The effect of kinesiophobia on functional outcomes following anterior cruciate ligament reconstruction surgery

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DOI:
10.1080/09638288.2021.1998665

Title: The effect of kinesiophobia on functional outcomes following anterior cruciate ligament reconstruction surgery: an integrated literature review.

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The effect of kinesiophobia on functional outcomes following anterior cruciate ligament reconstruction surgery: an integrated literature review.

Abstract

Purpose

Evaluate the effect of kinesiophobia on functional outcomes following anterior cruciate ligament reconstruction (ACLR).

Materials and Methods

A three-phase, integrated mixed-methods review of observational and qualitative studies was undertaken. (1) Systematic search of studies with participants over 12 years old, following ACLR and focusing on kinesiophobia, using the Tampa Scale of Kinesiophobia (TSK) for observational studies. Exclusion criteria included ipsilateral knee surgery and involvement of elite athletes. (2) Critical appraisal for both design types was undertaken. (3) Synthesis occurred in five stages. Results were reported as a relationship between the TSK and other functional outcome measures. Finally, qualitative results were integrated to explain results.

Results

Twenty-four studies (1174 participants) were included with no exclusion based on quality appraisal.

Six themes were identified: (1) return to sport (RTS); (2) activities of daily living; (3) knee-related quality of life; (4) gait; (5) reinjury; and (6) knee disability and physical function.

The highest strength of evidence was the negative association between increased TSK scores and both decreased activity levels and RTS.

Conclusions

Kinesiophobia affects a range of functional outcomes. Further research is required to identify screening tools and interventions for patients with kinesiophobia.

Key words

Anterior cruciate ligament reconstruction; kinesiophobia; fear of reinjury; functional outcomes; rehabilitation

Introduction

Anterior cruciate ligament (ACL) rupture commonly occurs in sports involving cutting and pivoting through both contact and non-contact mechanisms [1,2]. Four out of five patients opt for surgery, with the rate of ACLR at 24.2/100,000 people, equating to around 15,000 primary surgeries in England per annum [3,4]. The most frequently used grafts are hamstring or patellar tendons, yet despite differences between these surgical methods, no one graft type is viewed as universally superior [5]. It is estimated the cost of ACLR to the National Health Service per annum is around £63 million; additional financial effects of ACL injury include time off work [4].

The purpose of ACLR is to ensure that patients can return to pre-injury function, which usually involves return to sport (RTS) [6]. However, the RTS rate is poor post-surgery, with studies reporting that only between 40 and 60% of patients returned to pre-injury level sport, across a population of recreational to elite athletes [7,8]. Psychological factors significantly influence RTS and impact quality of life (QoL) and general well-being [9]. Kinesiophobia has been identified as one particularly important factor. It is defined as a negative emotional response to an injury, causing fear of reinjury during movement [1]. In a study of 201 people post-ACLR, the prevalence of kinesiophobia was identified as 62% (124/201) [9]. Kinesiophobia has its greatest impact following injury onset [10].

Research is required to identify strategies that help healthcare professionals reduce kinesiophobia in their patients [11,12]. A greater understanding could impact on typical negative psychological cycles that evolve that prevent RTS [13]. For instance, a cycle of activity avoidance, depression and decreased motivation often occurs [1], but this can be influenced by peer comparison, sharing and observation [14]. Such models should be addressed in rehabilitation as standard practice within a dynamic biopsychosocial model [15].

To fully understand this topic, different data sets should be used. Qualitative data have been able to illustrate why relationships between kinesiophobia and the biopsychosocial model occur [15,16] and identify how and where kinesiophobia can be addressed amongst this demographic of patients [17]. Observational studies have been able to quantify associations between patients with high kinesiophobia and other physical and functional outcomes [6,18,19].

Previous reviews either focus on the impact of kinesiophobia on RTS status (i.e. if the participant RTS or not) [11] or studied kinesiophobia as a small part of more generic psychological factors affecting rehabilitation [1]. To the best of the authors' knowledge, no review has been able to integrate different forms of data to ascertain how and why patients may be affected differently by kinesiophobia. The integration between studies of different types can identify discrepancies between patients' self-perceptions and their objective outcomes and allow rehabilitation therapists to understand patients more holistically.

The aim of this review is to establish how kinesiophobia functionally impacts patients following ACLR.

Methods

An integrated mixed-methods review was undertaken [20,21]. Three phases were included in the review process: (1) systematic search; (2) quality appraisal; and (3) synthesis of results. Summary tables were used throughout to supplement the review and provide easy extraction of data [22].

The search processes involved consideration to techniques associated with the Cochrane Handbook for Systematic Reviewers [20]. A PRISMA flow diagram [23] was used to record the search process (figure 1).

Prospero number: CRD42020161012

Phase 1: Systematic Search

Eligibility criteria

The standard method for formulating eligibility criteria was used (SPIDER – sample, phenomenon of interest, design, evaluation, research type) to ensure specificity of studies [24].

Sample. Studies were eligible for inclusion if their participants: (1) were aged over 12 – paediatric knee injuries have an increased risk of tibial avulsion fracture and other related injuries [25]; (2) had undertaken some form of post-operative physiotherapy following ACLR; (3) were classed as recreational, competitive or non-athletes pre-injury, with exclusion of elite athletes (to avoid discrepancy in the quantity and quality of rehabilitation offered to the participant); (4) had any type of graft surgery – evidence suggests there is no significant difference between outcomes for different types [26]; (5) did not require ipsilateral knee surgery for other major ligaments or ACL-revision surgery.

Phenomenon of interest. Studies were required to assess the effect of kinesiophobia on functional outcomes post-ACLR as a primary objective. Studies were also included if kinesiophobia was a 'significant' finding during the results synthesis, which would involve the provision of at least two paragraphs of text, or a contribution that offered substantial insight into the experiences of participants in relation to kinesiophobia. This is consistent with previous reviews [27].

Design. This is an integrated mixed-methods review, with no restriction of methodological designs within qualitative studies (e.g., hermeneutic phenomenological or social constructionist theory) and observational studies (e.g., cross-sectional, cohort or case-control).

Evaluation. The evaluation process varied between observational studies and qualitative studies:

(a) Observational studies: the TSK was used as the primary outcome measure in this review. There are two versions: (a) TSK-17, the full version with 17 questions [28]; and (b) TSK-11, the abbreviated version with 11 questions [29]. The TSK involves asking participants a series of questions about their response to injury and opinions about their pain and rehabilitation management. Although the TSK was originally developed for use with patients with chronic lower back pain, it has been commonly used for ACL injuries and is appropriate for use in this population [30].

In addition to the TSK, other functional outcome measures, inclusive of but not limited to, RTS status, strength testing, gait analysis and the Tegner Activity Scale, were acceptable and required for a study to be included.

(b) Qualitative studies: report themes or a focus on kinesiophobia, with kinesiophobia as the main evaluator for qualitative studies and a significant part of the results and discussion. The range of qualitative data collection tools could include researcher field diaries, participant diaries, qualitative observation and recorder discourse.

Research Type. Both qualitative and observational studies were used. Mixed-methods studies were included if they could provide a phase that fitted the above criteria. Quantitative explanatory studies and case studies were excluded.

Systematic search

The search of literature occurred between 18/11/19 and 01/09/21 using different sources for appropriate studies, with predefined search terms [20]. Electronic databases from inception included EBSCO Database, inclusive of Medline, AMED, CINAHL Plus and Sport Discuss databases. Searches were supplemented by other electronic sources, including the first 20 pages of Google Scholar and Sciencedirect.com. This was followed by searching reference lists of existing reviews and social profiles of researchers and included author home research webpages and citation chasing of included articles.

Databases were searched using the following terms: “ACL reconstruction OR anterior cruciate ligament reconstruction OR ACL repair OR anterior cruciate ligament repair OR ACL surgery OR anterior cruciate ligament surgery AND fear of reinjury OR decreased confidence OR kinesiophobia OR decreased self-efficacy”, with either, “TSK OR Tampa

Kinesiophobia scale AND functional outcomes OR functional recovery OR functional status OR return to sport", for observational studies or, "qualitative study OR qualitative research OR qualitative methods OR interview", for qualitative studies. Google Scholar and Science Direct were searched with: "fear of reinjury following ACL reconstruction"; "effect of kinesiophobia on functional outcomes following ACL reconstruction"; "qualitative studies kinesiophobia post ACL reconstruction surgery".

Study selection

Titles of studies were screened by the primary author for potential inclusion and abstracts read if there was ambiguity about the relevance from the title alone. Duplicates were removed. All abstracts were screened to match the eligibility criteria [31]. Full texts were reviewed if the abstract did not clearly discuss all aspects of the eligibility criteria or if the study was unidentifiable as clear exclusion or inclusion from the abstract alone.

Phase 2: Quality Appraisal

Four quality appraisal tools were used to analyse the studies for rigour, risk of bias and threats to external validity (appendix 1a, b, c, d):

(a) Observational Studies:

  (i) SIGN Tool for Cohort Studies [32]

  (ii) SIGN Tool for Case Control Studies [33]

  (iii)STROBE Tool for Cross-Sectional Studies [34]

(b) Qualitative Studies:

  (i) COREQ Tool for Qualitative Studies [35]

The critical appraisal aimed to identify any studies which were flawed in their methodology or results reporting. Critical appraisal has been reported narratively [20]. Whittemore & Knafl [21] state there is no gold standard for calculating quality scores so, for this study, fatally flawed articles were defined as those who scored less than 55% on their respective rigour assessment, which is in line with the modified COREQ results stating that any study scoring <7/13 should be excluded [36]. How the results were presented was also considered to ensure there were no concerns with the reporting, and a judgement made regarding the trustworthiness of the results. No studies were established as fatally flawed and therefore no studies were excluded from the review based on quality appraisal [36]. Comments regarding results were modified and strength of evidence applied to identify caution based on risk of bias [37]. Critical appraisal was supplemented with criteria on threats to external validity [38].

Phase 3: Synthesis and Analysis

A pre-defined extraction form was used for each study to gather information about study design and aims, eligibility criteria, participant information and demographics, outcomes measures and main results, which was adapted slightly for qualitative studies [22]. This information was tabularised (appendix 2a, b). Results were moderated based on levels and strength of evidence and were rated in terms of evidence level and risk of bias (appendix 3) [37]. To synthesise the results, data were extracted to identify main themes from the observational studies [22,39]. Appendix 4a shows the set of questions asked of the results to allow reporting primarily by the relationships between functional outcomes and the TSK. Results were copied into a table and key themes were identified within the studies and used to summarise the main results (appendix 4b). Qualitative results were copied into a table, with key themes identified by the primary author (appendix 4c). These were summarised and collated into more general themes to allow integration with observational studies.

Integration of Results

Analysis of results was quantitively-led, with relationships between the TSK and functional outcomes used primarily to form themes. The themes were supplemented with qualitative results to explain mixed results or further strength of association [21,40]. Overall conclusions were made based on quality and quantity of evidence to support relationships [21].

Results

Systematic Search: Study Characteristics/Demographics

Twenty-four studies were included in this review, of which 9 were qualitative and 15 were observational (cohort, n = 4; case-control, n = 1; cross-sectional, n = 10). A total of 1174 participants (male, n = 658; females, n = 458; unknown, n = 40, non-patients (parents and healthcare professionals), n = 18) participated in the studies, aged between 12 and 60 years old. Graft type varied across the studies: hamstring, 18%; bone-patella-bone, 18%; other, 11%; not reported, 53%). See figure 1 for the PRISMA Flow Diagram [23]. See table 1 for a summary of study characteristics and demographics. Full information is presented in appendix 2a, b.

Quality Appraisal

A summary of quality appraisal can be viewed in Table 2. The full quality appraisal can be viewed for individual studies in the appendix (1a, b, c, d).

(1) Risk of bias within observational studies

Across the review of observational studies, the most common high-risk area was related to the reporting of confounding variables and confidence intervals, with all four cohort studies lacking clear identification of confounders and the potential effect of these on the results. Whilst some studies only had one group of participants, those involving more than one group, e.g., when the cohort was separated into RTS and not return to sport (NRTS), often had the opportunity for blinding the assessors but no blinding is reported. Seven out of the ten cross-sectional studies made no effort to address, or had unclear reports of, potential biases within the study. The descriptions of sensitivity analyses and external validity were common omissions amongst cross-sectional studies.

Generally, the observational studies had clear identification of aims, which are referred to and analysed appropriately and succinctly throughout. Background information providing clear rationale for the studies, along with suitable justification for the method, were common areas of high quality amongst these studies.

(2) Risk of bias across observational studies

The lowest quality cross-sectional study was Tripp et al. [41] which scored 20/27 on the STROBE scale. This study lacked justification of sample size and had no mention of external validity, which were the main factors for a lower total score. Cohort studies by Ardern et al. [8] and Clifford et al. [42] each scored 5/7 on the SIGN tool, both losing quality marks based on an omission of discussion of confounders.

The highest quality study was that of Tajdini et al. [43], scoring 24/26 on the STROBE scale, only dropping points for lack of clarity around sensitivity and addressing any causes of potential bias.

(3) Trustworthiness within qualitative studies

Five out of nine qualitative studies lacked a justification for the formulation of the interview questions, with only four out of the nine studies providing the interview guide as part of the study. Four studies identified field notes that were written during the interview process. The reporting of the coding methods was generally poor across all nine studies; only one study scored two points (out of two) in section 25 of COREQ, regarding the description of the coding process, with three studies scoring zero points. Member checking was only recorded in two studies.

However, major themes were clearly identified and there was consistency between the presented data and the results reported for all nine studies.

(4) Trustworthiness across qualitative studies

Flanigan et al. [44] is the lowest quality observational study, scoring 20/33 on the COREQ scale. All the other qualitative studies used quotations to demonstrate major themes, but these were not presented by Flanigan et al. [44] and unlike the majority of the other studies, the range of the interview length was not reported.

Five studies scored equally highly (27/33) on the COREQ scale: Burland et al. [15], Filbay et al. [45], McVeigh & Pack [17], Pizzari et al. [46] and Ross et al. [47].

Synthesis of Results

Summary

Fifteen out of fifteen (100%) observational studies used the TSK as an outcome measure. TSK-11 was used by 9/15 (60%) studies, with mean scores ranging between 15.7 and 25.3 (maximum range: 11-44). TSK-17 was used by 6/15 (40%) studies, with values recorded between 32.9 and 41.2 (maximum range: 17-68). One study used a different scale for TSK-17 so values cannot be directly compared [48]. For both TSK-11 and TSK-17, a higher value indicated increased fear. While a score of 37 or over on the TSK-17 is recognised to show significantly high kinesiophobia, there is no equivalent set number on TSK-11 [49], although previous studies have used 17 as the boundary for high fear [50].

Associations of fear in relation to functional outcomes

Six main themes were identified from the results of the observational studies as to how kinesiophobia is associated with functional outcomes: (1) RTS; (2) activity levels and ADLs; (3) knee-related QoL; (4) gait; (5) reinjury; and (6) knee disability and physical function. The qualitative studies identified four main themes: modification of activities, hesitancy, hyperawareness and QoL. These four themes have been integrated into the observational studies to supplement results as appropriate.

(1) Return to sport. All six studies looking at RTS status found that a proportion of participants did NRTS. There were mixed results across the studies about whether kinesiophobia affected participants' RTS. One study (1/6, 16%) found no relationship between TSK and RTS, whilst five (5/6, 83%) deemed there was an association between the two.

Ardern et al. [8] identified no difference between those RTS (43% of participants, scoring 33/68 on the TSK-17) and those who did not return to a pre-injury level of sport at 2-years post-ACLR (57% of participants, scoring 34/68 on the TSK-17).

Three studies (3/6, 50%) [6,48,49] found there was a significant difference in TSK-11/TSK-17 in those who RTS (17.1/44, 15.7/44, 15/68, respectively) and those participants who did not (21.9/44, 19.7/44, 20/68, respectively). Baez et al. [6] further identified that for every 1-point increase on the TSK-11, participants were 17% less likely to RTS. This is further supported by Clifford et al. [42] who reported that 78.4% of their participants scored over 37/68 on the TSK-17, with fewer than 50% of participants returning to pre-injury level of sport.

Two studies (2/6, 33%) [41,42] concluded that kinesiophobia was the main predictor for participants NRTS following ACLR. Tripp et al. [41] found kinesiophobia was negatively associated with reported RTS status and was the sole predictor of RTS status. Seventy-five percent of participants who did not return to preinjury levels of sports participation identified kinesiophobia as the main cause, whilst 70% of participants not returning to preinjury level of performance reported the same [42].

All the studies were of medium to high quality, with no identifiable fatal flaws. Considering 5/6 studies support the association between fear of reinjury and RTS, it can be concluded with moderate confidence that increased TSK scores influences the decision of participants to RTS.

The qualitative findings from Burland et al. [15] provide an indication that physical activity self-confidence explains why participants may be cautious about RTS post-ACLR. Despite both RTS and NRTS participants having tendencies to be hesitant, those who did RTS became less concerned about this over time, with one participant stating he was initially worried but, “towards the end of physical therapy, I was over that”. Filbay et al. [45] added to this by stating that 53% of participants stopped playing sport because of fear of reinjury, whilst Flanigan et al. [44] identified fear of reinjury as the most common choice-related reason participants cited for NRTS (52%). Finally, Tjong et al. [51], found that flashbacks to the mechanism of injury and, consequently a fear of reinjury, were described by some participants, with one individual stating, “every time I thought I could get back out there, the scar would remind me and almost haunt me" and another getting, "flashbacks of the collision that put [them] out. The fear of a retear definitely stays on [their] mind".

Despite the results of Ardern et al. [8] and the lower quality of some of the observational studies, there can be moderate confidence that increasing TSK scores reduces the likelihood of RTS, or at the very least contributes to the decision to NRTS.

(2) *Activity levels and ADLs.* Four observational studies looked at how general activity levels changed following ACLR and all found a relationship between TSK scores and reduced activity on four different activity level outcome measures [18,52-54].

Hartigan et al. [18] found that for patients identified as 'noncopers', there was a significant negative correlation between TSK-11 and the Knee injury and Osteoarthritis Outcome Score for ADLs (KOOS-ADL) in the first 6 months post-ACLR. This was also reflected between the 6-month and 12-month groups for both 'copers' and 'noncopers' [18]. Whilst Norte et al. [53] found a negligible correlation between TSK-17 and the KOOS-ADL, there was a correlation, though weak, with the Godin leisure-time physical activity scale. Kochai et al. [52] found a significant inverse correlation between TSK and scores on the Tegner Activity Scale. Finally, Paterno et al. [54] identified the association between TSK-11 and the Marx Activity Scale, with participants having TSK-11 scores over 17 (high levels of kinesiophobia) being four times more likely to report decreased activity levels on the Marx Scale.

All four studies have reasonably high methodological quality on their respective scales, with a mixed strength of evidence. As all studies support the fact that increasing TSK scores leads to decreasing activity levels or increasing activity modifications, it can be concluded, with low caution, that increased kinesiophobia does decrease activity levels of individuals following ACLR.

Two qualitative studies address how fear impacts on activity modification and both find there is a relationship between the two. Filbay et al. [45] identified how participants modified their activities to accommodate the fear they were experiencing to reduce the risk of reinjury, either immediately post-ACLR or delayed after subsequent knee injuries post-RTS. Thirty percent of participants stopped playing competitive sport but remained physically active [45]. Ross et al. [47] found that some participants substituted their sports, e.g., from one involving pivoting or sidestepping to cycling, whilst others reduced the level at which they performed, with one participant stating, "I'm always worried at that level I am going to do the same damage".

Although the relationship between TSK and KOOS-ADL is not consistently reported, with contradicting results from Hartigan et al. [18] and Norte et al. [53], all four observational studies reporting on the effect of kinesiophobia on the modification of activities find there is some association with at least one activity-related outcome measure. Thus, there is moderate confidence that this is a key effect of kinesiophobia on functional outcomes following ACLR, particularly considering the supporting qualitative studies from Filbay et al. [45] and Ross et al. [47].

(3) Knee-related QoL. Only two observational studies considered the effect of knee-related QoL in relation to kinesiophobia. These had contradicting results [48,53].

Kvist et al. [48] found a strong negative correlation between TSK-17 and the Knee injury and Osteoarthritis Outcome Score for QoL (KOOS-QoL). However, Norte et al. [53] did not identify any correlation between the two, finding that TSK-17 for the high physical activity group was 31.4/68 and the low physical activity group was 34.4/68, with KOOS-QoL at 69.4 and 63.8, respectively. This was not statistically significant. Norte et al. [53] and Kvist et al. [48] have similar risk of bias results so can be considered equally in relation to TSK and knee-related QoL and are both rated as good quality cross-sectional studies for strength of evidence.

Three qualitative studies addressed the impact of kinesiophobia on knee-related QoL [45,47,51]]. Filbay et al. [45] found that participants who avoided sport or activity due to kinesiophobia had a lower QoL when compared to participants who overcame their fear and RTS. Even participants who reduced their level of sport or who modified their activities, were still able to have a satisfactory self-reported QoL, implying that fear preventing return to pre-injury activities only affects QoL if these are ceased completely [45].

Ross et al. [47] considers further impacts of reinjury that decrease QoL; for example, participants have kinesiophobia in case they have to undergo surgery and rehabilitation for a second time which would increase pain and general inconvenience and has financial implications if time off work is required. Some participants reported that family was prioritised, as reinjury would impact upon family commitments. Tjong et al. [51]

corroborates these studies, finding that kinesiophobia reduces QoL by preventing RTS, but also because of pain and financial implications post-injury. One participant from Tjong et al.'s study stated that they, "couldn't afford to get hurt in the same way" [51].

Whilst objectively there is no clear consensus on how TSK results affect KOOS-QoL, the evidence from qualitative studies indicates that following ACLR, patients feel as though kinesiophobia does and will have an impact on their QoL, through having to stop sport, modify activities, financial concerns, family commitments and the implications of undergoing further surgery and consequent lengthy rehabilitation. Concluding how kinesiophobia affects QoL needs to be moderated significantly due to the discrepancies between the observational/quantitative and qualitative results.

(4) Gait. Kinesiophobia did not have an impact on participants' gait, as two studies assessed the relationship between TSK and gait characteristics and neither found strong correlations linking the two [6,55]. However, a third study found that increased limb asymmetry during walking increased kinesiophobia [43].

Although Baez et al. [6] found that 72% of participants did not average 10,000 steps per day after ACLR rehabilitation, TSK-11 results did not have a direct association with the step count; instead, self-reported knee self-efficacy and knee-related QoL were the main contributors to step count. However, RTS status did partially affect step count so, indirectly, kinesiophobia have an impact if participants with kinesiophobia are less likely to RTS [6]. Luc-Harkey et al. [55] found there was no significant association between TSK-11 and gait speed, or between TSK-11 and knee extension/flexion moments when measuring gait characteristics during a 60 second walking gait trial. There was a weak correlation between increased TSK-11 scores and peak ground reaction force but, overall, Luc-Harkey et al. [55] did not identify that TSK-11 and gait deficiencies following ACLR were associated.

However, Tajdini et al. [43] identified a significant positive relationship between asymmetry of second peak vertical ground reaction force and TSK-11 scores, alongside a significant association with rectus femoris and biceps femoris during walking tests. As gait asymmetries exist post-ACLR, secondary to compensatory and guarded movements, these have the potential to lead to an increase in kinesiophobia [43].

Luc-Harkey et al. [55] has good methodological quality so the results can be considered with low caution. Baez et al. [6] has medium methodological quality so results would be viewed with moderate caution; however, because it corroborates with Luc-Harkey et al.'s study [55] and there are no conflicting results from other studies, the caution applied can be reduced. Both studies found strong evidence to suggest that gait and kinesiophobia were not directly associated. Despite this, Baez et al. [6] found that RTS affected step count; however, this was an indirect association and any direct correlations on gait were insignificant.

Whilst Tajdini et al. [43] found a correlation between kinesiophobia and gait patterns, their conclusion is that asymmetrical gait causes an increase in kinesiophobia rather than the reverse. As Luc-Harkey et al. [55] and Baez et al. [6] did not find a relationship, it can be concluded with moderate certainty that kinesiophobia does not cause gait asymmetries.

No qualitative studies included in this review directly considered or identified an impact on gait characteristics.

(5) *Reinjury.* Two observational studies assessed the effect of kinesiophobia on the likelihood of having a second injury and both found that there was an increased chance of reinjury with higher fear score [13,54].

Paterno et al. [54] found that participants with a TSK-11 score of 19+ at the point of RTS, were 13 times more likely to have a second ipsilateral ACL rupture within two years. However, the risk of a contralateral knee injury and TSK-11 scores were not associated. Trigsted et al. [13] did not directly assess the relationship between TSK-11 and reinjury, but instead between TSK-11 and movement patterns during jump landing tasks. Increased fear of reinjury caused movement pattern changes leading to increased stiffness in sagittal and transverse planes, whilst there was increased movement and pre-activation of joints and muscles in the frontal plane [13]. These biomechanical changes, particularly during jump landing, are associated with an increased risk of second ACL injury.

Whilst no qualitative studies directly assessed the effect of kinesiophobia on reinjury rates, Disanti et al. [16] consider that participants who are hesitant on RTS are fearful of reinjury and recognise that a change in playing style may increase this risk. For example, one participant states that, "if you're really timid in your playing, then you're going to get hurt again".

Both Paterno et al. [54] and Trigsted et al. [13] have medium to low risk of bias and as they have corroborating views, their evidence can be viewed with low caution. It can be concluded that higher fear of reinjury is therefore likely to increase the risk of reinjury. These results can be explained through the subjective opinions of Disanti et al. [16].

(6) *Knee disability and physical function.* Nine studies assessed the relationship between knee disability and physical function and kinesiophobia. The most common measure of knee disability was the International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form (5/9 studies, 56%). Other measures of knee disability and function include the Lysholm Knee Score, limb symmetry indices (LSI), lower limb strength and functional tests, such as hop testing.

Seven out of nine studies (78%) found there was an association between increased TSK scores and increased knee disability (3/6 studies, 50%) or decreased knee function (5/7, 71%). These figures include Norte et al. [53] who presented opposing associations for different outcome measures.

The three studies identifying a relationship between TSK and knee disability were Chmielewski et al. [50], Lentz et al. [19] and Norte et al. [53]. Chmielewski et al. [50] found that TSK-11 scores contributed to 12.7% of the variance in knee disability, which is deemed to be a significant contributing factor. Both Lentz et al. [19] and Norte et al. [53] found a correlation between TSK and IKDC, with the former identifying that the TSK-11 score was the third strongest association with the IKDC score, behind pain intensity and quadriceps index.

The four studies finding associations between TSK and outcome measures for knee function, including self-reported knee function, muscle strength and hop tests, were

Hartigan et al. [18], Norte et al. [53], Paterno et al. [54], Tajdini et al. [43] and Trigsted et al. [13]. Norte et al. [53] found that TSK-17 had a low correlation with triple hop and crossover distance and that there was a negative correlation between TSK-17 and hamstring strength, single leg hop and patient-reported function. Paterno et al. [54] further this as they found participants with TSK-11 scores of over 17 were seven times more likely to have a hop LSI of <95% and six times more likely to have quadriceps strength LSI of <90%. Tajdini et al. [43] found a significant difference between quadriceps strength between the two limbs and an associated relationship between asymmetry of rectus femoris and biceps femoris and TSK-11. Trigsted et al. [13] found a significant negative relationship between TSK-11 and knee, hip and trunk flexion and a significant positive correlation between TSK-11 and hip adduction and gluteus maximus pre-activation; this means that movements in the sagittal and transverse planes become stiffer, whilst there is greater movement and pre-activation in the frontal plane. Hartigan et al. [18] concluded that a decrease in kinesiophobia was associated with an increase in knee function, for both 'copers' and 'noncopers'.

However, two studies (37%) found no association between TSK scores and knee disability and function [49,51]. Kochai et al. [51] found there was no correlation between TSK-17 and Lysholm Knee Score. Lentz et al. [49] did not find a significant difference between the hamstring: quadriceps ratios of the RTS and NRTS-fear groups. Additionally, Norte et al. [53] did not find a correlation between TSK-17 and isokinetic flexion or single hop symmetry.

Six out of nine (67%) studies have good methodological quality and a low risk of bias [18,43,49,50,53,54] and 3/8 (37%) studies have moderate risk of bias [13,19,52]. The results, therefore, need to be considered with moderate caution, particularly because the results are mixed regarding the associations between TSK and knee disability and physical function.

Whilst no qualitative studies explicitly talked to patients about their knee disability and physical function following ACLR, there is reference to lack of confidence and hesitancy about the knee function. This can go some way to explaining why participants may therefore have resulting reduced knee function. Burland et al. [15] note that particularly in the early stages, individuals do have concerns about certain tasks due to decreased knee self-efficacy regarding function and task performance. However, during rehabilitation, confidence increased and knee function caution diminished, with one participant stating how they, "got to where [they] were doing things without a brace on, [they were] getting more confident" [15].

There is mixed evidence about the impact of TSK and the fear of reinjury on knee disability and knee physical function, with studies identifying contrasting results for both self-reported knee disability scales (IKDC, Lysholm Knee Score) and for physical function (LSI, muscle strength, joint movements). Therefore, it cannot be concluded definitively that kinesiophobia has a negative effect on global knee disability; however, it is likely that kinesiophobia will have some impact on knee physical function. Exactly how this will present for patients cannot be concluded with high confidence, as there is discrepancy between studies on the effect of kinesiophobia on different outcome measures.

Discussion

This review aimed to identify how kinesiophobia affected patients following ACLR in terms of functional outcomes. Kinesiophobia has a strong negative association with RTS status and moderate positive associations with likelihood of activity modifications and risk of reinjury. The association with knee disability and function is mixed depending on the outcome measure being assessed. There is no reported direct correlation between kinesiophobia and gait and there cannot be full confidence in an objective relationship between kinesiophobia and QoL.

As most patients undergo ACLR to return to sport or pre-injury levels of activity [14], the findings that increased kinesiophobia reduces the likelihood of RTS, both in terms of activity level and quality, is particularly important. However, there appears to be discrepancy between the views of therapists and patients, as whilst both observational/quantitative and qualitative results show the negative impact of kinesiophobia on RTS, McVeigh & Pack [17] found therapists perceived their patients were not impacted by kinesiophobia with regards to RTS. This may be explained by the lack of formal assessment for kinesiophobia and an acknowledgement that therapists may not feel competent in identifying risk factors or recording these findings appropriately [17].

In terms of QoL there is discrepancy between the objective findings, which found mixed results about the effect of kinesiophobia, and qualitative findings which found participants perceiving a reduced QoL. The patient perception of their function and QoL is equally important to ensure patient-centred biopsychosocial care. Rather than just the results of the outcome measures, it is important to reflect on how the patient's subjective thoughts impact upon their functional perceptions [56].

With all the themes identified, it is important to acknowledge whether kinesiophobia is causing the negative outcomes or if, for example, having reduced knee function or NRTS, is causing increased kinesiophobia. Likewise, it is unsurprising that NRTS reduces daily step count [6] as participants who RTS have an extra physical activity in which increased steps will naturally occur. Many of the outcomes are intrinsically linked and likely to impact on each other, regardless of whether kinesiophobia is directly related.

Kinesiophobia has been shown to vary over time. McVeigh & Pack [17] found kinesiophobia was identified in the early stages of rehabilitation but had the greatest impact towards the late phase when patients began considering the mechanism of their injury on clearance to RTS. This was also found by Paterno et al. [57]. Disanti et al. [16] identified fear as most prevalent amongst participants in the preparatory stage for RTS or just after RTS. Other variables also have an impact on, or alter the impact of, kinesiophobia, such as age, sport type and level and family commitments; for example, Lentz et al. [49] found that the NRTS-fear group was older than the RTS and NRTS-other groups.

Clinical Implications

As kinesiophobia has an impact on a variety of outcomes following ACLR, addressing it will be important for physiotherapists and other involved healthcare professionals, both pre- and post-ACLR and throughout the rehabilitation process. In rehabilitation, it is as important to focus on kinesiophobia as physical limitations.

Increased TSK scores influence the decision of participants to RTS. Being able to identify a TSK score that means a clinical intervention is needed would be useful to help direct rehabilitation and assist physiotherapists in providing appropriate and specific support for their patients. Using TSK as an outcome measure to monitor the progress of the patient with regards to kinesiophobia and readiness to RTS to assess how effective their chosen intervention is, and how this should be adapted if there is no improvement in fear. Another screening tool/outcome measure not analysed in this study but identified in the literature to assess participants' kinesiophobia is the ACL Return to Sport after Injury Scale (ACL-RSI) [57].

Fear is not only related to RTS; it also impacts QoL of the patient and other factors in their life, such as family and work. Having an awareness of this during rehabilitation would ensure physiotherapists were working alongside patients to identify their priorities and specific goals. As demonstrated in this review, objective QoL measures are not sufficient for discovering how QoL is impacted by kinesiophobia, therefore physiotherapists will need to address this issue during their subjective history taking.

With increased fear comes reduced activity or modified activity to reduce the perceived risk of reinjury. It is important for therapists to understand the choices the patient is making to not return to their pre-injury activity level to address the patient's concerns. This may be through psychoeducational interventions, but more research is needed to identify what these interventions involve. If patients are fully informed about the risks and they decide they do not want to RTS/activity, therapists need to work with the patient to modify tasks to achieve the patient's specific goals.

Ensuring the physiotherapeutic relationship between the physiotherapist and the patient is strong and built on trust has been shown to reduce the negative outcomes of high levels of kinesiophobia [17]. Promoting confidence and self-efficacy for the patient is an important part of the physiotherapist's role. Adherence to rehabilitation is negatively impacted by kinesiophobia [46] so encouraging the patient throughout rehabilitation would also help facilitate effective recovery.

It is important to acknowledge ways in which physiotherapists can help their patients overcome kinesiophobia, although not the main focus of this study. Whilst this is an under-documented area of research, there are some studies which address strategies used to reduce the risk of kinesiophobia limiting post-operative functional outcomes. Supporting patients pre-ACLR both physically and psychologically can address risk factors like kinesiophobia and improve outcomes [59]. Prehabilitation may help reduce the asymmetries in quadriceps strength post-operatively [43,59]. Another review found that some studies showed the benefits of using motor imagery to improve clinical outcomes, although further research is needed in this area [60,61]. Mahood et al.[62] found in a qualitative study that graded sports exposure was strategy participants used to help manage their kinesiophobia with regards to RTS.

Limitations

Heterogeneity of studies likely impacted the results. One of the main aspects this related to was clinical diversity and differences between participants, such as gender, age and graft type [63]. Studies were conducted across different countries and local application of results needs to be considered. However, the extent of this may be limited because of a lack of clear guidance of how to screen and support kinesiophobia. Different locations may place varied emphasis on the biopsychosocial model versus the biomedical model during rehabilitation post-ACLR. This could affect psychological outcomes of patients across studies. Limited consideration to extensive confounding variables was made and more may be possible, for example considering the impact of age, body mass index, time post-ACLR and graft type. Finally, it is difficult to assess whether kinesiophobia is the cause or effect of the variable functional outcomes and this may impact some of the conclusions drawn in this paper.

Conclusions

This study demonstrates that kinesiophobia following ACLR has a wide-reaching effect, beyond just RTS, and this should be better recognised by physiotherapists throughout the rehabilitation process. Research is needed that develops a screening process for kinesiophobia and identifies interventions to address kinesiophobia in patients throughout rehabilitation. Understanding how patients overcame kinesiophobia to RTS or to their pre-injury activities would be important in identifying strategies for physiotherapists to use in patients with high fear. For example, specific education of patients and strategies to measure psychological readiness to RTS or other functional activities. Finally, further research into the effect of confounding variables is needed.

Acknowledgements

The authors would like to thank the University of Birmingham. No funding was provided to support this research.

Declaration of Interest

The authors declare no conflicts of interest.

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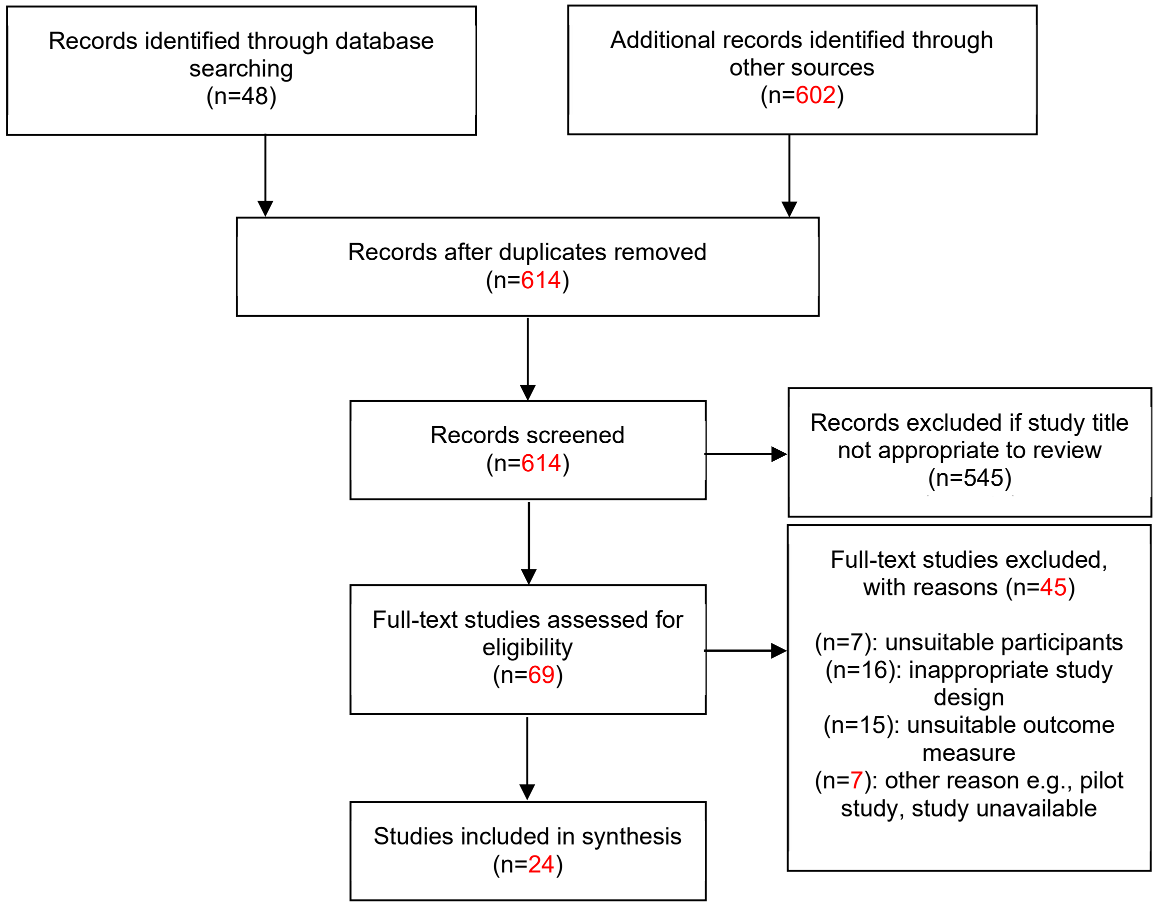
Figures

Figure 1. PRISMA Flow Diagram



Tables

Table 1. Study Characteristics and Demographic. Note: total participants include 8 healthcare professionals (McVeigh & Pack, 2015) and 10 parents (Paterno, et al., 2019), who are not included in the gender or graft type sub-sections.

Author	Total participants	Gender			Age (years)		Setting	Location	Graft type				Time post-ACLR (months)
		Male	Female	Unknown	Minimum	Maximum			Hamstring	Bone-patella-bone	Other	Not reported	
Ardern, et al. (2015)	122	76	46	0	15.1	60.1	Questionnaire	Melbourne, Australia	0	0	0	122	12
Baez, et al. (2019)	40	15	25	0	Mean 24.3		Research lab	Not reported	0	0	0	40	60
Burland, et al. (2018)	12	6	6	0	16	44	Academic medical centre	Not reported	0	0	0	12	12-120
Chmielewski, et al. (2008)	97	60	37	0	Not reported		Clinical database	Not reported	35		62	0	Not reported
Clifford, et al. (2017)	45	29	16	0	Mean 33.7		Questionnaire	Not reported	0	0	0	45	24-48
Disanti, et al. (2018)	10	3	7	0	15	18	Research lab	Michigan, USA	5	4	1	0	5.5±1.4
Filbay, et al. (2016)	17	10	7	0	23	50	Telephone interview	Not reported	0	0	0	17	60-240
Flanigan, et al. (2013)	135	67	68	0	15	56	Telephone interview	Not reported	0	0	0	135	12-25
Hartigan, et al. (2013)	111	77	34	0	Mean 26.7		Research lab	Delaware, USA	0	0	0	111	1.5+ (multiple time frames recorded)
Kochai, et al. (2019)	50	50	0	0	18	50	Research lab	Not reported	50	0	0	0	34.2

Author	Total participants	Gender			Age (years)		Setting	Location	Graft type				Time post-ACLR (months)
		Male	Female	Unknown	Minimum	Maximum			Hamstring	Bone-patella-bone	Other	Not reported	
Kvist, et al. (2005)	62	34	28	0	18	37	Questionnaire	Not reported	7	55	0	0	36-48
Lentz, et al. (2009)	58	38	20	0	15	45	Rehab centre	Florida, USA	18	12	28	0	6-12
Lentz, et al. (2015)	73	45	28	0	Mean 23.2		Rehab centre	Florida, USA	34	2	37	0	2.5
Luc-Harkey, et al. (2018)	30	9	21	0	Mean 20.4		Research lab	Not reported	16	14	0	0	49.4±27.3
McVeigh & Pack (2015)	8	N/A. Participants are healthcare professionals. 3-30 years since qualification, working in a variety of sports injury clinics.											
Norte, et al. (2019)	77	42	35	0	13	47	Research lab	Not reported	26	51	0	0	4.2-8.7
Paterno, et al. (2018)	40	0	0	40	Mean 16.2		Research lab	Not reported	0	0	0	40	7.6
Paterno, et al. (2019)	20	6	4	0	12	21	Physio clinic or telephone	Not reported	0	0	0	10	Not reported
Pizzari, et al. (2002)	11	4	7	0	21	52	Participants' homes or workplaces	Not reported	7	4	0	0	4.8
Ross, et al. (2017)	12	10	2	0	19	45	Telephone	Private hospital	0	0	0	12	5.8
Tajdini, et al. (2021)	28	28	0	0	21	25	Research Lab	Not reported	28	0	0	0	<6
Tjong, et al. (2014)	31	22	9	0	18	40	Telephone	Not reported	0	0	0	31	Not reported
Trigsted, et al. (2018)	36	0	36	0	18	26	Research lab	Wisconsin, USA	0	0	0	36	26.1
Tripp, et al. (2007)	49	27	22	0	16	53	Sports Medicine Clinic	Nova Scotia, Canada	0	49	0	0	12
Total	1174	658	458	40	12	60.1	N/A	N/A	208.5	208.5	128	611	-

Table 2. Summary of quality appraisal. Note: Abbreviations. COREQ = Consolidated criteria for reporting of qualitative research, SIGN = The Scottish Intercollegiate Guidelines Network, STROBE = Strengthening the reporting of observational studies in epidemiology.

Author	**Quality Appraisal Tool**	**Score**	**Comments**
Ardern, et al. (2015)	SIGN Cohort	5/7	• No discussion of the effect of confounders on results • Unclear measurement of exposure
Baez, et al. (2019)	STROBE Cross-sectional	21/27	• Lack of clarity regarding addressing potential biases • No description of sensitivity analyses • Missing data not acknowledged or reasoned • No discussion of external validity
Burland, et al. (2018)	COREQ Qualitative	27/33	• No report of participant-interviewer relationship • Field notes not identified
Chmielewski, et al. (2008)	STROBE Cross-sectional	27/30	• Lack of clarity regarding addressing potential biases • No description of sensitivity analyses
Clifford, et al. (2017)	SIGN Cohort	5/7	• No discussion of the effect of confounders on results • No provision of confidence intervals
Disanti, et al. (2018)	COREQ Qualitative	25/33	• No member checking • Lack of information about interviewer characteristics • Unclear sample selection
Filbay, et al. (2016)	COREQ Qualitative	27/33	• No member checking • Lack of information about interviewer characteristics • Unclear discussion regarding participant drop-out/refusal
Flanigan, et al. (2013)	COREQ Qualitative	20/33	• No member checking • Lack of information about interviewer characteristics • Unclear discussion regarding participant drop-out/refusal • No reporting of audio/visual recording • Duration of interview not reported
Hartigan, et al. (2013)	SIGN Cohort	6/9	• No blinding of assessors to the groups • No discussion of the effect of confounders on the results • No provision of confidence intervals

Author	Quality Appraisal Tool	Score	Comments
Kochai, et al. (2019)	STROBE Cross-sectional	22/28	• Lack of clarity regarding addressing potential biases • No description of sensitivity analyses • No discussion of external validity • Study design not clearly addressed in early in the paper
Kvist, et al. (2005)	STROBE Cross-sectional	22/28	• Lack of clarity regarding addressing potential biases • No description of sensitivity analyses • No discussion of external validity • No discussion of limitations
Lentz, et al. (2009)	STROBE Cross-sectional	22/27	• Lack of clarity regarding addressing potential biases • No description of sensitivity analyses • No discussion of external validity • Missing data not addressed
Lentz, et al. (2015)	SIGN Case control	8/10	• No blinding of assessors to exposure status • No provision of confidence intervals
Luc-Harkey, et al. (2018)	STROBE Cross-sectional	25/28	• No description of sensitivity analyses • No discussion of external validity
McVeigh & Pack (2015)	COREQ Qualitative	27/33	• No member checking • Duration of interview not reported
Norte, et al. (2019)	STROBE Cross-sectional	24/27	• No description of sensitivity analyses • No discussion of external validity
Paterno, et al. (2018)	SIGN Cohort	6/8	• No discussion of the effect of confounders on the results • No provision of confidence intervals
Paterno, et al. (2019)	COREQ Qualitative	26/33	• No member checking • Field notes not identified • Unclear discussion regarding participant drop-out/refusal • Lack of information about interviewer characteristics and participant-interviewer relationship
Pizzari, et al. (2002)	COREQ Qualitative	27/33	• Lack of information about interviewer characteristics and participant-interviewer relationship
Ross, et al. (2017)	COREQ Qualitative	27/33	• No member checking • Lack of information about interviewer characteristics and participant-interviewer relationship • Duration of interview not reported

Author	Quality Appraisal Tool	Score	Comments
Tajdini, et al. (2021)	STROBE Cross-sectional	24/26	• Unclear discussion of bias • No description of sensitivity analyses
Tjong, et al. (2014)	COREQ Qualitative	24/33	• No member checking • Lack of information about interviewer characteristics and participant-interviewer relationship • Unclear discussion regarding participant drop-out/refusal
Trigsted, et al. (2018)	STROBE Cross-sectional	22/27	• Lack of clarity regarding addressing potential biases • No description of sensitivity analyses • No discussion of external validity • No justification of study size
Tripp, et al. (2007)	STROBE Cross-sectional	20/27	• No description of sensitivity analyses • No discussion of external validity • No justification of study size