The Effects of Kinesiophobia on Outcome following Total Knee Replacement: A Systematic Review

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Abstract

Introduction

Kinesiophobia, the fear of physical movement and activity related to injury vulnerability, has been linked to sub-optimal outcomes following total knee replacement (TKR). This systematic review has two aims: to define the relationship between kinesiophobia and functional outcomes, pain and range of motion following TKR, and to evaluate published treatments for kinesiophobia following TKR.

Materials and Methods

A primary search of electronic databases, grey literature, and trial registries was performed in March 2020. English-language studies recruiting adult primary TKR patients, using the Tampa Scale of Kinesiophobia (TSK) were included. Outcome measures were grouped into short (<six months), medium (six-12 months), and long term (>12 months). Study quality was assessed using the Newcastle Ottawa Scale for cohort or case control studies, and the Cochrane Collaboration Risk of Bias tool for randomised controlled trials.

Results

All thirteen included papers (82 identified) showed adequately low risk of methodological bias. TSK1 (activity avoidance) correlated with WOMAC functional score at 12 months in three studies (r=0.20 p<0.05, R=0.317 p=0.001, and correlation coefficient 0.197 p=0.005). TSK score significantly correlated with mean active range of motion (ROM) at two weeks (65.98 (SD=14.51) vs 47.35 (SD=14.48) p=0.000), four weeks (88.20 (SD=15.11) vs 57.65 (SD=14.80) p=0.000), and six months (105.33 (SD=12.34) vs 85.53 (SD=14.77) p=0.000) post-operation. Three post-operative interventions improved TSK score vs control following TKR: a home-based functional exercise programme (TSK -14.30 (SD=0.80) vs -2.10 (SD=0.80) p<0.001)), an outpatient Cognitive behavioural therapy (CBT) programme (TSK 27.76 (SD=4.56) vs 36.54 (SD=3.58), and video-based psychological treatment (TSK 24 (SD=5) vs 29 (SD=5) p<0.01).

Conclusions

Kinesiophobia negatively affects functional outcomes up until one year post-operatively, while active ROM is reduced up to six months post procedure. Post-operative functional and psychological interventions can improve kinesiophobia following TKR.

Keywords: kinesiophobia; TKR; outcomes; treatments; systematic review

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Introduction

Total knee replacement (TKR) is performed to alleviate pain and improve function in patients with osteoarthritis (OA) [1]. Outcomes following TKR are influenced by surgical technique, prosthesis design, and patient co-morbidities [2], although the importance of psychological factors are recognised [2-4]. With the number of total knee replacements (TKR) and set to double in the United Kingdom between 2010 and 2035 [5], rehabilitation post-TKR is gaining importance on a population level.

Post-operative rehabilitation is crucial to improve function and reduce disability following TKR [6]. Nearly 20% of patients report moderate to severe pain at one year post-operatively [7]. Those who experience greater pain post-TKR are more reluctant to engage in exercise with a detrimental effect on their post-operative recovery [8]. The 'fear avoidance' model describes the relationship of behaviour, emotional, and cognitive factors in pain responses. Two responses to pain have been described: confrontation of pain, leading to reduction of fear over time and resumption of normal activity; and the avoidance and exacerbation of fear. Based on this, Kori, Miller and Todd developed the term 'kinesiophobia' which describes an excessive, irrational, and debilitating fear of physical movement and activity resulting from a feeling of vulnerability to painful injury or re-injury [9-10].

Kinesiophobia has gained greater attention recently. It has been hypothesised that mal-adaptive cognitive behaviours can create a vicious cycle of pain and disability [6]. Kinesiophobia can be seen as a normal physiological reaction in the early stages post-surgery, but is associated with the transition from acute to chronic pain and reduced health-related quality of life measures regardless of injury location [11-15]. First investigated in lower back pain [16], kinesiophobia has subsequently been associated with poorer functional outcomes in hip arthroplasty, ACL reconstruction, and patellofemoral pain [17-19].

With mounting evidence that kinesiophobia results in poorer outcomes in a variety of injuries and procedures, treatment strategies have gained attention. These have focussed on both physiological and psychological rehabilitation. Functional exercises have been shown to provide greater efficacy than isometric muscle exercises and range of motion exercises [20], while an outpatient-based Pilates programme has proven successful in lower back pain kinesiophobia [21]. Psychological treatments have focussed on strategies aimed at decreasing fear of movement [18], including imagining the execution of a motor function [22]. Although some strategies have been suggested, there are no specific systematic reviews of these following TKR.

To date, no systematic reviews have investigated kinesiophobia following TKR specifically. With an expanding post-operative patient cohort, the ability to understand the role of kinesiophobia and provide effective treatment to aid rehabilitation is gaining importance. The aim of this review is two-fold, to evaluate the existing evidence on the effect of kinesiophobia on outcomes following TKR, and to evaluate published treatments for kinesiophobia following TKR.

Materials and Methods

Search Strategy

A primary search of electronic databases (EMBASE, CINAHL, AMED, PubMed, PEDro and PsychINFO) via the Healthcare Databases Advanced Search platform was performed from inception until March 2020. Grey literature and trial registry searches were performed on OpenGrey, ISRCTN Registry, PDQT Open and the International Clinical Trials Registry Platform. The following PRISMA compliant search strategy was used for electronic databases and grey literature: [“kinesiophobia” OR (fear adj2 avoidance) OR (fear adj2 move*) AND (“total knee arthroplasty” OR “total knee replacement” OR “TKR” OR “TKA”)]. In addition to our primary search, reference lists of all suitable articles were screened for additional papers.

Inclusion/Exclusion Criteria

Inclusion criteria:

- Studies recruiting patient having undergone primary TKR
- Kinesiophobia or fear of movement included as a measured variable or outcome
- Kinesiophobia measured using the Tampa Scale of Kinesiophobia (TSK)
- Patient cohort age ≥18 years

Exclusion criteria:

- Non-English language papers

All full-tests that met the eligibility criteria were included in the final review. Study identification was independently performed by one reviewer (LH) and verified by another (CD) after reviewing titles and abstracts. The search strategy was run, titles and abstracts were reviewed, and relevant full papers were extracted. A further round of relevancy of the full papers was undertaken by three reviewers (OB, LH, CD).

Data Extraction

Two authors (OB, LH) independently extracted all key data from included studies onto a pre-defined data extraction table. This was then verified by another author (CD). All data were assessed for homogeneity and study type. Studies were grouped into those investigating the effect of kinesiophobia on outcomes after TKR, and those investigating treatments for kinesiophobia after TKR. A data extraction spreadsheet was synthesised to present all key demographic information and results. Where data were not easily extracted or omitted, corresponding authors were contacted.

Methodological Appraisal

Study quality was assessed using the Newcastle Ottowa Scale (NOS) for cohort or case-control study as appropriate, shown in ***Table 1*** and ***Table 2*** respectively.

All randomised controlled trials (RCTs) were assessed using the Cochrane Collaboration Risk of Bias (RoB 2.0) tool where five categories (randomisation, blinding, completeness of outcome data, selection of outcomes reported and other sources of bias) were assessed and itemized in ***Table 3***. Each study was evaluated against the checklist/tool by two reviewers (OB, LH) and verified by a third (CD). Any disagreements were resolved through a consensus.

Comparisons

Comparison 1: The effect of kinesiophobia on outcome following TKR

Outcome measures were split into short (less than six months), medium (six-12 months) and Long term (greater than 12 months) time periods for grouped analysis. Primary outcome measures consisted of: Functional outcome, measured using various patient-reported outcome measures (PROMS) and clinical tests. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [23], Oxford Knee Score (OKS) [24], Knee Society Score (KSS) [25], and Knee Injury and Osteoarthritis Outcome Score (KOOS-4) [26] were used to assess functional outcomes. The secondary outcome measures were pain and range of motion (ROM). Pain was stratified using either a Visual Analogue Scale (VAS) or a numerical rating scale. Range of motion was calculated actively or passively using a goniometer.

Comparison 2: Treatment of kinesiophobia following TKR

Outcome measures were split into short (<six months), medium (six-12 months) and Long term (>12 months) time periods for grouped analysis. Various modalities to improve kinesiophobia following TKR will be assessed. Our primary outcome was TSK score at six months. The Tampa Scale for Kinesiophobia (TSK) was developed by Miller et al. [27]. TSK is a self-completed 17-item questionnaire, designed to assess subjective rating of kinesiophobia. Each item is provided with a four-point Likert scale, with the final score ranging from 17 to 68, where a greater score indicates a higher degree of kinesiophobia [27][28]. Studies investigating the role of kinesiophobia used values between 38 and 40 as 'cut-points' between high and low TSK scores. There were no secondary outcomes for this comparison.

Data Analysis

An assessment of study heterogeneity was made by visual assessment of the data extraction tables. Data was presented as mean ± standard deviation (SD) where possible. Where the data were heterogeneous, a narrative review of the evidence was presented.

Results

Search Results

The search strategy identified 82 papers and were all exported as titles and abstracts. Screening based on abstracts, 35 papers were excluded. 47 full-text papers were retrieved, and 13 papers were reviewed as shown in a PRISMA flowchart ***Figure 1***.

Quality Assessment

All 13 papers described their cohorts' characteristics and eligibility criteria and demonstrated adequate reporting of background and objectives. The reporting of methodology was variable. All the cohort studies failed to report how potential sources of bias would be addressed and how the study size was calculated (***Table 1***). One study by Filardo et al [29] described potential bias due to using different prostheses in their cohort but attributed their robust results to the large cohort. Eight studies failed to report statistical methods used to examine missing data or loss to follow up and how participants with missing data may have affected the results. Four studies specified the number of patients at each stage of their study and whether there were any patients lost to follow up. Only two papers specified that the investigators were not involved in the patient questionnaire completion process. No studies reported on whether the investigator measuring flexion and extension was blinded to other patient factors. Most studies have demonstrated adequate reporting of their results and discussions. Two papers did not disclose any funding associated with their study.

Using NOS, all cohort studies and Unver et al.'s [30] case-control study were of 'good' quality (***Table 2***). Four RCTs described their randomisation process. The results of the Cochrane Risk of Bias tool is shown in ***Table 3***. Degirmenci et al [31], Monticone et al [6] and Cai et al [32] demonstrated low risk of bias, whereas Russo et al [33] failed to describe how their data were analysed, and whether if it was in accordance with pre-specified analysis plans.

Study Design and Demographics

A total of 1,191 patients were identified, ranging from 31 to 200 per study (***Table 4***). Russo et al [33] did not specify the gender split and Body Mass Index (BMI) in their study but stated that the two groups were homogenous in terms of pre-operative age, gender, functional and psychological scores. Degirmenci et al [31] did not specify the mean BMI, but stated BMI over 40 in the exclusion criteria. Of 12 studies, 34.9% (380 of 1,089) were men. Study follow up duration ranged from no follow up (ie time of discharge) to 36 months.

Clinical Findings

Thirteen studies were reviewed, four were RCTs eight were cohort studies and one case-controlled study. Three studies assessed the change in TSK over time as their primary outcome, six studies measured function as a primary outcome using validated scores such as WOMAC in four studies, KOOS in one study and OKS in one study. Four studies used functional assessments such as two- or six-minute walk test (2-MWT/6-MWT), Going Up and Down Scale (GUDS) and Timed Up and Go Test (TUGT) as their primary outcome. Other outcome measures include pain measured using a Numerical Rating Scale (NRS) or McGill Pain Score (MPS) in 13 studies and flexion or change in ROM in seven studies.

Comparison 1: The role of kinesiophobia in outcomes following TKR

Primary outcomes:

Functional outcomes were assessed by ten studies (Doury-Panchout et al [34], Kocic et al [2], Sullivan et al [35], Sullivan et al [36], Filardo et al [37], Guney-Deniz et al [38], Filardo et al [29], Brown et al [39], Unver et al [30], and Degirmenci et al [31]). The results from these studies are shown in ***Table 5***.

Functional outcomes at less than six months:

Six minute walk test (6-MWT) distance was measured by Doury-Panchout et al [34] on hospital discharge, with TSK cut-point at 40. The less than 40 group had a distance of 309 (SD 83.6), versus the 40 plus group with 264 (SD 96.5), p=0.048. Guney-Deniz et al [38] measured the 2-MWT and TUGT at day two post-surgery, with a TSK cut-point at 39.5. TSK <39.5 2-MWT were 36.77 (SD 6.04), versus 39.5 plus at 26.42 (SD 5.07), p<0.01, and TUG for TSK <39.5 were 51.91 (range 33.56-59.11) versus 51.99 (range 32.7-58.7) (non-significant). Degirmenci et al [31] measured the 2-MWT and TUGT at days two and five post-surgery, with mean values of day two and five reported, using a TSK cut-point of 40. TSK <40 2-MWT were 36.15 (SD 4.16) versus 40 plus at 25.76 (SD 4.5), p<0.001. TUGT for <40 were 44.7 (SD 5.6) versus 48.7 (SD 6.2), p=0.011. Sullivan et al [36] found TSK correlated with function (r=0.38) at six weeks post op (p<0.005) with Bonferroni corrected alpha set at 0.005. Regression analysis showed that TSK predicts post-surgical WOMAC physical function score (beta = 0.24, p=0.06).

Functional outcomes six-12 months:

Kocic et al [2] measured the OKS at six months, with a TSK cut-point at 38. The TSK <38 group had an OKS of 34.48 (SD 7.93) vs 25.82 (SD 6.90) for the 38 plus group. Filardo et al [29] found a correlation between TSK1 and Physical Health SF-12 subscale at six months, p = 0.001, R = −0.334, and a correlation between WOMAC at six months of follow-up (p = 0.005, R = 0.279). At six months, Unver et al [30] found a correlation between TSK and GUDS r=0.468, p<0.001.

Functional outcomes at 12 months plus:

TSK was split into its constituent parts, TSK1 (activity avoidance) and TSK 2 (harm) in three studies. Sullivan et al [35], Filardo et al [29], and Filardo et al [37] found a correlation of TSK1 to physical function measured by WOMAC score at 12 months (r=0.20 p<0.05, p = 0.001, R = 0.317, and p=0.005 correlation coefficient=0.197 respectively). This was also proven with multivariate analysis by Filardo et al [37] p=0.011, however no correlation was found at the final mean three-years follow up by Filardo 2015 [29].

Secondary outcomes:

Pain outcomes at less than six months (***Table 6***)

Guney-Deniz et al [38] had a TSK cut-point of 39.5, and measured pain at day two post-surgery using a VAS. TSK <39.5 had a VAS of 2.3 (range 1.2-4.2) versus 3.2 (range 1.4-6.3) for TSK 39.5, p=0.003. They correlated TSK with pain at day two post-surgery r = 0.80, p <0.001. Degirmenci et al [31] had a TSK cut-point of 40, and measured pain levels Day 5 post-op using a VAS. TSK <40 had a VAS of 4.2 (SD 0.8) versus TSK 40 plus at 6.6 (SD 0.9), p<0.001.

Filardo et al [29] correlated TSK1 with day five post-operative pain via numerical rating scale (p=0.031, R = 0.225).Pain on discharge day for Doury-Panchout et al's [34] TSK <40 cohort was 8.9 ± 10.5mm, vs 11.3 ± 12.2 (non-significant). Kocic et al [2] used a numerical rating scale, with TSK cut-point at 38. Pain at two weeks was 5.03 (SD 1.54) for <38 versus , 6.09 (SD 1.33) for TSK 38 plus, p=0.0123. Pain at four weeks was 3.12 (SD 1.23) for <38 versus 5.00 (SD 1.49) for 38+ (p=0.000). Sullivan et al [36] did not correlate TSK and pain post operatively using the WOMAC pain score (r=0.31, p<0.005). This remained non-significant with regression analysis (beta = 0.07).

Pain outcomes six-12 months (***Table 6***)

Kocic et al [2] correlated TSK and pain via a numerical rating scale at six months with TSK cut-point of 38. TSK <38 had pain ratings of 1.81 (SD 1.50), vs 3.24 (SD 1.98), p=0.0035. Unver et al [30] found a correlation between pain and TSK at six months (r=0.236, p=0.004).

Pain outcomes 12 months plus: (***Table 6***)

Sullivan et al [35] did not correlate TSK and WOMAC pain scale at 12 months (r=0.23). TSK did not correlate significant unique variance to the prediction of follow up pain severity (beta = 0.10). Filardo et al [29] correlated TSK1 with 12-month post-operative pain via numerical rating scale (p=0.018, R= 0.234).

ROM outcomes less than six months (***Table 7***)

Guney-Deniz et al [38] measured active knee flexion on day two post-operative, with TSK <39.5 having flexion of 71.67° (SD 8.35°) versus 65.95° (SD 6.73°), p=0.025. TSK was found to correlate with range of motion at two days post-operative (r=-0.47, p<0.001). Doury-Panchout et al [34] compared TSK <40 to TSK 40 plus on discharge day, finding maximum passive flexion of 114.3° (SD 7.3°) in TSK <40 versus 11.34° (SD 9.4°) in 40 plus (non-significant). Maximum active extension in <40 was -6.7° (SD 5.9°) vs -5.9° (SD 6.5°) for 40 plus (non-significant). Degirmenci et al [31] measured active knee flexion on day five post-operatively, with a TSK cut-point of 40. TSK <40 had flexion of 84.1° (SD 6.3°) versus TSK 40 plus at 64.9° (SD 8.1°), p<0.001.

Kocic et al [2] found those with TSK <38 had active knee flexion of 65.98° (SD 14.51°) at two weeks versus 47.35° (SD 14.48°) for 38+, p=0.000. At four weeks <38 active knee flexion was 88.20° (SD 15.11°) versus 57.65° (SD 14.80°) in 38 plus, p=0.000.

ROM outcomes six-12 months (***Table 7***)

Kocic et al [2] measured active knee flexion at six months, finding TSK <38 at 105.33° (SD 12.34°) versus 85.53° (SD 14.77°), p=0.000. Kocic et al also found a strong negative correlation between TSK score and flexion at all points assessed (p<0.001).

Comparison 2: Treatment of kinesiophobia following TKR

Primary outcome: TSK score

The effect of various interventions to improve kinesiophobia, measured by the TSK scale was investigated by five studies: Monticone et al [6], Cai et al [32], Russo et al [33], Brown et al [39], and Degirmenci et al [31]. Results for these can be seen in ***Table 8***. Monticone et al [6] compared a six-month period of home based functional exercises to standard physiotherapy following TKR. Pre-TKR, there was no statistical difference between the two groups (TSK experimental group 34.14 (SD 7.54) versus control 34.40 (SD 5.51), p=0.842). Significant differences existed between groups at six and 12 months post TKR however: six-months experimental group TSK -14.30 (SD 0.80) versus control -2.10 (SD 0.80) (MD -12.2 (-14.5 to -9.9)) p<0.001; 12 months experimental group -18.30 (SD 0.80) versus control -2.80 (SD 0.80) MD -15.4 (-17.7 to -13.2), p <0.001.

Cai et al [32] conducted a RCT comparing inpatient physiotherapy plus an outpatient four week Cognitive behavioural therapy (CBT) programme designed to treat kinesiophobia with standard inpatient physiotherapy. There was no significant difference between the groups at baseline (TSK 46.98 (SD 5.44) versus 47.72 (SD 6.17), p=0.526. At six months post TKR, experimental group TSK was 27.76 (SD 4.56) versus 36.54 (SD 3.58) in the control group. Analysis revealed a group effect (p<0.001) between CBT and non-CBT groups.

Video treatment to produce positive insight into kinesiophobia was investigated by Russo et al [33], pre-operatively and at three months post TKR. Both groups showed a significant (p<0.001) difference between baseline and follow-up TSK, and there was a significant difference between video and no video groups at follow up (TSK 24 (SD 5) versus control 29 (SD 5) p<0.01).

Brown et al [39] investigated the effect of showing patients an intra-operative photograph of their knee's maximal passive flexion as an incentive to improve ROM. Post-operatively, the mean active knee flexion among the photo group was 99^{o} (SD 17.4^{o}) versus 106.1^{o} (SD 14.4^{o}) for the control group, p=0.1. Passive flexion in the photo group was 94.1^{o} (SD 18.5^{o}) versus 100.9^{o} (SD 15.5^{o}), p=0.14. There were no secondary outcomes for this comparison.

Degirmenci et al [31] conducted a randomised controlled trial comparing regional anaesthesia and deep sedation with regional anaesthesia and light sedation, measuring kinesiophobia with TSK score at days two and five post-operatively. Deep sedation was defined as Bispectral Index Score (BIS) of 60-70, while light sedation was defined as BIS up to 80. Significant differences between the two groups were shown at both time points: day two deep sedation TSK 40.5 (SD 6.1) versus light sedation 46.9 (SD 10.4) (p=0.005); day five deep sedation TSK 37.7 (SD 5.7) versus light sedation 46.4 (SD 10.0) (p<0.001).

Discussion

In this systematic review, we have found that kinesiophobia, measured by TSK score, negatively influences functional outcomes following TKR. This was found to be true at all three time points investigated. Functional outcomes measured included the Two- and Six-Minute Walk Tests (2/6-MWT), the Oxford Knee Score (OKS), the WOMAC functional score, and the Timed Up-and-Go (TUG test). Only the TUG test at day two post operatively, measured by Guney-Deniz et al [38], was not significantly different between high-TSK and low-TSK groups. Multivariate analysis conducted for functional outcomes and TSK score agreed that a correlation existed. When TSK1 (activity avoidance) and TSK2 (harm) were separated, it was TSK1 that correlated with WOMAC score at 12 months, but not at mean three years follow-up.

Sullivan et al [35], Sullivan et al [36], Filardo et al [37] and Filardo et al [29] found that kinesiophobia can predict post-surgical function independently of other psychological and physical variables. It was also demonstrated by Filardo et al that the effects of kinesiophobia can be seen for up to one year [37], and although its impact decreases in longer term follow up, higher TSK scores may still present with lower final outcomes [29].

Studies differed widely on the correlation between pain and TSK score. While Doury-Panchout et al [34] and Guney-Deniz et al [38] measured pain on day two and discharge date respectively, finding no significant differences between high-TSK and low-TSK groups; Degirmenci et al [31] found pain and TSK score correlated at day five post operatively. Kocic et al [2] found high-TSK and low-TSK groups to be significantly different at two and four weeks, and six months. This could be explained by a longer hospital stay demonstrated in kinesiophobic patients, apart from the fact that Sullivan et al [36], Sullivan et al [35], and Unver et al [30] all found no correlation between TSK and pain score. Again, Filardo et al [29] found TSK1 significant on day five post operatively but not TSK2. As a result, it is not clear whether a true statistical correlation between kinesiophobia and pain post-TKR exists based on our findings.

There were fewer data sets available for range of motion, but a mixed picture was also provided by our results. Kocic et al [2] demonstrated active knee flexion to be higher in low-TSK groups at two and four weeks, and at six months with a strong negative correlation at all points assessed. Guney-Deniz et al [38] Brown et al [39], and Degirmenci et al [31] also found a correlation between TSK and active knee flexion. However, Doury-Panchout et al [34] found no significant difference between high-TSK and low-TSK groups in max passive flexion and max active extension on discharge day, and Filardo et al [29] found no correlation between TSK1 and TSK2 in active or passive ROM. Measuring outcomes on discharge day could result in significant length of stay related biases, however. Our evidence suggests that there may be a negative relationship between active knee flexion and kinesiophobia, but not all studies are in agreement.

In our second comparison, increased levels of anaesthetic sedation were correlated with a reduced TSK score at days two and five post-operatively by Degirmenci et al [31], as well as superior performance in the 2-MWT and TUGT, and reduced pain. Intra-operative use of anaesthesia may therefore influence the early post-operative fear avoidance behaviour. Whether this continues to affect kinesiophobia more long-term is uncertain.

Our second comparison indicated that three of the four post-operative interventions to treat kinesiophobia had a positive impact. Home based functional exercises, an outpatient CBT programme, and video treatment could be used separately or in combination depending on the individual patient’s needs to improve quality of care for kinesiophobic patients. Brown et al [39] proved that showing a patient a photograph of their maximal passive knee flexion in theatre did not improve their active or passive ROM. Kinesiophobia is defined as an irrational fear, so it makes sense that trying to cure it based on appealing to rational thought processes may not yield the intended results.

The three successful interventions focussed on physiotherapy or psychotherapy, and a combination between the these two may yield the most successful result.

Using the TSK score has enabled an excellent means of stratifying kinesiophobia, and most of our papers used it to separate patients into high and low-TSK groups. All included studies had a threshold within two points of each other, but the decision to choose cut-off points by individual studies was not completely explained. This raises the possibility that these decisions may have affected outcomes. Filardo et al [29] split the TSK score into its component parts, activity avoidance and harm, enabling further analysis. This highlighted that TSK1 correlates better with pain and function, although this could not be compared to the cohorts of other studies.

This systematic review presented with a number of limitations. For example heterogeneity amongst studies in terms of outcome, whether reporting statistical significance between two groups or an overall correlation following regression analysis, restricted our ability to perform statistical comparisons. The statistical reporting of data also varied widely between studies, with some using standard deviation and others quoting ranges. The discrepancy between studies’ TSK thresholds also acted to prevent direct comparison between studies or meta-analysis, and is a metric that must be established for future research.

Conclusion

The role of kinesiophobia in outcomes post-TKR is inherently complicated, but our results indicate that functional outcomes are negatively influenced by its presence at time frames up to one year. Pain is correlated with kinesiophobia at six months. Active range of motion is negatively affected by kinesiophobia, but cannot be treated by simply showing patients that it is possible to achieve good ROM in theatre. Kinesiophobia can be improved through post-operative functional and psychological interventions such as long term physiotherapy, CBT, and video-based psychological therapy.

Tables and Figures

List of Tables and figures

Table 1: Newcastle-Ottowa Quality Assessment form for Cohort Studies

	Doury-Panchout et al., 2015	**Kocic et al.,2015**	**Sullivan et al., 2011**	**Sullivan et al., 2009**	**Filardo et al., 2016**	**Güney-Deniz et al., 2017**	**Filardo et al., 2015**	**Brown et al., 2015**
Selection (max 4)								
1	★	★	★	★	★	★	★	★
2	★	★				★		★
3	★	★	★	★	★	★	★	★
4	★	★	★	★	★	★	★	★
Comparability (max 2)								
1	★★	★★	★★	★★	★★	★★	★★	★★
Outcome (max 3)								
1	★	★	★	★	★	★	★	★
2		★	★	★	★		★	★
3	★	★	★	★	★	★	★	★
Total	8	9	8	8	8	8	8	9
Quality	Good	Good	Good	Good	Good	Good	Good	Good

Table 1. Selection Q2 (selection of non-exposed cohort). As all participants in these studies were subject to a TKR, the exposure for the purposes of this review will be defined as a patient scoring highly on the TSK. Selection Q4, the 'outcome of interest' is usually present at start of study (eg pain, range of movement) but the primary outcome measures are changes in the outcome, therefore we have assumed the 'outcome of interest' is not present at the start.

Table 2: Newcastle Ottowa Score for case-controlled studies

	Unver et al., 2014
Selection (max 4)	
1	★
2	★
3	
4	★
Comparability (max 2)	
1	★
Exposure (max 3)	
1	
2	★
3	★
Total	6
Quality	Good

Table 3: RoB 2.0 tool

	Monticone et al., 2013	Cai et al., 2017	Russo et al., 2017	Degirmenci et al. 2020
Randomisation	L	L	L	L
Deviation from intended intervention	L	L	L	L
Missing outcome data	L	L	L	L
Measurement of outcome	L	L	L	L
Selection of reporting	L	L	SC	L
Overall	L	L	SC	L

Table 3. L = Low risk of bias, SC = some concerns, H = high risk of bias Attempts were made to contact authors for their study protocol to accurately assess their ‘selection of reporting’. One author responded and stated their protocol was not written in English and would be difficult to retrieve.

Table 4. Demographic data (SD reported in brackets)

Paper	Doury-Panchout et al.	Kocic et al.	Monticone et al.	Sullivan et al.	Sullivan et al.	Cai et al.	Filardo et al.	Russo et al.	Güney-Deniz et al.	Filardo et al.	Brown et al.	Unver et al.	Degirmenci et al.
N	89	78	110	120	75	100	200	102	46	101	79	36	60
Age	72.6 (8.9)	68.5 (6.6)	67.5 (6.6)	67.0 (8.1)	68.6 (9.8)	65.7 (7.7)	65.7 (9.1)	69.1 (13.0)	63.8 (5.2)	65.6 (8.0)	64.3 (9.1)	65.2 (6.5)	67.7 (6.7)
BMI	29.6 (5.1)	30.9 (5.6)	28.2 (4.3)	30.8 (5.2)	29.9 (5.3)	26.6 (3.9)	28.2 (4.1)		22.7 (5.5)	28.5 (4.3)	32.1 (6.6)	28.4 (3.2)	<40 in all
Gender split (M:F)	37:52	19:59	40:70	47:73	29:46	38:62	66:134		15:31	31:70	39:40	0:36	19:41
Follow up (months)	0.3	6	12	12	1.4	6	12	3	0 Assessed on discharge day	Mean 38 (24-50)	6	6	0 (assessed day 2 and 5 post op)

Table 5: Comparison one - TSK and functional outcome results, split into time frames

Author	Doury-Panchout			Kocic			Sullivan	Sullivan	Filardo		Guney-Deniz		Filardo	Brown	Unver
Year	2015			2015			2011	2008	2016		2017		2015	2015	2014
Groups	TSK score high and low (cut-off = 40)			TSK score high and low (cut-off =38)			correlation with TSK presented	correlation with TSK presented	TSK split into subsets TSK 1 (activity avoidance) and TSK 2 (harm) and correlation measured		17 point Turkish version of TSK Cut-off 39.5 between high and low		TSK split into subsets TSK 1 (activity avoidance) and TSK 2 (harm) and correlation measured	correlation with TSK presented	patients with TKR and control group
subgroups	TSK <40	TSK >=40	P value	TSK <38	TSK >=38	P value			TSK 1 (activity avoidance)	TSK 2 (harm)	low TSK (<39.5) (gp 2) mean TSK 46.01 +/- 10.25	high TSK (>39.5) (gp 1) mean TSK 29.01 +/- 7.13	TSK 1 (activity avoidance), TSK 2 (pain = body damage)		of TKR group, none
Functional outcomes <6 months	6MWT distance 309 +/- 83.6 (discharge day)	6MWT distance 264 +/- 96.5 (p=0.048). (discharge day)	p=0.048					Post operation, TSK correlated with function (r=0.38, p<0.005). Regression analysis on TSK predicting physical function: beta = 0.24 p = 0.06			TUG 51.91 (33.56-59.11), 2MWT 36.77 +/- 6.04	TUG 51.99 (32.7-58.7) NS, 2MWT 26.42 +/- 5.07 (p<0.01)		distance walked (ft) correlation with TSK. Beta -0.46, SE 2.04, p=0.83	
Functional outcomes 6-12 months				oxford knee score (6 months) 34.48 +/- 7.93 (SD)	oxford knee score (6 months) 25.82 +/- 6.90 (SD)	p=0.0003							TSK correlated with WOMAC score p=0.005, r=0.279 (6 months). Also Physical Health SF-12 subscale at 6 months p = 0.001, R = −0.334		TSK correlation to going up and down scale (GUDS) r=0.468, p<0.001. (at 6 months)
Functional outcomes >12 months							TSK correlated with WOMAC function scale (r=0.22, p<0.01). TSK did not correlate significant unique variance to the prediction of follow up physical function (beta = 0.06)		TSK 1 correlated with 12-month WOMAC score (p=0.005, p=0.197)	no correlation between TSK2 and any outcome score.			TSK1 correlated with WOMAC score at 12 months (p=0.001, r=0.317). patients' perceived function at 12m (p=0.025, R=-0.223). TSK1 correlated with SF-12 at 12m (p<0.001, R=-0.320. Physical Health SF-12 subscale at 12 months p = 0.005, R = −0.277		

TSK = Tampa scale of Kinesiophobia, 6MWT = 6-minute walk time, WOMAC score = Western Ontario and McMaster Universities Osteoarthritis Index,

Table 6: Comparison one - TSK and pain results, split into time frames

Publication author	Doury-Panchout			Kocic			Sullivan	Sullivan	Filardo		Guney-Deniz			Filardo	Brown	Unver
Publication year	2015			2015			2011	2008	2016		2017			2015	2015	2014
Groups	TSK score high and low (cut-off = 40)			TSK score high and low (cut-off =38)			correlation with TSK presented	correlation with TSK presented	TSK split into subsets TSK 1 (activity avoidance) and TSK 2 (harm) and correlation measured		17 point Turkish version of TSK. Cut-off 39.5 between high and low			TSK split into subsets TSK 1 (activity avoidance) and TSK 2 (harm) and correlation measured	correlation with TSK presented	patients with TKR and control group
timepoints measured	discharge day			2 weeks, 4 weeks, 6 months			12 months	6 weeks	12 months post TKR		day 2 post-op			5 days, and 1, 6, 12 months. Final follow up at average 3.2 years	post op day 1-4, as well as outpatient follow up week 2,6,12,26	pre-op, discharge date, 2 weeks, 4 weeks, 6 months (most results reported at 6 months)
subgroups	TSK <40	TSK >=40		TSK <38	TSK >=38				TSK 1 (activity avoidance)	TSK 2 (harm)	low TSK (<39.5) (gp 2) mean TSK 46.01 +/- 10.25	high TSK (>39.5) (gp 1) mean TSK 29.01 +/- 7.13		TSK 1 (activity avoidance), TSK 2 (pain = body damage)		of TKR group, none
Pain <6 months	pain intensity (mm) 8.9 +/- 10.5	pain intensity (mm) 11.3 +/- 12.2	non-significant	NRS 2 weeks 5.03 +/- , 1.54, 4 weeks 3.12 +/- 1.23	NRS 2 weeks 6.09 +/- 1.33, 4 weeks 5.00+/- 1.49	2 weeks p=0.0123, 4 weeks p=0.000					VAS/10 = 2.3 (1.2-4.2) (day 2 post op)	VAS/10 = 3.2 (1.4-6.3) (day 2 post op)	p=0.003	TSK1 correlated with post op pain (NRS) 5 days p=0.031, R = 0.225)		
Pain 6-12 months				NRS 6 months 1.81 +/- 1.50	NRS 6 months 3.24 +/- 1.98	p=0.0035										pain correlation to TSK reported r=0.236, p=0.004)
Pain >12 months														TSK1 correlated with post op pain (NRS) 12 months (p=p=0.018, R= 0.234)		

TSK = Tampa scale of Kinesiophobia, NRS = numerical rating scale, VAS = visual analogue scale

Table 7: Comparison one – TSK and range of motion results, split into time frames

Publication author	Doury-Panchout			Kocic			Sullivan	Sullivan	Filardo		Guney-Deniz			Filardo	Brown	Unver
Publication year	2015			2015			2011	2008	2016		2017			2015	2015	2014
Groups	TSK score high and low (cut-off = 40)			TSK score high and low (cut-off =38)			correlation with TSK presented	correlation with TSK presented	TSK split into subsets TSK 1 (activity avoidance) and TSK 2 (harm) and correlation measured		17 point Turkish version of TSK. Cut-off 39.5 between high and low			TSK split into subsets TSK 1 (activity avoidance) and TSK 2 (harm) and correlation measured	correlation with TSK presented	patients with TKR and control group
timepoints measured	discharge day			2 weeks, 4 weeks, 6 months			12 months	6 weeks	12 months post TKR		day 2 post-op			5 days, and 1, 6, 12 months. Final follow up at average 3.2 years	post op day 1-4, as well as outpatient follow up week 2,6,12,26	pre-op, discharge date, 2 weeks, 4 weeks, 6 months (most results reported at 6 months)
subgroups	TSK <40	TSK >=40		TSK <38	TSK >=38				TSK 1 (activity avoidance)	TSK 2 (harm)	low TSK (<39.5) mean TSK 46.01 +/- 10.25	high TSK (>39.5) mean TSK 29.01 +/- 7.13		TSK 1 (activity avoidance), TSK 2 (pain = body damage)		of TKR group, none
ROM <6 months	max passive flexion degrees 114.3 +/- 7.3. max active extension -6.7 +/- 5.9 (discharge day)	max passive flexion degrees 113.4 +/- 9.4. Max active extension -5.9 +/- 6.5 (discharge day)	non-significant	active knee flexion: 2 weeks 65.98 +/- 14.51, 4 weeks 88.20 +/- 15.11	active knee flexion 2 weeks 47.35+/- 14.48, 4 weeks 57.65 +/- 14.80	p=0.000 2 weeks, p=0.000 4 weeks					active knee flexion ROM. 71.67 +/- 8.35	active knee flexion 65.95 +/- 6.73	p=0.025	no correlation between TSK1 or TSK2 and active or passive ROM	TSK correlation with active and passive knee flexion. Negative correlation 1 point increase in TSK associated with 0.47degree decrease in active knee flexion (B=-0.47, SE 0.18, p<0.01) and 0.66 degree decrease in passive knee flexion (B=-0.66, SE 0.18, p<0.01)	
ROM 6-12 months				active knee flexion 6 months 105.33 +/- 12.34	active knee flexion 6 months 85.53 +/- 14.77	p=0.000										
ROM >12 months																

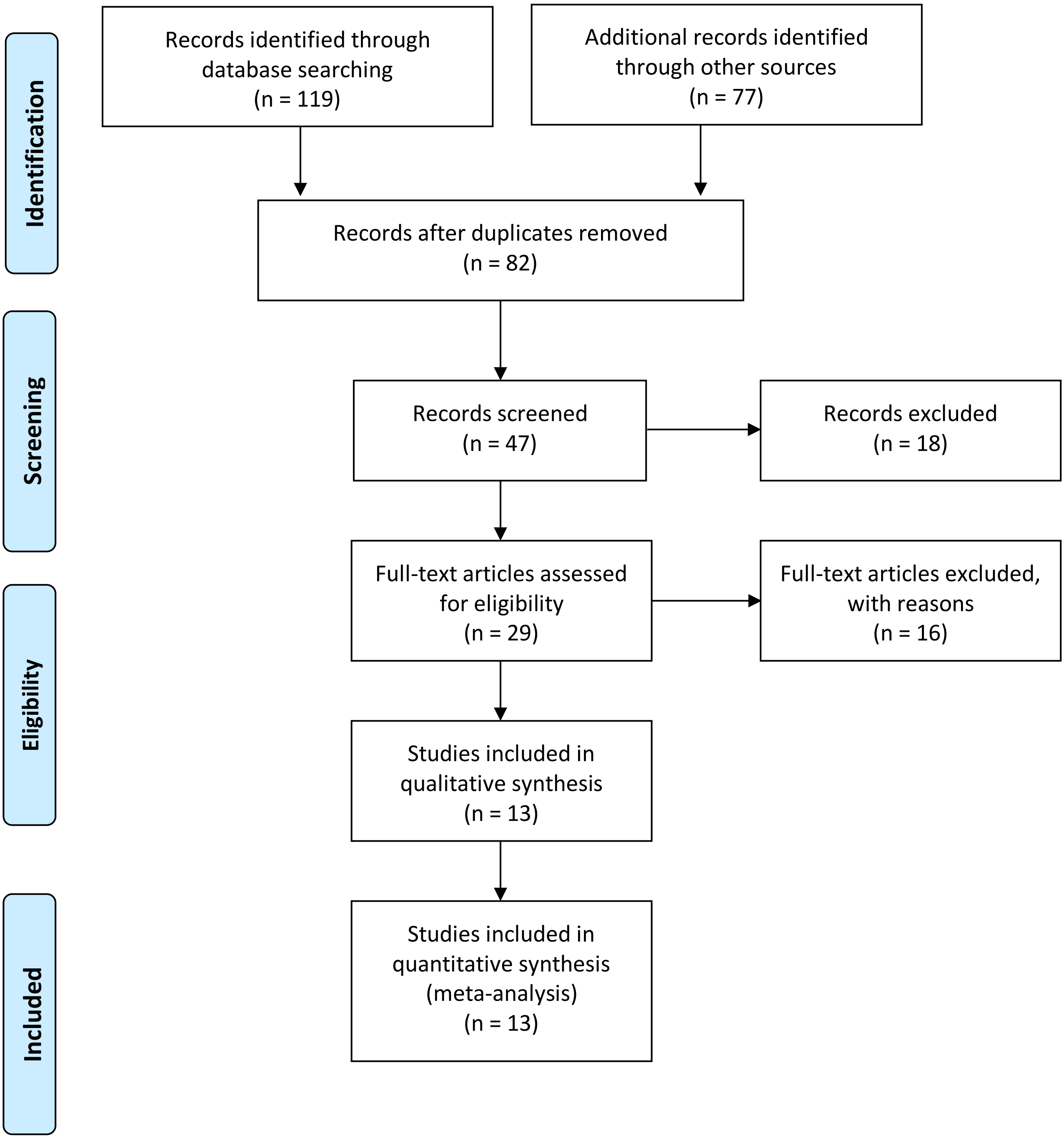
TSK = Tampa scale of Kinesiophobia

Table 8: Comparison two results

Author	Monticone et al			Cai et al			Russo et al		
Year	2013			2017			2017		
Description	RCT comparing home based functional exercises for six months to standard physiotherapy (used Italian 13-point version of TSK)			RCT comparing CBT programme with no CBT programme			comparison of video treatment with group without video treatment		
Groups	home based functional exercises	control	statistical significance	CBT	non-CBT	statistical significance	video to produce positive insight	no video	statistical significance
Timepoints measured	at discharge from rehab unit (t0), 6 months after (t1 - when rehab programme stopped), and 12 months post Dx (t2)			day 1 or 2 post-TKR, 4 weeks, 6 months			pre operatively, and 3 months after surgery		
baseline	31.14 +/- 7.54 (at discharge)	34.40 +/- 5.51 (at discharge)	p=0.842	46.98 +/- 5.44	47,72 +/- 6.17	p=0.526	36 +/- 8	38 +/- 6	p<0.01
Less than 3 months				38.90 +/- 5.07 (4 weeks)	44.18 +/- 5.83 (4 weeks)				
3-11 months	baseline - 14.30 +/- 0.80 (6 months)	baseline -2.10 +/- 0.80 (6 months)	MD -12.2 (-14.9 to -9.9), p<0.001	27.76 +/- 4.56 (6 months)	36.54 +/- 3.58 (6 months)	F=33.867, p<0.001	24 +/- 5	29 +/- 5	p<0.01
12 months plus	baseline - 18.30 +/- 0.80 (12 months)	baseline -2.80 +/- 0.80 (12 months)	MD -15.4 (-17.7 to -13.2) p<0.001						

RCT = Randomised controlled trial, TSK = Tampa scale of Kinesiophobia, MD = mean difference, CBT = cognitive behavioural therapy

Figure 1: Search strategy. PRISMA diagram showing search results and route taken to finalise studies included in this review



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