R. C., Givens, J., & Brand, J. C. (2014). International Knee Documentation Committee knee survey use after anterior cruciate ligament reconstruction: A 2005–2012 systematic review and world region comparison. *Arthroscopy*, *30*(11), 1505–1512. https://doi.org/10.1016/j.arthro.2014.05.043

Wright, A. A., Hensley, C. P., Gilbertson, J., Leland, J. M., & Jackson, S. (2015). Defining patient acceptable symptom state thresholds for commonly used patient reported outcomes measures in general orthopedic practice. *Manual Therapy*, *20*(6), 814–819. https://doi.org/10.1016/j.math.2015.03.011

Wright, R. W., Gill, C. S., Chen, L., Brophy, R. H., Matava, M. J., Smith, M. V., & Mall, N. A. (2012). Outcome of revision anterior cruciate ligament reconstruction: A systematic review. *The Journal of Bone and Joint Surgery*, *94*(6), 531–536. https://doi.org/10.2106/JBJS.K.00733

Zhu, Y., Matsuyama, Y., Ohashi, Y., & Setoguchi, S. (2015). When to conduct probabilistic linkage vs. deterministic linkage? A simulation study. *Journal of Biomedical Informatics*, *56*, 80–86. https://doi.org/10.1016/j.jbi.2015.05.012

Appendices

Appendix A

Odds Ratios for the Likelihood of Achieving a KOOS[4] PASS Score

Variable			Unadjusted [a]				Adjusted [b]			
			OR	95% CI		*p*	*OR*	95% CI		*p*
				LL	*UL*			*LL*	*UL*	
Time	Pre-surgery		1.00			< 0. 0001	1.00			< 0.0001
	0–6 months		5.34	4.92	5.79		6.37	4.76	8.53	
	7–12 months		10.87	9.96	11.86		13.92	10.55	18.53	
	13–24 months		13.99	12.64	15.40		16.08	11.63	22.22	
Time x gender	Pre-surgery	Female	0.72	0.62	0.83	< 0.0001	0.67	0.58	0.78	< 0.0001
		Male	1.00				1.00			
	0–6 months	Female	0.79	0.70	0.88		0.72	0.64	0.82	
		Male	1.00				1.00			
	7–12 months	Female	0.98	0.86	1.11		0.89	0.78	1.02	
		Male	1.00				1.00			
	13–24 months	Female	1.06	0.90	1.25		1.00	0.84	1.18	
		Male	1.00				1.00			
Time x age at date of ACLR	Pre-surgery	8–20 years	1.00			< 0.0001	1.00			< 0.0001
		21–30 years	0.70	0.58)	0.83		0.72	0.60	0.87	
		31–40 years	0.57	0.46	0.71		0.56	0.45	0.70	
		41–69 years	0.47	0.37	0.59		0.46	0.37	0.58	
	0–6 months	8–20 years	1.00				1.00			
		21–30 years	0.68	0.58	0.79		0.76	0.64	0.89	
		31–40 years	0.59	0.50	0.71		0.66	0.55	0.79	
		41–69 years	0.63	0.53	0.76		0.69	0.58	0.83	
	7–12 months	8–20 years	1.00				1.00			
		21–30 years	0.75	0.63	0.90		0.87	0.72	1.05	
		31–40 years	0.52	0.43	0.64		0.63	0.52	0.78	
		41–69 years	0.65	0.53	0.79		0.76	0.62	0.94	
	13–24 months	8–20 years	1.00				1.00			
		21–30 years	0.79	0.62	0.99		0.90	0.71	1.14	
		31–40 years	0.65	0.51	0.83		0.77	0.60	1.00	
		41–69 years	0.87	0.68	1.12		0.99	0.77	1.29	
Time x any physiotherapy treatment	Pre-surgery	No	1.00			0.0024	1.00			0.0035
	0–6 months	Yes	1.12	0.95	1.31		1.19	1.01	1.41	
		No	1.00				1.00			
	7–12 months	Yes	1.21	1.08	1.36		1.18	1.05	1.33	
		No	1.00				1.00			
	13–24 months	Yes	0.86	0.68	1.09		0.84	0.67	1.07	
		No	1.00				1.00			

Variable			Unadjusted [a]				Adjusted [b]			
			OR	95% CI		*p*	*OR*	95% CI		*p*
				LL	*UL*			*LL*	*UL*	
Time x vocational rehabilitation	Pre-surgery	Yes	0.64	0.54	0.75	< 0.0001	0.69	0.59	0.82	< 0.0001
		No	1.00				1.00			
	0–6 months	Yes	0.57	0.5	0.64		0.60	0.52	0.68	
		No	1.00				1.00			
	7–12 months	Yes	0.56	0.49	0.64		0.59	0.52	0.68	
		No	1.00				1.00			
	13–24 months	Yes	0.61	0.52	0.72		0.63	0.53	0.75	
		No	1.00				1.00			
Time x days from ACL injury to ACLR	Pre-surgery	14–79	1.00			< 0.0001	1.00			< 0.0001
		80–126	1.61	1.29	2.01		1.62	1.29	2.02	
		127–230	1.84	1.48	2.29		1.94	1.56	2.42	
		230+	2.11	1.70	2.61		2.27	1.83	2.81	
	0–6 months	14–79	1.00				1.00			
		80–126	1.08	0.92	1.27		1.07	0.91	1.26	
		127–230	1.19	1.01	1.40		1.23	1.04	1.45	
		230+	1.27	1.08	1.50		1.31	1.10	1.55	
	7–12 months	14–79	1.00				1.00			
		80–126	1.12	0.93	1.34		1.13	0.94	1.36	
		127–230	0.95	0.79	1.14		0.98	0.82	1.18	
		230+	0.91	0.76	1.09		0.93	0.78	1.12	
	13–24 months	14–79	1.00				1.00			
		80–126	1.17	0.92	1.48		1.16	0.92	1.47	
		127–230	1.03	0.82	1.29		1.03	0.82	1.30	
		230+	0.94	0.75	1.17		0.91	0.72	1.14	

Note. ACL = anterior cruciate ligament; ACLR = anterior cruciate ligament repair; CI = confidence interval; KOOS[4] PASS = Knee Injury Osteoarthritis and Outcome Score, patient acceptable symptom state; *LL* = lower limit; *UL* = upper limit.

[a] unadjusted except for time effects.

[b] adjusted for gender, age at date of ACLR, presence of vocational rehabilitation post-ACLR, and number of days between ACL injury and ACLR.

Appendix B

Odds Ratios for the Likelihood of Achieving a Normative Marx Activity Rating Scale Score

Variable			Unadjusted [a]				Adjusted [b]			
			OR	95% CI		*p*	*OR*	95% CI		*p*
				LL	*UL*			*LL*	*UL*	
Time	Pre-surgery		1.00			< 0.0001	1.00			< 0.0001
	0–6 months		2.20	1.90	2.55		14.66	6.66	32.28	
	7–12 months		5.86	5.10	6.73		37.85	18.37	77.96	
	13–24 months		7.53	6.52	8.70		35.14	16.75	73.73	
Time x gender	Pre-surgery	Female	0.85	0.65	1.09	0.0001	0.80	0.62	1.04	< 0.0001
		Male	1.00				1.00			
	0–6 months	Female	0.82	0.68	1.00		0.75	0.62	0.92	
		Male	1.00				1.00			
	7–12 months	Female	0.74	0.64	0.85		0.65	0.55	0.75	
		Male	1.00				1.00			
	13–24 months	Female	0.77	0.65	0.90		0.70	0.59	0.84	
		Male	1.00				1.00			
Time x age at date of ACLR	Pre-surgery	8–20 years	1.00			< 0.0001	1.00			< 0.0001
		21–30 years	0.53	0.40	0.71		0.54	0.40	0.74	
		31–40 years	0.42	0.29	0.62		0.45	0.31	0.67	
		41–69 years	0.23	0.14	0.38		0.31	0.19	0.51	
	0–6 months	8–20 years	1.00				1.00			
		21–30 years	0.47	0.37	0.58		0.49	0.39	0.62	
		31–40 years	0.24	0.18	0.34		0.27	0.19	0.38	
		41–69 years	0.20	0.14	0.28		0.25	0.17	0.36	
	7–12 months	8–20 years	1.00				1.00			
		21–30 years	0.56	0.47	0.66		0.64	0.53	0.77	
		31–40 years	0.28	0.22	0.35		0.35	0.28	0.45	
		41–69 years	0.16	0.12	0.20		0.22	0.17	0.29	
	13–24 months	8–20 years	1.00				1.00			
		21–30 years	0.69	0.56	0.85		0.73	0.59	0.91	
		31–40 years	0.34	0.26	0.44		0.38	0.29	0.50	
		41–69 years	0.18	0.13	0.24		0.23	0.17	0.32	
Time x any physiotherapy treatment	Pre-surgery	No	1.00			0.0003	1.00			0.15
	0–6 months	Yes	0.95	0.71	1.27		0.91	0.68	1.23	
		No	1.00				1.00			
	7–12 months	Yes	1.27	1.12	1.46		1.13	0.97	1.31	
		No	1.00				1.00			
	13–24 months	Yes	1.40	1.12	1.75		1.24	0.97	1.58	
		No	1.00				1.00			

Variable			Unadjusted [a]				Adjusted [b]			
			OR	95% CI		*p*	*OR*	95% CI		*p*
				LL	*UL*			*LL*	*UL*	
Time x vocational rehabilitation	Pre-surgery	Yes	0.81	0.61	1.06	< 0.0001	1.04	0.77	1.38	< 0.0001
		No	1.00				1.00			
	0–6 months	Yes	0.65	0.52	0.80		0.85	0.68	1.07	
		No	1.00				1.00			
	7–12 months	Yes	0.51	0.43	0.59		0.57	0.48	0.68	
		No	1.00				1.00			
	13–24 months	Yes	0.77	0.65	0.92		0.89	0.73	1.08	
		No	1.00				1.00			
Time x days from ACL injury to ACLR	Pre-surgery	14–79	1.00			< 0.0001	1.00			< 0.0001
		80–126	1.14	0.80	1.62		1.20	0.84	1.72	
		127–230	1.00	0.69	1.44		1.16	0.8	1.69	
		230+	1.10	0.77	1.57		1.39	0.97	2.01	
	0–6 months	14–79	1.00				1.00			
		80–126	0.94	0.73	1.21		0.98	0.76	1.27	
		127–230	0.73	0.56	0.95		0.82	0.62	1.07	
		230+	0.61	0.46	0.80		0.72	0.54	0.97	
	7–12 months	14–79	1.00				1.00			
		80–126	0.79	0.65	0.95		0.81	0.66	0.99	
		127–230	0.47	0.39	0.58		0.50	0.41	0.62	
		230+	0.45	0.37	0.56		0.52	0.42	0.65	
	13–24 months	14-–9	1.00				1.00			
		80–126	0.91	0.73	1.14		0.96	0.76	1.22	
		127–230	0.65	0.52	0.81		0.71	0.56	0.91	
		230+	0.51	0.40	0.64		0.60	0.47	0.77	

Note. ACL = anterior cruciate ligament; ACLR = anterior cruciate ligament repair; CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

[a] unadjusted except for time effects.

[b] adjusted for gender, age at date of ACLR, presence of vocational rehabilitation post-ACLR, and number of days between ACL injury and ACLR.

THANK YOU NZJP REVIEWERS!

We would like to take this opportunity to thank all of the reviewers who completed reviews of manuscripts for the *New Zealand Journal of Physiotherapy* in 2022. We truly appreciate your time, willingness and expertise in contributing to the peer review process, and your thoughtful comments and recommendations which assist our decision-making and improve the quality of published papers. We could not publish our *Journal* without you!

Daniela Aldabe
Tom Adams
Miranda Buhler
Ally Calder
Sarah Candy
Cathy Chapple
Melissa Davidson
Jennifer Dunn
Edith Elgueta Cancino
Nicola Jepsen
Mandeep Kaur
Edel Kelly
Kimberley Haines
Leigh Hale
Sandy Hall
Helen Harcombe
Julia Hill
Jenna Lang
Mark Laslett
Sue Lord
Hannu Luomajoki
Ruth McLaren
Sarah Mitchell
Leena Naik
Dave Nichols
Christie Oldfield
Sarah Rhodes
Ann Sezier
Jacqueline Smidt-Busby
Gisela Sole
Gunilla Stenberg
Caroline Stretton
Todd Stretton
Will Taylor
Bronwyn Thompson
Nicola Towersey
Sione Vaka
Kate Waterworth