SUPPLEMENTARY FILE 1: Consensus Meetings Materials

1. **Consensus meetings agendas**
2. **Draft Definitions Discussed at Consensus Meeting 1**
3. **Draft Recommendations (clinical and research) Discussed at Consensus Meetings 2-6**
4. **Evidence Summary for Review Prior to Consensus Meetings 2-6**

Whittaker JL, *et al. Br J Sports Med* 2022;0:1–13. doi: 10.1136/bjsports-2022-106299

1. CONSENSUS MEETINGS AGENDAS

DATES: Six, 2-hour sessions between January 31-May 2, 2022. This will allow us to submit the consensus document by July 2022

LOCATION: https://ubc.zoom.us Meeting ID: XXX XXXX XXXX, Passcode: XXXXXX

ATTENDEE LIST: Clare Ardern, Bjørnar Berg, Alessio Bricca, Andrea Bruder, Garrett Bullock, Kay Crossley, Adam Culvenor, Carolyn Emery, Allison Ezzat, Stephanie Filbay, Mick Girdwood, Mel Haberfield, Paetur Holm, Lina Holm Ingelsrud, Carsten Juhl, Karim Khan, Chris Le, Stefan Lohmander, Justin Losciale, Matilde Lundberg, Erin Macri, Britt Elin Øiestad, Brooke Patterson, Anu Raisanen, May Arna Risberg, Ewa Roos, Soren Skou, Jonas Thorlund, Clodagh Toomey, Linda Truong, Anouk Urhausen, Belle van Meer, Marienke van Middelkoop, Tom West, Jackie Whittaker, James Young,

MEETING 1: Monday January 31, 2022 at 11:00-13:00 PST (12:00-14:00 MST, 15:00-17:00 GMT, 20:00-22:00 CET, and +1 6:00-8:00 AEDT) OPTIKNEE OVERVIEW & DEFINITIONS			
Time	**Agenda Item**	**Facilitator/Presenter**	**Attachment(s)**
00-0:20	Welcome & Introductions Purpose of the OPTIKNEE Consensus and Guiding Principles Summary of Work Completed & Next Steps	*Jackie Whittaker & Steering Committee*	*1 - Proposed OPTIKNEE 2022 Schedule* *2 - Evidence Summaries*
0:20-0:30	Definitions & Overarching Concepts: Summary • *3 – Abbreviations & Definitions*	*Adam Culvenor*	*3 - Abbreviations & Definitions*
0:30-1:00	Small group (breakout rooms of ~n=6) discussion of Abbreviations & Definitions • *(see below for assignments)*	*Group Facilitators*	
1:00-1:30	Small group discussion summaries by group facilitators (*5 min each)**	*Group Facilitators*	
1:30-2:00	Full group discussion of Abbreviations & Definitions**	*Facilitator Clare Ardern*	

**Summarize agreement, dissent, and wording changes discussed during small group conversations. **Attempt to reach a general consensus/understanding of abbreviations, definitions and overarching concepts. ***Delegates will indicate their level of agreement and record any dissenting viewpoint.*

Group Number	**Group 1**	**Group 2**	**Group 3**	**Group 4**	**Group 5**
Facilitator	*Khan*	*Ardern*	*Macri*	*Lohmander*	*Emery*
Trainee Expert	*West**	*Truong**	*Patterson**	*Le**	*Losciale**
Group Members	*Filbay*	*Holm*	*Berg*	*Urhausen*	*van Middelkoop*
	Øiestad	*Risberg*	*Skou*	*Toomey*	*Bricca*
	Raisanen	*Bruder*	*Ezzat*	*Girdwood*	*vanMeer*
	Thorlund	*Young*	*Haberfield*	*Bullock*	*Lundberg*
		Ingelsrud			

**Responsible for recording breakout rooms, keeping an eye on the chat box, saving the chat box conversation, reaching out to steering committee if questions arise, keeping an eye on the clock. Group facilitator, trainee exerts and grouping varied from meeting to meeting.*

MEETING 2: 11:00 am PST, February 21, 2022 (see here for local time) - RISK FACTORS FOR KNEE PTOA			
Time	**Agenda Item**	**Facilitator/Presenter**	**Attachment(s)**
0:00-0:15	Who and What to Target, and When to Act, to Reduce the Risk of Knee PTOA: Summary and Recommendations • *4 - Clinical Recommendations C1a-c, C2a-b* • *4 - Research Recommendations R1a-c, R2a-b*	*Jackie Whittaker*	*2 - Evidence Summaries* *3 - Abbreviations & Definitions* *4 - Recommendations* *5 - Risk Factor SR*
0:15-0:45	Small group (breakout rooms of ~n=6) discussion of recommendations • *(see below for assignments)*	*Group Facilitators*	
0:45-1:15	Small group discussion summaries by group facilitators (*5 min each)**	*Group Facilitators*	
1:15-1:55	Full group discussion of Recommendations *C1a-c, C2a-b, R1c, R2a-b* **	*Facilitator Clare Ardern*	
1:55-2:00	Summary	*Adam Culvenor*	
2:00-2:15	Vote on agreement for definitions (D1-7) through an anonymous URL***	*Online Voting*	

**Summarize agreement, dissent, and wording changes discussed during small group conversations. **Attempt to reach a general consensus/understanding of abbreviations, definitions and overarching concepts. ***Delegates will indicate their level of agreement and record any dissenting viewpoint.*

MEETING 3: 12:00 pm PST, March 14, 2022 (see here for local time) - ACL TEAR REHABILITATION APPROACH & INTERVENTIONS			
Time	**Agenda Item**	**Facilitator/Presenter**	**Attachment(s)**
0:00-0:15	What to Do After an ACL Tear and When: Summary and Recommendations • *4 - Clinical Recommendations C3a-f, C4a, C5a* • *4 - Research Recommendations R2c*	*Adam Culvenor* *Paetur Holm*	*2 - Evidence Summaries* *3 - Abbreviations & Definitions* *4 - Recommendations* *6, 7 - Intervention SRs*
0:15-0:45	Small group (breakout rooms of ~n=6) discussion of recommendations • *(see below for assignments)*	*Group Facilitators*	
0:45-1:15	Small group discussion summaries by group facilitators (*5 min each)**	*Group Facilitators*	
1:15-1:55	Full group discussion of Recommendations *C3a-f, C4a, C5a, R2c*	*Facilitator Clare Ardern*	
1:55-2:00	Summary	*Jackie Whittaker*	
2:00-2:15	Vote on agreement for recommendations (*C1a-c, C2a-b & R1a-c, R2a-b*) through an anonymous URL***	*Online Voting*	

**Summarize agreement, dissent, and wording changes discussed during small group conversations. **Attempt to reach a general consensus/understanding of abbreviations, definitions and overarching concepts. ***Delegates will indicate their level of agreement and record any dissenting viewpoint*

MEETING 4: 12:00 pm PST, March 28, 2022 (see here for local time) – BURDEN OF KNEE INJURY (ACL TEAR)			
Time	**Agenda Item**	**Facilitator/Presenter**	**Attachment(s)**
0:00-0:15	What to Monitor and When: Summary and Recommendations • *4 - Clinical Recommendations C5a-c* • *4 - Research Recommendations R3a-d*	*Stephanie Filbay*	*2 - Evidence Summaries* *3 - Abbreviations & Definitions* *4 - Recommendations* *8 - Burden SR*
0:15-0:45	Small group (breakout rooms of ~n=6) discussion of recommendations • *(see below for assignments)*	*Group Facilitators*	
0:45-1:15	Small group discussion summaries by group facilitators (*5 min each)**	*Group Facilitators*	
1:15-1:55	Full group discussion of Recommendations *C5a-c, R3a-d*	*Facilitator Clare Ardern*	
1:55-2:00	Summary	*Adam Culvenor*	
2:00-2:15	Vote on agreement for recommendations (*C3a-f, C4a, C5a, R2c*) through an anonymous URL***	*Online Voting*	

**Summarize agreement, dissent, and wording changes discussed during small group conversations. **Attempt to reach a general consensus/understanding of abbreviations, definitions and overarching concepts. ***Delegates will indicate their level of agreement and record any dissenting viewpoint*

MEETING 5: 12:00 pm, April 19, 2022 (see here for local time) - PROMs			
Time	**Agenda Item**	**Facilitator/Presenter**	**Attachment(s)**
0:00-0:15	PROM Selection and Interpretation: Summary and Recommendations • *4 - Clinical Recommendations C6a, C7a-e* • *4 - Recommendations Research R4a-c*	*Erin Macri*	*2 - Evidence Summaries* *3 - Abbreviations & Definitions* *4 - Recommendations* *9 - PROMs SR*
0:15-0:45	Small group (breakout rooms of ~n=6) discussion of recommendations • *(see below for assignments)*	*Group Facilitators*	
0:45-1:15	Small group discussion summaries by group facilitators (*5 min each)**	*Group Facilitators*	
1:15-1:55	Full group discussion of Recommendations *C6a, C7a-e, R4a-c*	*Facilitator Clare Ardern*	
1:55-2:00	Summary	*Adam Culvenor*	
2:00-2:15	Vote on agreement for recommendations (*C5a-c, R3a-d*) through an anonymous URL***	*Online Voting*	

**Summarize agreement, dissent, and wording changes discussed during small group conversations. **Attempt to reach a general consensus/understanding of abbreviations, definitions and overarching concepts. ***Delegates will indicate their level of agreement and record any dissenting viewpoint*

MEETING 6: 4:00 am PST, May 2, 2022 (see here for local time) – MUSCLE STRENGTH & FUNCITONAL PERFORMANCE			
Time	**Agenda Item**	**Facilitator/Presenter**	**Attachment(s)**
0:00-0:15	Muscle Function & Functional Performance: Summary & Recommendations • *4 - Clinical Recommendations C6c-g, C7a,b,d* • *5 - Research Recommendations R5a-c, R6a-d*	*Anouk Urhausen* *Bjørnar Berg*	*2 - Evidence Summaries* *3 - Abbreviations & Definitions* *4 - Recommendations* *10,11 - Muscle Strength and Functional Performance evidence summaries and SRs*
0:15-0:45	Small group (breakout rooms of ~n=6) discussion of recommendations • *(see below for assignments)*	*Group Facilitators*	
0:45-1:15	Small group discussion summaries by group facilitators (*5 min each)**	*Group Facilitators*	
1:15-1:55	Full group discussion of Recommendations *C6c-g, C7a,b,d, R5a-c, R6a-d*	*Facilitator Clare Ardern*	
1:55-2:00	Summary	*Jackie Whittaker*	
2:00-2:15	Vote on agreement for recommendations (*C5a-c, R3a-d*) through an online anonymous link***	*Online Voting*	

**Summarize agreement, dissent, and wording changes discussed during small group conversations. **Attempt to reach a general consensus/understanding of abbreviations, definitions and overarching concepts. ***Delegates will indicate their level of agreement and record any dissenting viewpoint*

2. Draft Definitions for Consensus Meeting 1

Word	Definition
D1. Rehabilitation[1]	A set of interventions designed to optimize functioning and reduce disability in individuals with health conditions in interaction with their environment. *WHO https://www.who.int/news-room/fact-sheets/detail/rehabilitation*
D2. Prevention[1]	Activities that aim to reduce risk factors for disease or illness. These activities can focus on preventing risk factors (*primary prevention*), preventing progression to disease or illness once a risk factor(s) exists (*secondary prevention*), and/or improving function and reducing disability in persons diagnosed with a disease or illness (*tertiary prevention*). Oleckno WA. Epidemiology: Concepts and Methods: Waveland Press Inc. 2008
D3. Structural Osteoarthritis[2]	OA defined by the presence of structural features on radiograph, MRI or ultrasound, which reach an 'expert consensus threshold' of magnitude and character to be termed OA.
D4. Symptomatic Osteoarthritis[2]	OA defined by consensus-based clinical signs (e.g., age ≥45, crepitus, restricted range of motion, bony enlargement) and symptoms (e.g., activity related joint pain, either no morning knee stiffness or stiffness ≤30 minutes) that are associated with functional or quality-of-life decrements with or without the presence of structural features on radiography, MRI, or ultrasound. Zhang et al 2010, Peat t al 2006, https://www.nice.org.uk/guidance
D5. Injury[3]	Disruption to the body induced by a singular or repetitive event (e.g., joint trauma).
D6. Post-traumatic Osteoarthritis[3]	OA that develops after joint trauma (i.e., disruption of a joint induced by a singular or repetitive event), and is associated with altered biology or pathophysiology (e.g., structural features), symptoms (e.g., pain) and functional or quality-of-life decrements.
D7. Pre-PTOA[3]	Pre-PTOA is a state of heightened OA risk after joint trauma, but where the definitions for structural or symptomatic PTOA are not fulfilled. Pre-PTOA may include evidence of cartilage or meniscal defects on magnetic resonance imaging and/or early symptoms such as joint-related pain leading to functional modifications.
D8. Early-onset PTOA[4]	OA that develops following joint trauma in youth and young adults (e.g., ≤45 years of age) and is associated with pathology, symptoms and functional or quality-of-life decrements.
D9. Gender	Socially constructed roles, behaviours, expressions and identities of girls, women, boys, men, and gender diverse people. It influences how people perceive themselves and each other, how they act and interact, and the distribution of power and resources in society. *https://cihr-irsc.gc.ca/e/48642.html*
D10. Sex	A set of biological attributes in humans and animals. It is primarily associated with physical and physiological features including chromosomes, gene expression, hormone levels and function, and reproductive/sexual anatomy. Sex is usually categorized as female or male but there is variation in the biological attributes that comprise sex and how those attributes are expressed. *https://cihr-irsc.gc.ca/e/48642.html*
D11. Disease	The underlying biology and pathophysiology of a health condition.
D12. Illness	A person's experience of a health condition.
D13. Function (physical)	Body functions, activities and involvement in life situations that require moving around and performing activities. *https://www.who.int/standards/classifications/international-classification-of-functioning-disability-and-health*
D14. Functional (physical) Performance	The action of carrying out or accomplishing a movement, movement task or movement activity.
D15. Functional (physical) Impairment	*A* decrement in physical functioning at the body level. *https://www.who.int/standards/classifications/international-classification-of-functioning-disability-and-health*
D16. Activity Limitation (physical)	A decrement in physical functioning at a person level. *https://www.who.int/standards/classifications/international-classification-of-functioning-disability-and-health*

D17. Participation Restriction (physical)	A decrement in physical functioning at a societal level. *https://www.who.int/standards/classifications/international-classification-of-functioning-disability-and-health*
D18. Credibility	The quality of being trusted, convincing or believable.
D19. Health Burden	The impact of a health problem as measured by financial (years of life lived with disability, disability adjusted life years), mortality, morbidity (e.g., pain, functional or HRQOL decrements), or other indicators.
D.20 Health-related Quality of Life (HRQOL)	A person's perception of their 'health' well-being. HRQOL is a multifactorial construct that consists of the physical, psychological, and social aspects of health and is influenced by an individual's perceptions, experiences, expectations, and beliefs. Solan et al 2008
D.21Muscle Function	An overarching term that refers to the capacity of a muscle to do work. It includes; strength (force), torque, power, endurance and rate of force development.
D.22 Muscle Strength	The ability of a muscle to produce tension and a resulting force • Isometric: a change in muscle tension with no change in muscle length • Isotonic: a change in muscle length with a given muscle tension • Isokinetic: a change in muscle length and tension with a set contraction speed • Slow speed: 60, 90 and 120 deg/s • High speed: 180 and 300 deg/s Biodex Medical System. System 4 Clinical Resources Manual. Isokinetic Testing and Data Interpretation
D.23 Muscle Power	The ability of a muscle to produce a force quickly (force x velocity (distance/time)) = rate of work).
D.24 Muscle Endurance	The ability of a muscle to contract repeatedly against a load, generate and sustain tension and resist fatigue over a period of time.
D.25 Neuromuscular Control Exercises	Activities that aim to enhance the optimal unconscious neurological and motor responses required for joint, limb and whole-body control of efficient postures and movement (e.g., balance, proprioceptive, readiness of response).
D.26 Plyometrics	Activities that involve a rapid resisted eccentric muscle contraction immediately followed by a rapid resisted concentric contraction (reversal of movement) of the same muscle aimed at improving muscle power.

Definitions 1-8 were discussed at the first consensus meeting, the remaining definitions (9-26) were provided for reference only.

3. Draft Recommendations Discussed at Consensus Meetings 2-6

Clinical Recommendations for Discussion

Abbreviations: ACL (anterior cruciate ligament), ACLR (ACL reconstruction), GRADE (Grading of Recommendations Assessment, Development and Evaluation approach), GROC (global rating of change), PASS (patient acceptable symptom state), PTOA (post-traumatic osteoarthritis)

Topic	Clinical Recommendation	Evidence Level
Who to Target?	C1a. Persons with single (i.e., cruciate ligament, collateral ligament, meniscus, chondral, fracture or dislocation) AND multi-structure (i.e., ACL with concomitant injuries, and patellar dislocation with chondral injuries) knee injuries are at elevated risk of symptomatic knee PTOA.	Moderate (GRADE)[1]
	C1b. Persons with ACL tears, meniscal tears, intra-articular tibiofemoral fractures, patellar dislocations with chondral lesions, or ACLR with partial or total meniscectomy have the most elevated risk of symptomatic knee PTOA.	Moderate (GRADE)[1]
	C1c. Persons with elevated risk of symptomatic knee PTOA experiencing knee-related symptoms and/or functional impairments should be priority targets to prevent osteoarthritis.	Expert opinion

Topic	Clinical Recommendation	Evidence Level
What to Target to Prevent Knee PTOA and When	C2a. Efforts to prevent ***symptomatic knee PTOA*** should promote knee health through:	Expert opinion[2]
	i. Informational support *(e.g., medium and long-term impact of knee injuries on physical, mental and social health, explain PTOA and the elevated risk, self-monitoring function, benefits of exercise, adjusting exercise prescription, debunk myths related to early ACLR, brace use and avoiding weight-bearing, when to seek healthcare support)*	
	ii. Facilitating self-management [a]	
	iii. Mitigating established modifiable risk factors for non-traumatic OA *(i.e., physical activity and exercise-therapy strategies to minimize unhealthy adiposity, leg muscle impairments and sedentary non-weight-bearing behaviours)*	
	iv. Person-centred goals [a]	
	C2b. Efforts to prevent ***symptomatic knee PTOA***:	Expert opinion[2]
	i. commence at the time of knee injury (as possible)	
	ii. continue across the lifespan	

Topic	Clinical Recommendation	Evidence Level
What to Do – Approach (ACL Tear)	C3a. After an ACL tear (barring any complications):	
	i. all persons should be offered and participate in goal-based exercise-therapy rehabilitation until they: a. reach and sustain what they report is an acceptable functional level or, b. cannot achieve an acceptable functional level without activity-related knee instability (i.e., giving way) despite sufficient muscle function	Low[3 4] (GRADE) Expert opinion
	ii. a person's decision to undergo ACLR, should be informed by an orthopaedic surgeon, rehabilitation professional, and other relevant stakeholders (e.g., family, coach) as appropriate.	Expert opinion
	C3b. ACLR rehabilitation should:	
	i. be goal or criterion-based	Expert opinion[5]
	ii. feature shared decision-making	Expert opinion[6]
	iii. begin with structured in-person rehabilitation and progress to structured home (gym)-based rehabilitation	Moderate (GRADE)[3]
What to Do - Core Rehabilitation Treatment (ACLR)	C3c. ACLR rehabilitation should progress through:	
	i. weight-bearing (WB) and range of motion (ROM) exercises	Expert opinion[5]
	ii. open and closed kinetic chain resistance exercises targeting the quadriceps and hamstring muscles	Moderate (GRADE)[3]
	iii. lower limb neuromuscular control exercises	Very low (GRADE)[3]
	iv. lower limb plyometrics	Very low (GRADE)[4]
What to Do - Adjunct Rehabilitation Treatment ACLR	C3d. ACLR rehabilitation can include the following adjunct treatments to improve quadriceps strength:	
	i. neuromuscular electrical stimulation	Moderate (GRADE)[3]
	ii. blood-flow restriction training	Very low (GRADE)[3]
	iii. whole-body vibration	Very low (GRADE)[3]
	C3e. ACLR rehabilitation should not include the following adjunct treatments as there is evidence that they are not beneficial:	
	i. continuous passive motion	Very low (GRADE)[3]
	ii. knee bracing	Moderate (GRADE)[3]
	C3f. Psychological interventions (i.e., guided imagery, relaxation, coping modelling and visual imagery) can improve anxiety and fear after ACLR.	Low (GRADE)[3]
When – Rehabilitation Treatment (ACLR)	C4a. After ACLR	
	i. Weight bearing and range of motion exercises should start immediately	Expert opinion[5]
	ii. open and closed kinetic chain exercises targeting the quadriceps and hamstring muscles should start within the first month	Moderate (GRADE)[3]
	iii. if used, adjunct rehabilitation treatments (e.g., neuromuscular electrical stimulation, blood-flow restriction, plyometrics) to improve quadriceps strength should start within the first 2 months	Very Low (GRADE)[3]

Topic	Clinical Recommendation	Evidence Level
What to Monitor	C5a. Core domains to monitor after knee injury include:	Systematic review & Expert consensus[7 8]
	i. pain	
	ii. physical function (including self-reported function, functional performance and/or muscle function)	
	iii. knee-related quality of life	
	iv. health-related quality of life including physical and mental aspects	
	v. return to sport readiness	
	C5b. Additional domains that may be important for clinicians to monitor after knee injury include:	Expert consensus[7] Expert opinion[6 9]
	i. participation in meaningful physical activities and sport	
	ii. participation in occupation	
	iii. psychological considerations (e.g., fear, frustration, depression)	
	iv. sleep (e.g., quantity and quality as appropriate)	
	v. fatigue	
	vi. social /community participation	
	C5c. After knee injury, diagnostic imaging is only used if it will inform treatment planning	Expert consensus[10]

Topic	Clinical Recommendation	Evidence Level
How to Monitor - PROMs	C6a. Recommended PROMs for use after knee injury include (in alphabetical order):	Systematic review[8 11]
	i. to assess PAIN: • Numerical Rating Scale (NRS) • Visual Analogue Scale (VAS) • Knee injury and Osteoarthritis Outcome Score Pain subscale ($KOOS_{pain}$)	NRS (Expert opinion) VAS (Expert opinion) $KOOS_{pain}$ (COSMIN 2/8 positive scores)[8]
	ii. to assess PHYSICAL FUNCTION: • Knee injury and Osteoarthritis Outcome Score Function in Sport and Recreation subscale ($KOOS_{SR}$) • International Knee Documentation Committee Subjective Form (IKDC-SF)	ACL Tear $KOOS_{SR}$ (COSMIN 2/8 positive scores)[8] IKDC-SF (COSMIN 3/8 positive scores)[8] Meniscus Tear IKDC-SF (COSMIN 2/8 positive scores)[12]
	iii. to assess knee-related QUALITY OF LIFE: • Knee injury and Osteoarthritis Outcome Score QOL subscale ($KOOS_{QOL}$: single and multi-structure injuries) • ACL Quality of Life Score (ACL QOL; ACL Tear only) • Western Ontario Meniscal Evaluation Tool (WOMET; Meniscus tear only)	$KOOS_{QOL}$ (COSMIN 2/8 positive scores)[8] ACL QOL (COSMIN 3/8 positive scores)[8] WOMET (COSMIN 4/8 positive scores)[12]
	iv. to assess health-related QUALITY OF LIFE after knee injury: • Short-form 36 (SF-36)	Expert Opinion[9]
	v. to assess knee-related COGNITIVE BEHAVIOURAL FACTORS*: • ACL Return to Sport Index (ACL RSI; ACL Tear only) • Knee Self-Efficacy Scale (K-SES) • Tampa Scale of Kinesiophobia 11 or 17 (TSK-11 or TSK-17)	ACL-RSI (COSMIN 6/8 positive scores)[8] K-SES (Expert opinion) TSK-17, TSK-11 (Expert opinion)

Topic	Clinical Recommendation	Evidence Level
How to Monitor - Muscle Function	C6b. Recommended measures of muscle function after knee injury are peak knee extensor and flexor strength tests.	Expert Opinion[13 14]
	C6c. Measure peak knee extensor and flexor strength in clinical settings with the following tests (listed most to least rigorous); i. Concentric isokinetic computerised dynamometry (>60°/s) ii. Isometric Hand-Held Dynamometry* (HHD, same assessor) estimate one repetition maximum (1RM) iii. Concentric isotonic 1RM with weight machine (knee extension or prone leg curl) **As HHD can underestimate strength, it is important to secure the femur, have the patient push into resistance generated by a fixed belt, and for re-assessment to be conducted by the same assessor. 1RM should be based on the average of at least two measures of maximum effort. Isometric scores are not interchangeable with isokinetic or isotonic scores.*	Extensor (isokinetic ≥60°/s) GRADE[13] + Very low (Intra-rater reliability) + Moderate (Construct validity) Flexor (isokinetic 60-120°/s) GRADE[13] + Very low (Intra-rater reliability) - Moderate (Construct validity Extensor/Flexor (isotonic) GRADE[13] + High (Criterion validity) Extensor (isometric) GRADE[13] + Moderate (Intra-rater reliability) - Very low (Inter-rater reliability) Extensor/Flexor (isotonic) GRADE[13] + High (Criterion validity)
How to Monitor - Functional Performance	C6d. Recommended measures of functional performance after a knee injury are hop performance tests.	Expert opinion
	C6e. After knee injury, assess hop performance with:	
	i. a battery of hop tests	
	ii. the hop battery should include tests that assess forward (single and repeated), lateral and vertical hopping	
	C6f. Recommended hop tests for use after knee injury include (in alphabetical order): • Crossover Hop Test (CH) • Single Leg Hop Test (SLH) • Triple Hop Test (TH) • 6-meter Timed Hop Test (6mTH) • Vertical hop (VH)	CH GRADE[15] + Moderate (Intra-rater reliability) + Low (Construct validity) + Low (Responsiveness) SLH GRADE[15] + High (Intra-rater reliability) + Low (Construct validity) + Low (Responsiveness) TH GRADE[15] + Very low (Intra-rater reliability) + Moderate (Construct validity) - Low (Responsiveness) VH GRADE[15] + Moderate (Intra-rater reliability) + Moderate (Construct validity) 6mTH GRADE[15] + Moderate (Intra-rater reliability) + Low (Construct validity) + Low (Responsiveness)

+ (sufficient measurement property), - (insufficient measurement property) as per the COSMIN

Topic	Clinical Recommendation	Evidence Level
Interpreting Outcome Domain Change and Status	C7a. To interpret a change in an outcome domain, persons who have had a knee injury should be asked if they have noticed a meaningful change in the domain. *For example: 'Have you noticed a meaningful change in your insert domain (e.g., knee pain) over the last insert time period?'*	GROC concept[16] PASS concept[17] Expert opinion
	C7b. To assess the acceptability of the current state of an outcome domain, persons who have had a knee injury should be asked if they feel their current state is satisfactory. *For example: 'Taking into consideration all you do in a typical day, is the current state of your insert domain (e.g., knee pain) satisfactory'?*	
	C7c. Clinicians should review individual PROM items responses of persons who have had a knee injury to identify what factors might be important to their experience of an outcome domain. *For example: Is a person's knee pain primarily due to twisting, and/or fully straightening the knee bending the knee, walking on a flat surface, navigating stairs, sleeping, sitting, lying, standing.'*	
	C7d. Clinicians should ask persons who have had a knee injury about individual PROM item responses to better understand their experience of an outcome domain. *For example (KOOS Q3): 'You indicate you are severely troubled by a lack of knee confidence, can you tell me a bit more about that? What activities or situations do you feel confident and lack confidence?'*	
	C7e. To report/record on an outcome domain (health record or report) for a person who has had a knee injury, the following information should be recorded:	
	i. The baseline and change (either increase or decrease) in the outcome *For example: insert name started at xx and had an 8-point increase in their Knee injury and Osteoarthritis Outcome Score Pain subscale over insert time period*	
	ii. If the person felt the change in the outcome was meaningful *For example: insert name felt that the increase was meaningful*	
	iii. If the person feels that their current state of an outcome is satisfactory/acceptable *For example: insert name reports that after taking into account all they have to do in a typical day, the current state of their insert domain is not acceptable.*	

Research Recommendations for Discussion

Topic	Research Recommendation
Overarching Research Considerations for knee PTOA	R1a. Research about PTOA should prioritize ***symptomatic*** definitions of OA (structural + symptoms or functional impairment) over ***structural*** definitions.
	R1b. Consensus on how to operationalize, measure (including timepoints) and handle definitions of ***symptomatic and structural knee PTOA*** are needed to facilitate meta-analysis.
	R1c. Research investigating the influence of sex, gender, race, and other social determinants of health on the development of PTOA is needed to understand and address disparity in outcomes across populations.
Study Design – Risk Factors for Knee OA after Injury	R2a. Research investigating risk factors for ***symptomatic knee PTOA*** should consider both ACL tear and non-ACL tear related injuries.
	R2b. Structural knee OA data should be reported by joint compartment (i.e., medial tibiofemoral, lateral tibiofemoral and patellofemoral) and overall knee joint.
Study Design – Interventions after Knee Injury	R2c. Research studies including follow-up beyond 5 years would assist in better understanding if interventions can reduce the risk of ***symptomatic*** and ***structural OA*** after knee injury.

Topic	Research Recommendation	Evidence Level
Study Design - Outcome Domains	R3a. Intervention and observational studies of persons at risk of ***symptomatic knee PTOA*** should consider assessing the following core outcome domains:	Systematic review & Expert consensus[7 8]
	i. pain	
	ii. physical function including self-reported function, functional performance and muscle function	
	iii. knee-related quality of life	
	iv. health-related quality of life including physical and mental aspects	
	v. general overall self-assessment	
	vi. adverse events	
	R3b. Depending on the research question, it may also be important to assess:	Expert consensus[7] Expert opinion[6 9 10]
	i. re-injury and subsequent injury	
	ii. return to and participation in meaningful activities*	
	iii. return to and participation in one's occupation	
	iv. psychological considerations (e.g., fear, frustration, depression)	
	v. sleep	
	vi. fatigue	
	vii. joint structure (e.g., imaging)	
	viii. molecular molecules (e.g., inflammatory biomarkers)	
	ix. comorbidities	
	x. social /community participation	
	xi. economic	
Study Design – Follow-up	R3d. Consider monitoring individuals at elevated risk of ***symptomatic knee PTOA*** across the entire timespan from injury to any OA diagnosis.	Systematic review & Expert opinion[2 8]

Topic	Research Recommendation	Evidence Level
Study Design - PROMs	R4a. In the knee PTOA field, meaningful PROM thresholds:	Expert opinion[11]
	i. Should be used to evaluate individual pre- to post-treatment change in score	
	ii. Should not be used as a primary outcome or to calculate sample sizes to assess group level differences	
PROM Selection	R4b. Recommended PROMs for use after knee injury include:	Systematic review[8 11] / Expert opinion
	i. to assess PAIN: • Numerical Rating Scale (NRS) • Visual Analogue Scale (VAS) • Knee injury and Osteoarthritis Outcome Score Pain subscale ($KOOS_{pain}$)	NRS (Expert opinion) VAS (Expert opinion) $KOOS_{pain}$ (COSMIN 2/8 positive scores) [8]
	ii. to assess PHYSICAL FUNCTION: • Knee injury and Osteoarthritis Outcome Score Function in Sport and Recreation subscale ($KOOS_{SR}$) • International Knee Documentation Committee Subjective Form (IKDC-SF)	ACL Tear $KOOS_{SF}$ (COSMIN 2/8 positive scores)[8] IKDC-SF (COSMIN 3/8 positive scores)[8] Meniscus Tear IKDC-SF (COSMIN 2/8 positive scores)[12]
	iii. to assess knee-related QUALITY OF LIFE: • Knee injury and Osteoarthritis Outcome Score QOL subscale ($KOOS_{QOL}$) • Anterior Cruciate Ligament Quality of Life Score (ACL QOL; ACL Tear only) • Western Ontario Meniscal Evaluation Tool (WOMET; Meniscus tear only)	$KOOS_{QOL}$ (COSMIN 2/8 positive scores)[8] ACL QOL (COSMIN 3/8 positive scores)[8] WOMET (COSMIN 4/8 positive scores)[12]
	iv. to assess health-related QUALITY OF LIFE: • SF-12 (physical and mental components) • SF-36 (bodily pain) • EQ-5D Index	Expert opinion[9]
	v. to assess knee-related COGNITIVE BEHAVIOURAL factors • ACL RSI • K-SES • TSK-17/TSK-11	ACL-RSI (COSMIN 6/8 positive scores)[8] K-SES (Expert opinion) TSK-17, TSK-11 (Expert opinion)
	vi. to assess PATIENT GLOBAL ASSESSMENT: • Patient Acceptable Symptom State (PASS) • Treatment Failure (TF) • Global Rate of Change Score (GROC)	PASS,[17] TF,[18] GROC[16] (Expert opinion)[11]

Topic	Research Recommendation	Evidence Level
PROM Interpretation	R4c. Researchers can be somewhat confident that the following group level PROM score changes are meaningful after a knee injury:	Expert opinion[11]
	i. PAIN PROM scores: • NRS and VAS: change of 1.5/10 • $KOOS_{Pain}$: change of 12/100	NRS[19] VAS[19] $KOOS_{Pain}$ (Low credibility)[11]
	i. SYMPTOMS PROM scores: • $KOOS_{symp}$: change of 6/100 (ACL tear), 12/100 (meniscus surgery)	$KOOS_{Symp}$ (Low credibility)
	ii. PHYSICAL FUNCTION PROM scores: • $KOOS_{SR}$: change of 22/100 (ACL tear), 17/100 (meniscus tear) • IKDC-SF: change of 16/100 (ACL tear), 11/100 (meniscus tear)	ACL Tear $KOOS_{SR}$ (Low credibility)[11 16] IKDC-SF (Low credibility)[11 20] Meniscus Tear IKDC-SF (Very Low/Low credibility)[11 21]
	iii. Knee-related QUALITY OF LIFE PROM scores: • $KOOS_{QOL}$: change of 18/100 • ACL QOL: change of 9/100 • WOMET: change of 15/100	$KOOS_{QOL}$ (High Credibility)[11 16] ACL QOL (Very Low credibility)[22] WOMET (Very Low credibility[12 23]
	iv. Health-related QUALITY OF LIFE PROM scores: • SF-36 bodily pain: change of 8/100 • Sf-12: change of 5.1/100 (PCS), 4.3/100 (MCS) • EQ-5D Index: change of 0.32	Expert Opinion
	v. Knee-related COGNITIVE BEHAVIOURAL factor scores: • ACL RSI: change of 3/100 • K-SES: change of 15/100 • TSK-11: change of 5 (ACL tear) • TSK-17: change of 1 (ACL tear), 8 (meniscus tear)	ACL Tear ACL RSI (Low credibility)[11 24] K-SES (Expert opinion) TSK-17 (ACL – Low credibility)[11 25] TSK-11 (Expert opinion) Meniscus Tear TSK-17 (meniscus - Expert Opinion)
	vi. Patient Global Assessment (PASS): • $KOOS_{Pain}$: change of 93/100 (ACLR), 81/100 (meniscal surgery) • $KOOS_{SR}$: change of 88/100 (ACLR,) 80/100 (meniscal surgery) • $KOOS_{QOL}$: change of 78/100 (ACLR), 57/100 (meniscal surgery) • IKDC-SF: change of 85/100 (ACLR), 69/100 (meniscal surgery)	ACLR KOOS[11 26] IKDC-SF, ACLR[11 26] Meniscus Surgery KOOS[11 21 27] IKDC-SF[11 21]

Topic	Research Recommendation	Evidence Level
How to Monitor – Muscle Function	R5a. The best available measure of muscle function after knee injury are peak knee extensor and flexor strength tests.	Expert opinion[13 14]
	R5b. In order of most to least rigorous, the following tests should be used to measure peak knee extensor and flexor strength in clinical settings; i. Concentric isokinetic computerised dynamometry (>60°/s) ii. Isometric Hand-Held Dynamometry* (HHD, same assessor) one repetition maximum (1RM) iii. Concentric isotonic 1RM with weight machine (knee extension or prone leg curl) **HHD assessment of isometric knee extensor and flexor strength can underestimate strength and overestimate limb symmetry index (LSI). Isometric scores are not interchangeable with isokinetic or isotonic scores.*	Extensor (isokinetic ≥60°/s) GRADE[13] + Very low (Intra-rater reliability) + Moderate (Construct validity) Flexor (isokinetic 60-120°/s) GRADE[13] + Very low (Intra-rater reliability) - Moderate (Construct validity Extensor/Flexor (isotonic) GRADE[13] + High (Criterion validity) Extensor (isometric) GRADE[13] + Moderate (Intra-rater reliability) - Very low (Inter-rater reliability) Extensor/Flexor (isotonic) GRADE[13] + High (Criterion validity)
How to Interpret – Muscle Strength	R5c. The following change or variation* in muscle strength scores can GUIDE interpretation of a meaningful change after knee injury. • Peak concentric knee extensor strength (60°/s): variation of 23% • Peak concentric knee extensor strength (180°/s): variation of 8% • Peak concentric knee extensor normalised (body weight) strength: change of 1.7% • Peak concentric knee extensor strength LSI: change of 10.5% • Peak concentric knee flexor strength (60°/s and 180°/s): variation of 9%	GRADE[13] Very low

+ (sufficient measurement property), - (insufficient measurement property) as per the COSMIN

Topic	Research Recommendation	Evidence Level
How to Monitor - Functional Performance	R6a. The best available measure of functional performance after a knee injury is hop performance.	Expert Opinion
	R6b. After knee injury, hop performance should be assessed with:	
	i. a battery of hop tests	
	ii. the hop battery should include tests that assess forward (single and repeated), lateral and vertical hopping	
	R6c. Recommended hop tests for use after knee injury include (in alphabetical order): • Crossover Hop Test (CH) • Single Leg Hop Test (SLH) • Triple Hop Test (TH) • Vertical hop (VH) • 6-meter Timed Hop Test (6mTH)	CH GRADE[15] + Moderate (Intra-rater reliability) + Low (Construct validity) + Low (Responsiveness) SLH GRADE[15] + High (Intra-rater reliability) + Low (Construct validity) + Low (Responsiveness) TH GRADE[15] + Very low (Intra-rater reliability) + Moderate (Construct validity) - Low (Responsiveness) VH GRADE[15] + Moderate (Intra-rater reliability) + Moderate (Construct validity) 6mTH GRADE[15] + Moderate (Intra-rater reliability) + Low (Construct validity) + Low (Responsiveness)
How to interpret Functional Performance	R6d. The following change in hop performance can GUIDE interpretation of a meaningful change after knee injury. • Single Leg Hop Test: change of 6.7%-9.7% (LSI) • Crossover Hop Test: change of 14.6% (LSI) • 6-meter Timed Hop Test: change of 15.5% (LSI) • Triple Hop Test: change of 12.0% (LSI) • Vertical Hop: change of 10% (LSI) *Limb symmetry index (LSI) is influenced by changes performance of both the injured and contralateral leg.*	SLH, CH, 6mTH, TH GRADE Very low[15] VH Expert opinion

+ (sufficient measurement property), - (insufficient measurement property) as per the COSMIN

4. Evidence Summary for Review Prior to Consensus Meetings 2-6

Meeting 2: Risk factors for knee osteoarthritis after knee trauma: a systematic review and meta-analysis of randomised controlled trials and cohort studies for the OPTIKNEE consensus

Objective: Identify risk factors for osteoarthritis following knee trauma.

Design: Systematic review and meta-analyses that estimated the odds of osteoarthritis for risk factors assessed in four or more studies using random-effects models. Remaining risk factors underwent semi-quantitative synthesis. The modified GRADE approach for prognostic factors guided assessment.

Data Sources: MEDLINE, EMBASE, CENTRAL, SPORTDiscus, CINAHL searched from inception to 09-2021.

Eligibility: Randomized Controlled Trials (RCT) and cohort studies assessing risk factors for symptomatic or structural osteoarthritis in persons with knee trauma, mean injury age ≤30 years, and minimum 2-year follow-up.

Results: Across 66 included studies, 81 unique potential risk factors were identified. High risk-of-bias due to attrition or confounding was present in 64% and 49% of studies, respectively. Semi-quantitative syntheses identified moderate-certainty evidence that cruciate ligament, collateral ligament, meniscal, chondral, dislocation, fracture, and multi-structure injuries increase symptomatic osteoarthritis odds. Ten risk factors for structural osteoarthritis underwent meta-analysis (sex, rehabilitation for ACL tear, ACL reconstruction (ACLR), ACLR age, ACLR body mass index, ACLR graft source, ACLR graft augmentation, ACLR+cartilage injury, ACLR+partial meniscectomy, ACLR+total medial meniscectomy). Very-low certainty evidence suggests increased odds of structural osteoarthritis related to ACLR+cartilage injury (OR=2.31; 95%CI 1.35,3.94), ACLR+partial meniscectomy (OR=1.87; 1.45,2.42), and ACLR+total medial meniscectomy (OR=3.14; 2.20,4.48).

Conclusion: Moderate-certainty evidence suggests that various injury types (not just ACL tears) increase symptomatic osteoarthritis odds after knee trauma. Risk factor heterogeneity, limited RCT evidence and inconsistency in risk factors and osteoarthritis definition makes identifying treatment targets for preventing post-traumatic knee osteoarthritis challenging.

What is already known?

- Medial meniscal injury and/or meniscectomy associated with an Anterior Cruciate Ligament (ACL) tear, and isolated meniscal injuries are associated with an increased risk of structural knee osteoarthritis.
- Beyond meniscal injury or meniscectomy, little is known about risk factors for symptomatic or structural knee osteoarthritis after an ACL tear and non-ACL tear related knee trauma.
- Currently, it is unclear if there are modifiable risk factors after knee trauma that can be targeted to prevent symptomatic or structural osteoarthritis.

What are the new findings?

- Non-modifiable risk factors: There is moderate-certainty evidence that various single (cruciate ligament, collateral ligament, meniscus, chondral, fracture or dislocation) AND multi-structure knee injuries (ACL with meniscal injuries, and patellar dislocation with chondral injuries) increase the odds of symptomatic knee osteoarthritis.
- Modifiable risk factors: Significant heterogeneity in potential risk factors assessed, low-certainty of evidence and inconsistency in how risk factors and osteoarthritis are operationalized, measured, and analysed, makes it challenging to identify modifiable risk factors, or treatment targets for preventing symptomatic or structural knee osteoarthritis after knee trauma.
- In the absence of high-certainty evidence of modifiable risk factors for osteoarthritis after knee trauma, the logical attempts to prevent post-traumatic osteoarthritis should include evidence-based injury prevention programs, and addressing modifiable risk factors for non-traumatic osteoarthritis after a wide range of knee injuries (not just ACL tears). This includes physical activity and exercise-therapy strategies to minimize unhealthy adiposity and quadriceps weakness.

Meeting 3: Rehabilitation after anterior cruciate ligament and meniscal injuries: a best-evidence synthesis of systematic reviews for the OPTIKNEE consensus

Objective: Summarise evidence for effectiveness of rehabilitation interventions following anterior cruciate ligament (ACL) and/or meniscal tear.

Design: Overview of systematic reviews with GRADE certainty-of-evidence.

Data sources: MEDLINE, EMBASE, CINAHL, SPORTDiscus, Cochrane Library.

Eligibility criteria: Systematic reviews of randomised controlled trials investigating rehabilitation interventions following ACL and/or meniscal tears in young adults.

Results: We included 22 systematic reviews (142 trials of mostly males) evaluating ACL injured individuals and none evaluating isolated meniscal injuries. We synthesised data from 16 reviews evaluating 12 different interventions. Moderate-certainty evidence was observed for: i) neuromuscular electrical stimulation to improve quadriceps strength; ii) open- vs closed-kinetic-chain exercises to be similarly effective for quadriceps strength and self-reported function; iii) structured home-based vs structured in-person rehabilitation to be similarly effective for quadriceps and hamstring strength and self-reported function; and iv) postoperative knee bracing being ineffective for physical function and laxity. There was low-certainty evidence that: i) preoperative exercise-therapy improves self-reported and physical function postoperatively; ii) cryotherapy reduces pain and analgesic use; iii) psychological interventions improve anxiety/fear; and iv) whole-body vibration improves quadriceps strength. There was very low-certainty evidence that: i) protein-based supplements improve quadriceps size; ii) blood-flow restriction training improves quadriceps size; iii) neuromuscular control exercises improve quadriceps and hamstring strength and self-reported function; and iv) continuous passive motion has no effect on ROM.

Conclusion: The general level of evidence for rehabilitation after ACL or meniscal tear was low. Moderate-certainty evidence indicates that several rehabilitation types can improve quadriceps strength, while brace use has no effect on knee function/laxity.

What is already known?

- Anterior cruciate ligament and meniscal injuries are often associated with a poor outcome – many fail to return to pre-injury level of sport and there is a high risk of re-injury, persistent symptoms and impaired quality of life.
- There is little consensus regarding the optimal components of ACL and meniscal rehabilitation to achieve successful outcomes, leading to substantial heterogeneity in rehabilitation protocols.

What are the new findings?

- Despite 22 systematic reviews including 142 unique RCTs, there is mainly low level of evidence for the effectiveness of ACL rehabilitation interventions to improve symptomatic and functional outcomes.
- The highest level of evidence for ACL rehabilitation in this review (moderate certainty) was observed for: i) neuromuscular electrical stimulation to improve quadriceps strength; ii) open vs closed kinetic chain exercises to be similarly effective for improving quadriceps strength and self-reported function; iii) structured home-based rehabilitation to be similarly effective to structured in-person rehabilitation for improving quadriceps and hamstring strength and self-reported function; and iv) postoperative knee bracing being ineffective for physical function and knee laxity.
- There is an urgent need for high-quality randomised clinical trials with sufficient sample size to improve the overall certainty of evidence.
- There was no evidence identified in this systematic review to inform the rehabilitation of isolated traumatic meniscal injuries in young adults.

Meeting 3: The effects of different management strategies and rehabilitation approaches on knee joint structural and molecular biomarkers following knee injury: a systematic review of randomized controlled trials for the OPTIKNEE consensus

Objectives: To summarize the effectiveness of management strategies and rehabilitation approaches for outcomes related to knee joint structural and molecular biomarkers following ACL and/or meniscal tear.

Design: Systematic review

Data sources: MEDLINE, EMBASE, CINAHL, CENTRAL, and SportDiscus all up to November 3, 2021.

Eligibility criteria: Randomized controlled trials (RCT) investigating the effectiveness of management strategies or rehabilitation approaches for structural and molecular biomarkers of knee joint health following ACL and/or meniscal tear.

Results: We included five RCTs reported in nine papers, all with ACL tear as the primary injury. Two RCTs compared initial management strategies (rehabilitation+early vs optional delayed ACL surgery), reporting on structural biomarkers (radiographic osteoarthritis, cartilage thickness, meniscal damage) in five papers and molecular biomarkers (inflammation, cartilage turnover) in one paper. Three RCTs compared different post-ACL surgery reconstruction (ACLR) rehabilitation approaches (high vs low intensity plyometric exercises, accelerated vs non-accelerated rehabilitation, continuous passive vs active motion), reporting on structural biomarkers (joint space narrowing) in one paper and molecular biomarkers (inflammation, cartilage turnover) in two papers. There was no differences in structural or molecular biomarkers between various post-ACL surgery rehabilitation approaches. One RCT comparing initial management strategies demonstrated that rehabilitation+early ACLR was associated with greater patellofemoral cartilage thinning, elevated inflammatory cytokine response, and reduced incidence of medial meniscal damage over five years compared to no or delayed ACLR.

Conclusion: Very-low certainty evidence suggests that different initial management strategies, but not post-operative rehabilitation approaches may influence structural and molecular biomarkers of knee joint health following ACL tear.

What is already known?

- ACL and meniscal tears are followed by a cascade of structural and molecular alterations that drive the progression of knee osteoarthritis
- Given the uncertainty about how different management strategies or different rehabilitation approaches influence structural and molecular alterations after knee injury, there are questions surrounding the choice of strategy or treatment approach best preserve current and future knee joint health

What are the new findings?

- Rehabilitation with early ACLR may lead to greater patellofemoral cartilage thinning, elevated inflammatory cytokine response, and reduced incidence of medial meniscal damage over five years compared to no or delayed ACLR.
- Different post-ACL surgery rehabilitation approaches (high and low intensity plyometric exercises, accelerated and non-accelerated rehabilitation, and continuous passive/active motion) appear to have similar effect on knee joint health.
- Due to no RCT evidence to inform management strategies or rehabilitation approaches following primary meniscal tears, the current findings are restricted to primary ACL tears.
- Due to the very low certainty of evidence for the effect of different initial management strategies or rehabilitation approaches on structural and molecular biomarkers of knee joint health following knee injury, clinicians should consider costs and the patient's values and preferences to guide treatment decisions.

Meeting 4: The long-term burden of anterior cruciate ligament and meniscal injury: a systematic review and meta-analysis for the OPTIKNEE consensus

Objective: Determine the long-term physical activity, work limitation, health/economic cost, health-related quality-of-life (HRQoL), and disease burden of traumatic anterior cruciate ligament (ACL) and/or meniscal injury.

Design: Random-effects meta-analysis evaluated HRQoL [SF-36/SF-12/VR-12 physical-component-scores (PCS), mental-component-scores (MCS), EQ-5D] stratified by time post-injury, and pooled mean differences (95% CI) between ACL-injured and uninjured controls. Other outcomes were synthesised descriptively. Risk-of-bias (RoB) and certainty of evidence (GRADE) were assessed.

Data sources: MEDLINE, EMBASE, CENTRAL, SPORTDiscus, CINAHL searched inception-22/11/2021.

Eligibility: Studies reporting physical activity, work limitations, health/economic costs, HRQoL or disease burden, ≥2 years post-ACL and/or meniscal injury.

Results: Fifty studies were included (10 high-RoB, 28 susceptible-to-some-bias, 12 low-RoB). Meta-analysis (27 studies, very low certainty of evidence) estimated a pooled mean (95% CI) PCS of 52.4(51.4-53.4) and MCS of 54.0(53.0-55.0) 2-14 years post-ACL injury. Pooled PCS scores were worse >10 years [50.8(48.7-52.9)] compared to 2-5 years [53.9(53.1,54.7)] post-injury. Excluding high-RoB studies, PCS scores were worse in ACL-injured compared to uninjured controls [-1.5(-2.9, -0.1)]. Six studies (low certainty of evidence) informed a pooled EQ-5D score of 0.83(0.81-0.84). ACL injury was associated with significant direct and indirect costs, and early ACL reconstruction may be less cost-effective than rehabilitation. Some individuals experienced prolonged work absenteeism and modified activities >2 years post-ACL injury. Three studies evaluated meniscal injury outcomes.

Conclusion: There is very-low certainty of evidence that PCS scores ≥2 years post-ACL injury are worse than uninjured controls and decline over time, whereas MCS scores remain high. ACL injury can result in prolonged work absenteeism and high health/economic costs.

What is already known?

- ACL and meniscal injury can result in knee pain, reduced knee function, fear of re-injury, sport cessation and poor quality of life in the short term.
- The long-term burden of knee injury on generic constructs, including physical activity, work limitations, health/economic costs, burden of disease, and overall health-related quality-of-life (HRQoL) are less clear.
- It is unclear how generic health constructs compare to uninjured controls or population norms, more than 2 years following traumatic ACL and/or meniscal injury.

What are the new findings?

- Physical aspects of HRQoL >2 years after ACL injury were worse than uninjured controls and declined over time, whereas mental aspects of HRQoL remained high >2 years after ACL injury.
- Some individuals experience a prolonged period of leave from work after ACL injury, and others reduce work intensity or report work limitations >2 years after ACL injury.
- Although people often change the type of activities they participate in after ACL injury, on average, self-reported physical activity levels may be similar to the general population. Research using objective measures of physical activity at a variety of timepoints after injury is needed.
- The long-term cost of knee injury requires further investigation in a variety of countries and health-care systems. Two RCTs found that early ACL reconstruction may be less cost-effective compared to rehabilitation and optional delayed ACLR.
- There is a need for high-quality studies investigating the long-term burden of traumatic meniscal injury.

Meeting 5: Meaningful thresholds for patient-reported outcomes following interventions for anterior cruciate ligament tear or traumatic meniscus injury: an systematic review for the OPTIKNEE consensus

Objective: We synthesized and assessed credibility of thresholds that define meaningful scores for patient-reported outcome measures (PROMs) following interventions for anterior cruciate ligament (ACL) tear or traumatic meniscus injury.

Design: Systematic review and narrative synthesis.

Data sources: We searched five databases, hand-searched references of included studies, and performed citation tracking.

Eligibility: Included studies investigated: Individuals with ACL tear or meniscus injury; mean age <35 years; and PROM thresholds calculated using any method to define a minimal important change (MIC) or a meaningful post-treatment score (Patient Acceptable Symptom State [PASS] or Treatment Failure).

Results: We included 18 studies (15 ACL, 3 meniscus). Three different methods were used to calculate anchor-based MICs across 9 PROMs, PASS thresholds across 4 PROMs, and Treatment Failure for 1 PROM. Credibility was rated 'high' for only one study — a MIC of 18 for the Knee injury and Osteoarthritis Outcome Score Quality-of-life (KOOS-QOL) subscale. Where multiple thresholds were calculated among 'low' credibility thresholds in ACL studies, MICs converged to within a 10-point range for KOOS-Symptoms (-1.2-5.4), function in daily living (ADL 0.5-8.1), and QOL (18.3-27.3) subscales, and the International Knee Documentation Committee Subjective Knee Form (7.1-16.2). Other PROM thresholds differed up to 30 points. PASS thresholds converged only in KOOS-ADL for ACL tears (92.3-100), and KOOS-Symptoms (73-78) and KOOS-QOL (53-57) in meniscus injuries.

Conclusion: Meaningful PROM thresholds were highly susceptible to methodological heterogeneity. While PROM thresholds can aid interpretability in research and clinical practice, they should be applied at an individual patient level and cautiously interpreted.

What is already known?

- Considering whether a patient-reported outcome or change score is clinically meaningful is an important aspect of interpreting clinical trials results.
- Selecting a threshold to define as clinically meaningful in treatment of individuals following ACL tear or meniscus injury is challenging as reported thresholds differ due to study design, contextual factors, or calculation methods.

What are the new findings?

- A change of 18 points on the KOOS-QOL subscale should be considered an important change (MIC) 6-24 months following reconstructive surgery for an ACL tear.
- Due to low credibility, we are unable to recommend concrete MIC, PASS and Treatment Failure thresholds for other PROMs used after ACL tear or meniscal injury.
- When selecting MIC, PASS or Treatment Failure PROM thresholds, researchers should carefully weigh factors such as study quality, contextual factors, credibility, calculation method, and how much range among thresholds is acceptable for their specific study question.

Meeting 6: What tests should be used to assess functional performance following anterior cruciate ligament or meniscal injury? A systematic review of measurement properties for the OPTIKNEE consensus

Objectives: To critically appraise and summarise measurement properties of functional performance tests in individuals following anterior cruciate ligament (ACL) or meniscal injury.

Design: Systematic review.

Data sources: Systematic searches were performed in Medline (Ovid), Embase (Ovid), CINAHL (EBSCO), and SPORTSDiscus (EBSCO) on July 07 2021.

Eligibility criteria: Studies evaluating at least one measurement property of a functional performance test including individuals following an ACL tear or meniscal injury with a mean injury age of ≤30 years. The COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) Risk of Bias checklist was used to assess methodological quality. A modified Grading of Recommendations Assessment, Development, and Evaluation (GRADE) assessed evidence certainty.

Results: Thirty studies evaluating 26 functional performance tests following ACL injury were included. No studies were found in individuals with an isolated meniscal injury. Included studies evaluated reliability (n=5), measurement error (n=3), construct validity (n=26), structural validity (n=1), and responsiveness (n=1). The Single Leg Hop and Crossover Hop tests showed sufficient intra-rater reliability (high and moderate certainty evidence, respectively), construct validity (low and moderate certainty evidence, respectively), and responsiveness (low certainty evidence).

Conclusion: Frequently used functional performance tests for individuals with ACL or meniscal injury lack evidence supporting their measurement properties. The Single Leg Hop and Crossover Hop are currently the most promising tests following ACL injury. High-quality studies are required to facilitate stronger recommendations of performance-based outcomes following ACL or meniscal injury.

What is already known?

- Functional performance tests are frequently used in research and clinical practice to assess physical function following knee injury.
- Functional performance tests complement patient-reported outcomes, but consensus on which tests have the best measurement properties and clinical relevance in individuals who have had an anterior cruciate ligament (ACL) tear or meniscal injury are lacking.

What are the new findings?

- A wide variety of functional performance tests have been used following ACL injury, but there is a paucity of evidence about their measurement properties.
- The Single Leg Hop Test and Crossover Hop Test are the highest rated tests for use with individuals that have had an ACL injury and reconstruction, displaying excellent intra-rater reliability, and support for construct validity and responsiveness.
- The 6-meter Timed Hop Test and Triple Hop Test demonstrate good intra-rater reliability and support for construct validity, but insufficient responsiveness.
- There is a paucity of knowledge about the measurement properties of functional performance tests for use after isolated meniscal injury.

Meeting 6: Measurement properties for muscle strength tests following anterior cruciate ligament or meniscal injury – where do we need to go and what tests to use? A systematic review of measurement properties for the OPTIKNEE consensus

Objectives: To critically appraise and summarize the measurement properties of knee muscle strength tests for young individuals with anterior cruciate ligament (ACL) or meniscus injury.

Design: Systematic review.

Data sources: Medline (Ovid), Embase (Ovid), CINAHL (EBSCO), and SPORTSDiscus (EBSCO) on 07 July 2021.

Eligibility criteria: Studies evaluating at least one measurement property of a knee extensor or flexor strength test in individuals with ACL or meniscus injuries at a mean injury age of ≤30 years were included. The COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) Risk of Bias checklist assessed methodological quality and a modified Grading of Recommendations Assessment, Development, and Evaluation (GRADE) assessed evidence certainty.

Results: Thirty different modes, instruments and equipment for muscle strength tests were identified in individuals following an ACL injury (33 studies) or an isolated meniscus injury (one study). Strength tests were assessed for reliability (n=eight), measurement error (n=seven), construct validity (n=25) and criterion validity (n=seven). Isokinetic concentric extensor strength tests were the best rated with good intra-rater reliability and construct validity (very-low and moderate evidence certainty, respectively). Isotonic extensor and flexor strength tests (one repetition maximum, 1RM) showed good criterion validity (high evidence certainty).

Conclusion: This systematic review includes 30 different muscle strength tests for knee extensor and flexor strength tests following ACL injury. More high-quality studies on measurement properties is urgently needed. The isokinetic concentric extensor strength test is currently the most reliable and valid test, and isometric test using HHD could be used by the same rater.

What is already known:

- Knee extensor and flexor strength deficits are common following ACL or meniscus injuries, hence, an important part of clinical and physical examinations.
- Isokinetic computerised dynamometry is considered the gold standard to assess strength, yet handheld dynamometry (HHD) and conventional weight machines are more often available in clinical settings.
- There is a lack of consensus about which strength tests (modes, instruments, equipment, procedures and variables reported) are most clinically applicable and have the best measurement properties
- There is lack of evidence synthesis for strength tests to identify which test to be used in clinical settings and the knowledge gaps on measurement properties to be answered in future high-quality studies.

What are the new findings:

- Studies evaluating measurement properties for different muscle strength tests following ACL or meniscus injuries include a large variety of modes, instruments, equipment, procedures and variables reported, and high-quality studies on measurement properties are scares.
- Isokinetic concentric strength tests are currently the most promising tests to assess extensor strength deficits in individuals with an ACL injury, displaying good intra-rater reliability and construct validity.
- The isometric extensor strength test using HHD offers good intra-rater reliability when a single rater tests consecutive contractions within one session.
- Conventional isotonic weight machines testing one-repetition maximum (1RM) might be a good alternative to computerised isokinetic dynamometry when assessing extensor or flexor strength in a clinical setting.

REFERENCES

1. Whittaker JL, Losciale JM, Juhl CB, et al. Risk factors for knee osteoarthritis after knee trauma: a systematic review and meta-analysis of randomised controlled trials and cohort studies for the OPTIKNEE consensus. *Br J Sports Med* Under Review
2. Whittaker JL, Runhaar J, Bierma-Zeinstra S, et al. A lifespan approach to osteoarthritis prevention. *Osteoarthritis Cartilage* 2021;29(12):1638-53. doi: 10.1016/j.joca.2021.06.015 [published Online First: 2021/09/25]
3. Culvenor AG, Girdwood MA, Juhl CB, et al. Rehabilitation after anterior cruciate ligament and meniscal injuries: a best-evidence synthesis of systematic reviews for the OPTIKNEE consensus. *Br J Sports Med* 2022 doi: 10.1136/bjsports-2022-105495
4. Holm PM, Juhl C, Culvenor AG, et al. Effectiveness of initial management strategies and rehabilitation approaches to improve knee joint structural and biological outcomes after injury: a systematic review of ransomised controlled trials for the OPTIKNEE consensus. *Osteoarthritis Cartilage* Under Review
5. Andrade R, Pereira R, van Cingel R, et al. How should clinicians rehabilitate patients after ACL reconstruction? A systematic review of clinical practice guidelines (CPGs) with a focus on quality appraisal (AGREE II). *Br J Sports Med* 2020;54(9):512-19. doi: 10.1136/bjsports-2018-100310 [published Online First: 2019/06/09]
6. Truong LK, Mosewich AD, Holt CJ, et al. Psychological, social and contextual factors across recovery stages following a sport-related knee injury: a scoping review. *Br J Sports Med* 2020;54(19):1149-56. doi: 10.1136/bjsports-2019-101206 [published Online First: 2020/02/16]
7. Smith TO, Hawker GA, Hunter DJ, et al. The OMERACT-OARSI Core Domain Set for Measurement in Clinical Trials of Hip and/or Knee Osteoarthritis. *J Rheumatol* 2019;46(8):981-89. doi: 10.3899/jrheum.181194 [published Online First: 2019/01/17]
8. Gagnier JJ, Shen Y, Huang H. Psychometric Properties of Patient-Reported Outcome Measures for Use in Patients with Anterior Cruciate Ligament Injuries: A Systematic Review. *JBJS Rev* 2018;6(4):e5. doi: 10.2106/JBJS.RVW.17.00114 [published Online First: 2018/04/11]
9. Filbay SR, Skou ST, Bullock GS, et al. The long-term burden of anterior cruciate ligament and meniscal injury: A systematic review and meta-analysis for the OPTIKNEE consensus. Under Review
10. Emery CA, Whittaker JL, Mahmoudian A, et al. Establishing outcome measures in early knee osteoarthritis. *Nature reviews Rheumatology* 2019;15(7):438-48. doi: 10.1038/s41584-019-0237-3 [published Online First: 2019/06/16]
11. Macri EM, Young JJ, Ingelsrud LH, et al. Meaningful thresholds for patient-reported outcomes following interventions for anterior cruciate ligament tear or traumatic meniscus injury: an OPTIKNEE systematic review. *Br J Sports Med* Under Review
12. Abram SGF, Middleton R, Beard DJ, et al. Patient-reported outcome measures for patients with meniscal tears: a systematic review of measurement properties and evaluation with the COSMIN checklist. *BMJ open* 2017;7(10):e017247. doi: 10.1136/bmjopen-2017-017247 [published Online First: 2017/10/17]
13. Urhausen A, Berg B, Oiestad BE, et al. Measurement properties for muscle strength tests following anterior cruciate ligament or meniscal injury – where do we need to go and what tests to use? A systematic review of measurement properties for the OPTIKNEE initiative. *Br J Sports Med* Under Review
14. Tayfur B, Charuphongsa C, Morrissey D, et al. Neuromuscular Function of the Knee Joint Following Knee Injuries: Does It Ever Get Back to Normal? A Systematic Review with Meta-Analyses. *Sports medicine* 2021;51(2):321-38. doi: 10.1007/s40279-020-01386-6 [published Online First: 2020/11/29]
15. Berg B, Urhausen AP, Oiestad BE, et al. What tests should be used to assess functional performance in youth and young adults following anterior cruciate ligament or meniscal injury? A systematic review of measurement properties for the OPTIKNEE consensus. *Br J Sports Med* 2022 doi: 10.1136/bjsports-2022-105510 [published Online First: 2022/06/14]

16. Ingelsrud LH, Terwee CB, Terluin B, et al. Meaningful Change Scores in the Knee Injury and Osteoarthritis Outcome Score in Patients Undergoing Anterior Cruciate Ligament Reconstruction. *Am J Sports Med* 2018;46(5):1120-28. doi: 10.1177/0363546518759543 [published Online First: 2018/03/09]
17. Tubach F, Ravaud P, Baron G, et al. Evaluation of clinically relevant states in patient reported outcomes in knee and hip osteoarthritis: the patient acceptable symptom state. *Ann Rheum Dis* 2005;64(1):34-37.
18. Barenius B, Forssblad M, Engström B, et al. Functional recovery after anterior cruciate ligament reconstruction, a study of health-related quality of life based on the Swedish National Knee Ligament Register. *Knee Surg Sports Traumatol Arthrosc* 2013;21(4):914-27.
19. Laigaard J, Pedersen C, Ronsbo TN, et al. Minimal clinically important differences in randomised clinical trials on pain management after total hip and knee arthroplasty: a systematic review. *Br J Anaesth* 2021;126(5):1029-37. doi: 10.1016/j.bja.2021.01.021 [published Online First: 2021/03/09]
20. Tigerstrand Grevnerts H, Gravare Silbernagel K, Sonesson S, et al. Translation and testing of measurement properties of the Swedish version of the IKDC subjective knee form. *Scand J Med Sci Sports* 2017;27(5):554-62. doi: 10.1111/sms.12861 [published Online First: 2017/02/17]
21. Maheshwer B, Wong SE, Polce EM, et al. Establishing the Minimal Clinically Important Difference and Patient-Acceptable Symptomatic State After Arthroscopic Meniscal Repair and Associated Variables for Achievement. *Arthroscopy: The Journal of Arthroscopic & Related Surgery* 2021
22. Lafave MR, Hiemstra L, Kerslake S, et al. Validity, Reliability, and Responsiveness of the Anterior Cruciate Ligament Quality of Life Measure: A Continuation of Its Overall Validation. *Clin J Sport Med* 2017;27(1):57-63. doi: 10.1097/JSM.0000000000000292 [published Online First: 2016/01/19]
23. Van Der Wal RJP, Heemskerk BTJ, Van Arkel ERA, et al. Translation and Validation of the dutch western ontario meniscal evaluation tool. *J Knee Surg* 2017;30(04):314-22.
24. Slagers AJ, van den Akker-Scheek I, Geertzen JHB, et al. Responsiveness of the anterior cruciate ligament - Return to Sports after Injury (ACL-RSI) and Injury - Psychological Readiness to Return to Sport (I-PRRS) scales. *Journal of sports sciences* 2019;37(21):2499-505. doi: 10.1080/02640414.2019.1646023 [published Online First: 2019/07/25]
25. Huang H, Nagao M, Arita H, et al. Reproducibility, responsiveness and validation of the Tampa Scale for Kinesiophobia in patients with ACL injuries. *Health and quality of life outcomes* 2019;17(1):150.
26. Muller B, Yabroudi MA, Lynch A, et al. 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* 2016;44(11):2820-26.
27. Pedersen JR, Roos EM, Thorlund JB, et al. Cut-off values to interpret short-term treatment outcomes after arthroscopic meniscal surgery measured with the Knee Injury and Osteoarthritis Outcome Score. *J Orthop Sports Phys Ther* 2021(0):1-31.