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Review Article

Effects of Combined Exercise and Psychological Interventions on Psychological Factors After Total Knee Arthroplasty: A Systematic Review

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SUMMARY

Psychological factors, including pain catastrophizing, depression, and anxiety are factors that influence chronic pain and physical function after total knee arthroplasty (TKA). Previous studies have shown that exercise and psychological interventions improve psychological factors. However, the level of evidence on the effect of the combined exercise and psychological interventions on psychological factors after TKA is unclear. The purpose of this study was to determine whether the combined exercise and psychological interventions for patients who underwent TKA improves psychological factors compared to exercise alone or psychological intervention alone, and to determine the quality of the evidence. Moreover, to identify interventions with a high level of evidence that improve psychological factors in patients who underwent TKA. Randomized controlled trials (RCTs) were researched in PubMed, Cochrane Library, Cumulative Index to Nursing and Allied Health Literature, Physiotherapy Evidence Database (PEDro), and Igaku Chuo Zasshi. The PEDro scale was used for assessing the risk of bias. This study included seven RCTs. Combined exercise and cognitive behavioral therapy may be more effective than exercise intervention alone in improving pain catastrophizing in patients who underwent TKA. Additionally, combined exercise and auditory or visual intervention may be more effective than exercise intervention alone in improving depression in patients who underwent TKA.

1. Introduction

Total knee arthroplasty (TKA) is commonly performed to relieve pain and improve the functional status of end-stage knee osteoarthritis (OA). The number of TKAs performed annually in the United States is rising and is expected to increase by 855% between 2012 and 2050.[1] Pain catastrophizing, depression, anxiety, and self-efficacy are factors affecting chronic pain and physical function after TKA.[2] The prevalence of chronic pain in patients who underwent TKA has been reported to be approximately ≥ 20%.[3,4] Therefore, interventions that focus on psychological factors are important in reducing the number of patients suffering from chronic pain after TKA.[5]

Exercise and psychological interventions can be used to improve psychological factors after TKA. Exercise interventions are mainly used to improve physical functions, such as improving joint range of motion and muscle strength,[1] but have also been reported to be effective in improving psychological factors.[6] Several treatment guidelines, exercise intervention is recommended in patients who underwent TKA.[1,7] Psychological interventions can contribute to various psychological factors such as anxiety and depression.[8] In the previous decade, cognitive behavioral therapy (CBT)[9] and pain coping skills training (PCST)[10] and guided imagery (GI), which focuses on sensory information such as vision, hearing, and touch, have also been reported to contribute to the improvement of psychological factors.[11] These findings suggest that combined exercise and psychological interventions may be beneficial in improving psychological factors in patients who underwent TKA.

Few systematic reviews have investigated the combined effect of exercise and psychological interventions in patients with knee OA. Previous systematic reviews have reported that exercise interventions (with or without any other interventions) can effectively improve the quality of life and psychosocial factors in patients with knee OA.[12] As for CBT (with or without exercise therapy), it has been shown to be effective in improving self-efficacy, depression, and psychological distress in patients with knee OA.[12] However, the impact on psychological factors when exercise intervention is combined with various psychological interventions other than CBT has not been clarified. Moreover, the level of evidence for the effects of combined exercise and psychological interventions on psychological factors in patients who underwent TKA remains unclear. Combined exercise and psychological interventions have been shown to im-

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prove pain and physical function.[13] However, its impact on psychological factors is not clarified. If the efficacy of these combinations is evident and effective interventions are identified, they can be recommended.

The purpose of this systematic review was to determine whether the combined exercise and psychological intervention improves psychological factors in patients who underwent TKA compared to the exercise alone or the psychological intervention alone, and to determine the quality of evidence. Moreover, to identify interventions with a high level of evidence that improve psychological factors in patients who underwent TKA.

2. Materials and methods

This systematic review was performed based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[14] This study is registered in the University Hospital Medical Information Network (UMIN) to prevent duplication and reduce reporting bias (approval number: UMIN000044568).

2.1. Data sources and search strategy for identification of studies

To reduce language bias, the search languages were English and Japanese. The following electronic databases were searched from the earliest date of each database until September 10, 2021: PubMed, the Cochrane Central Register of Controlled Trials (CENTRAL), the Cumulative Index to Nursing and Allied Health Literature (CINAHL), the Physiotherapy Evidence Database (PEDro), and the Igaku Chuo Zasshi (ICHUSHI). The ICHUSI was a Japanese database. Moreover, the reference lists of the included studies and previous systematic reviews were manually scanned to ensure that all relevant trials were identified. The search strategy was a combination of free text words and Medical Subject Headings (MeSH) terms. The concepts of "intervention" and "outcome" were combined with the "AND" operator. The intervention was the combined exercise and psychological interventions, and the outcomes were psychological factors. For each concept, synonyms and MeSH terms were combined with the "OR" operator.

2.2. Eligibility criteria

The inclusion criteria were as follows: (i) studies of patients who underwent TKA for OA, (ii) those of patients who received combined exercise and psychological interventions in the experimental group, (iii) those with control group who received exercise intervention alone, psychological intervention alone, or no intervention at all, (iv) randomized controlled trials (RCTs), and (v) articles written in English or Japanese.

Meanwhile, the exclusion criteria were as follows: (i) studies of patients with rheumatoid arthritis, (ii) those of patients with systemic lupus erythematosus, (iii) those of patients who underwent bilateral TKA, and (iv) those of patients who underwent revision TKA.

The definition of exercise intervention was as follows: (i) explanations and instructions about exercise are given, (ii) range of motion (ROM) exercises, strength training, loading exercises, and gait exercises are given in hospital or outpatient department. The psychological interventions were defined as follows: (i) CBT, (ii) PCST, and (iii) interventions related to sight, sound, and sense of movement. Previous reports have defined psychological intervention as the use of specific principles or techniques that can improve psychological well-being or can reduce symptoms associated with psychological difficulties including pain.[15] Psychological interventions eligible for inclusion in this review include CBT, PCST, and interventions related to sensory information such as GI.[15,16] Image on GI manifests as sight, sound, and sense of movement.[16] Therefore, in this review, interventions related to sensory information such as sight, sound, and sense of movement were also defined as psychological interventions.

2.3. Article screening and selection

The first author (JN) searched the databases. Two authors (JN and KO) screened the titles and abstracts of all retrieved results screened for eligibility. At the first screening process, we aimed to narrow down the volume of articles by rejecting all studies that did not meet the eligibility criteria. Then, we removed duplicates. Next, we collected the full-text copies of articles that were not excluded based on titles or abstracts and reapplied the criteria. The full-text papers were evaluated by two reviewers (JN and KO). If disagreements arise at the article screening and selection screening stage, we resolved the disagreements by discussion, including the third party.

2.4. Data extraction process

We prepared a spreadsheet created using the Microsoft Excel (Microsoft, Redmond, WA) to extract data (patient information, intervention methods, outcome measures, and results). Two authors (JN and KO) discussed and agreed on the results of the extracted data.

2.5. Risk of bias in individual studies

Two reviewers (JN and KO) independently applied PEDro to rate the methodological quality and statistical reporting of each trial.[17] Each item is scored yes or no, with a maximum score of 10 if no points are deducted at all. Moreover, it has moderate inter-rater reliability (intraclass correlation coefficient = 0.68 [95% confidence interval (CI): 0.57–0.76]) for clinical trials.[18] The PEDro scale was reported that < 4 are considered "poor", 4 to 5 are considered "fair", 6 to 8 are considered "good" and 9 to 10 are considered "excellent".[19] Therefore, a trial with a score ≥ 6 had a high quality, which is consistent with the result of previous reviews.[20]

2.6. Synthesis of results

We planned to combine data in a meta-analysis, in which a minimum of two trials were clinically homogenous trials. Clinically homogeneous trials were those that used a common population and outcome measures and had the same intervention duration and content. For the meta-analysis, we planned to use inverse variance method and random effects analysis and Review Manager version 5.4 (The Cochrane Collaboration, Freiburg, Germany).

3. Results

3.1. Study selection

The combined database search yielded 429 trials. After adjusting for duplicates, 375 trials were considered. Among them, 342 were eliminated as they do not meet the inclusion criteria based on abstract review. The complete text of the remaining 33 studies was examined in detail. In total, 26 studies did not meet the inclusion criteria, as described previously. Finally, seven studies fulfilled the inclusion criteria[21–27] (Figure 1).

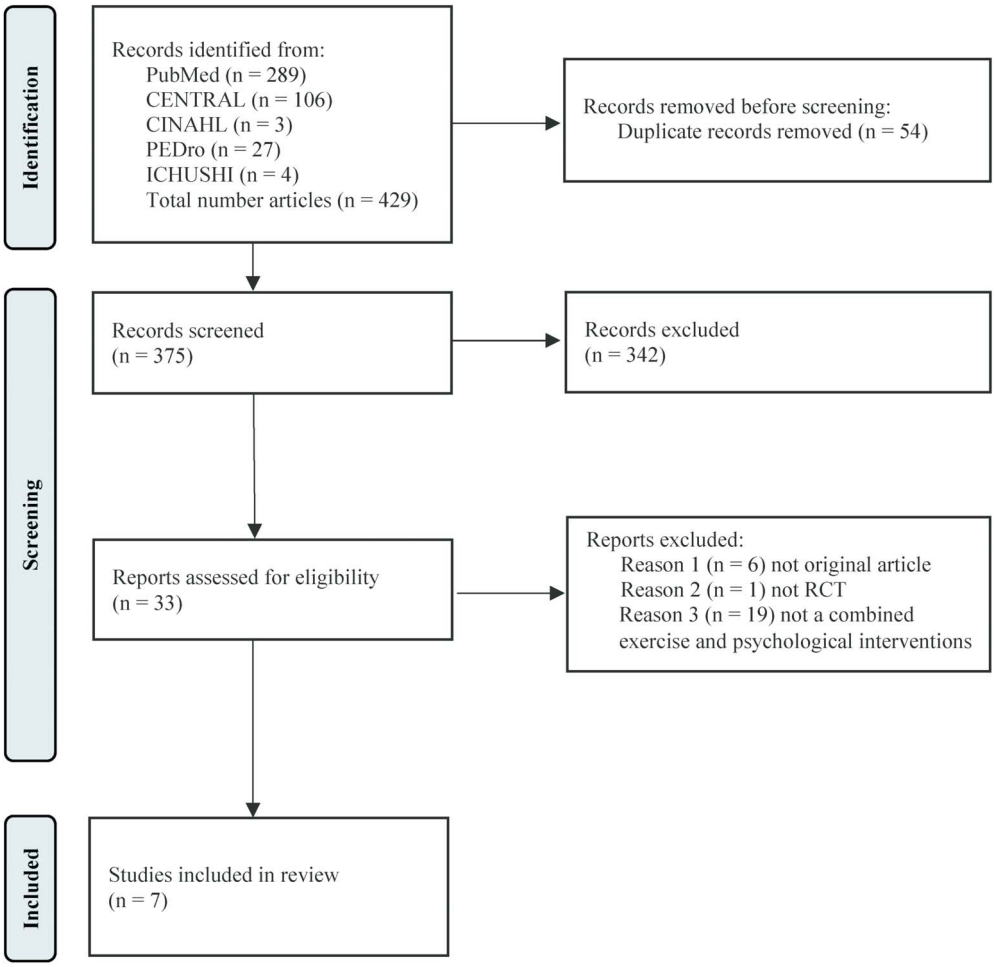

Figure 1. Flow chart of included and excluded studies. CENTRAL, Cochrane Central Register of Controlled Trials; CINAHL, Cumulative Index to Nursing and Allied Health Literature; ICHUSHI, Igaku Chuo Zasshi; PEDro, the Physiotherapy Evidence Database.

3.2. Study characteristics

This research included 667 participants (331 comparisons and 336 interventions). The age of the participants ranged from 60.2 to 75.5 in the control group and from 57.8 to 75.8 in the intervention group. The gender of the participants ranged from 55.2-100% in the control group and 45.2-82.3% in the experimental group were female. Only one study had not data about age and sex. Table 1 shows the summary of the included studies.

3.3. Types of exercise

Two studies included exercise description and instruction;[21,23] four, ROM exercises;[22,25–27] one, continuous passive motion exercises;[24] two, active exercises;[24,27] four, weight-bearing exercises;[22,23,26,27] one, functional task-oriented exercises;[23] one, quadriceps training;[25] three, gait exercise;[25–27] and one, stair training.[25] Some studies were duplicated. In all studies that were included, the control group received exercise interventions alone. The exercise in these studies[21–27] above lasted 10 days to 12 weeks.

3.4. Types of psychological interventions

One study was a structured telephone follow-up;[21] one, video-based intervention;[22] two CBT;[23,24] one, isometric quadriceps muscle exercise with auditory and visual feedback intervention;[25] one, rehabilitation based on a biopsychosocial model including PCST;[26] and one, relaxation exercise therapy.[27] Psychological interventions in these studies[21–27] above lasted from 3 days to 3 months.

3.5. Outcome measures

The Beck Depression Inventory (BDI) and Hospital Anxiety and Depression scale (HADS) were used to assess depression. The State-Trait Anxiety Inventory (STAI) and HADS were applied to evaluate anxiety. Pain catastrophizing was assessed using the Pain Catastrophizing Scale (PCS). None of the articles assessed self-efficacy.

3.6. Timing of interventions

One RCT[26] reported starting the intervention on postoperative day 0; two[25,27] on postoperative day 1; one[23] on postoperative day 1–2; one[22] on postoperative day 3; one[21] after postoperative week 1 and discharge from the hospital; and one[24] 2 weeks preoperatively and on postoperative day 2.

3.7. Timing of improvement in psychological factors through a combined exercise and psychological intervention

Three RCTs[23,24,26] reported a significant improvement in PCS at 1 month, one[24] at 3 months, one[23] at 6 months, and one[24] at 12 months postoperatively. Two studies[21,22] reported significant improvement in BDI at 3 months postoperatively. One RCT[21] reported

Table 1
Summary of included studies.

Study	Participants (EG)			Participants (CG)		
	Sample Size	Mean age (SD)	Female (%)	Sample Size	Mean age (years)	Female (%)
Eymir et al. (2022)[27]	55	66.0†	70.9	51	68.0†	80.4
Bhatia et al. (2020)[26]	11	66.17 (7.08)	63.6	12	66.91 (9.02)	100
Kondo et al. (2022)[25]	34	75.8 (5.8)	82.3	35	75.5 (6.1)	82.8
Sun et al. (2020)[24]	42	57.8 (8.7)	45.2	38	60.2 (8.2)	55.2
Cai et al. (2018)[23]	50	65.26 (8.30)	60.0	50	66.18 (7.04)	64.0
Russo et al. (2017)[22]	50	Unclear	Unclear	52	Unclear	Unclear
Chen et al. (2016)[21]	94	66.18 (3.59)	68.0	93	67.05 (4.05)	73.1

Study	Intervention					
	Contents	Frequency	Duration	Data collection points	Outcome	Results
Eymir et al. (2022)[27]	E: Standard physical therapy + Relaxation. C: Standard physical therapy.	Standard physical therapy: unclear. Relaxation: three times.	Standard physical therapy: during the inpatient period. Relaxation: 3 days.	Total= three Baseline Discharge 3 months postoperatively	HADS anxiety HADS depression	There was no significant difference between the two groups during at discharge, and at 3 months postoperatively.
Bhatia et al. (2020)[26]	E: Standard TKR rehabilitation protocol + Bio psychosocial model of rehabilitation. C: Standard TKR rehabilitation protocol.	Standard TKR rehabilitation protocol: unclear. Bio psychosocial model of rehabilitation: unclear.	Standard TKR rehabilitation protocol: 4 weeks. Bio psychosocial model of rehabilitation: 4 weeks.	Total= two Baseline 4 weeks postoperatively	PCS	EG had significantly lower PCS scores at 4 weeks postoperatively.
Kondo et al. (2022)[25]	E: Standardized inpatient rehabilitation exercise program + Auditory and visual feedback (instead of the traditional quadriceps sets). C: Standardized inpatient rehabilitation exercise program.	Standardized inpatient rehabilitation exercise program: every day. Auditory and visual feedback: began on the second postoperative day and was performed daily.	Standardized inpatient rehabilitation exercise program: under 3 weeks hospitalization management. Auditory and visual feedback: postoperative days 2 to 14.	Total= four Before TKA 1 week postoperatively 2 weeks postoperatively 3 weeks postoperatively	HADS anxiety HADS depression PCS	HADS anxiety and depression were not significantly different between the EG and CG at all time points. EG has significantly lower anxiety scores at 2 and 3 weeks postoperatively compared to preoperatively.
Sun et al. (2020)[24]	E: Active exercise and continuous passive motion exercise + CBT. C: Active exercise and continuous passive motion exercise.	Active exercise and continuous passive motion exercise: unclear. CBT: three times.	Active exercise and continuous passive motion exercise: unclear. CBT: 3 days.	Total= four Preoperative 1 month postoperatively 3 months postoperatively 12 months postoperatively	PCS	EG had significantly lower PCS scores at one, three, and 12 months postoperatively.
Cai et al. (2018)[23]	E: Rehabilitation exercises + CBT. C: Rehabilitation exercises.	Rehabilitation exercises: unclear. CBT: unclear.	Rehabilitation exercises: during hospitalization. CBT: 4 weeks.	Total= Three Preintervention 4 weeks postoperatively 6 months postoperatively	PCS	The EG improved PCS score in patients with severe kinesiophobia. The treatment effect lasted for at least 6 months after the end of the intervention.
Russo et al. (2017)[22]	E: PT programme + The Videoinsight® Method. C: PT programme.	PT programme: six times a week. The Videoinsight® Method: seven times a week until 15th day, three times a week after the 15th day (The Videoinsight® Method).	PT programme: 10 days. The Videoinsight® Method: 3 months.	Total = Two Before the operation 3 months postoperatively	STAI BDI	In the EG, the STAI and BDI scores at three months postoperatively were significantly reduced.
Chen et al. (2016)[21]	E: Standardized home exercises + Structured telephone follow-up. C: Standardized home exercises.	Standardized home exercises: everyday. Structured telephone follow-up: three times.	Standardized home exercises: 12 weeks. Structured telephone follow-up: 6 weeks.	Total = Three Before the operation 3 months postoperatively 6 months postoperatively 12 months postoperatively	BDI	EG significantly reduced the BDI score at 3 months postoperatively.

CG, Control group; EG, Experimental group.
BDI, Beck Depression Inventory; CBT, cognitive behavioral therapy; HADS, Hospital Anxiety and Depression Scale; PCS, Pain Catastrophizing Scale; PT, physical therapy; SD, standard deviation; STAI, State-Trait Anxiety Inventory; TKA, total knee arthroplasty; TKR, total knee replacement.
† Median.

significant improvement in STAI at 3 months postoperatively. Finally, six RCTs[21–26] reported improvement in psychological factors among patients. Some studies were duplicated.

3.8. Risk of bias across studies

Table 2 presents the PEDro scores of the included studies. There were five high-quality trials (PEDro score > 5), with a mean score of 6.2 across all trials. The total PEDro scores were 8 for one trial,[23] 7 for two trials,[21,22] 6 for two trials,[24,25] and 5 for two trials.[26,27] The items on the PEDro scale that were most adhered to were random allocation, use of similar groups at baseline, and between group statistical comparisons, which were evident in all trials. Participants or therapists were blinded to one paper only.[23] Four trials reported employing an intention-to-treat analysis.[23–26] Four used allocation concealment;[21–23,27] five used blinded outcome assessors;[21–24,27] and four performed measurements of at least one key outcome for > 85% of the participants.[21–23,25]

3.9. Synthesis of results

Inconsistencies were observed between the RCTs, including differences in the duration and content of the intervention. Therefore, a meta-analysis could not be performed.

4. Discussion

This study aimed to determine whether the combined exercise and psychological intervention improves psychological factors in patients who underwent TKA compared to the exercise alone or the psychological intervention alone, and to determine the quality of the evidence. Moreover, to identify interventions with a high level of evidence that improve psychological factors in patients who underwent TKA. This study found that RCTs have assessed the combined effects of exercise and psychological interventions against pain catastrophizing, depression, and anxiety in patients who underwent TKA. Of the seven RCTs, six[21–26] showed that the combined exercise and psychological interventions improved psychological factors after TKA, and the quality of the evidence in each RCT was also clear, thus achieving the purpose of this study. Furthermore, the combined exercise and CBT or exercise and visual and auditory intervention via telephone or video may improve psychological factors such as pain catastrophizing and depression in patients who underwent TKA. Thus, by identifying the interventions with a high level of evidence that improved psychological factors in patients who underwent TKA, we were able to achieve the purpose of this study. However, the control group in all studies had exercise interventions, and whether combined exercise and psychological interventions was more effective than psychological interventions alone remains unclear.

To the best of our knowledge, this was the first systematic review about the effects of combined exercise and psychological interventions in patients who underwent TKA for knee OA. Previous systematic reviews have reported that most psychological interventions did not improve patient-reported outcomes after arthroplasty, and most articles included patients who underwent total hip arthroplasty.[28] In addition, previous systematic reviews and meta-analyses of persistent pain after TKA have shown that pain catastrophizing, depression, and anxiety are predictors of persistent pain.[2] In particular, pain catastrophizing is a factor affecting chronic pain and postoperative outcomes in patients who underwent TKA.[29] Although it has been reported that psychological aspects are a risk factor for persistent pain in patients who underwent TKA, it is unclear which interventions can improve psychological aspects in patients who underwent TKA. This review focused on patients who underwent TKA. Results showed that combined exercise intervention and CBT or combined exercise and visual or auditory intervention could improve pain catastrophizing and depression in patients who underwent TKA. The strength of this study is that it confirmed the intervention and timing that improved pain catastrophizing and depression. Furthermore, combined exercise and psychological interventions were not indicated in existing guidelines and may contribute to future updates.

Combined exercise and CBT could improve pain catastrophizing one month in patients who underwent TKA. Pain catastrophizing can affect pain perception and response to physical activity and the outcome of TKA.[30] Two studies included in this review improved pain catastrophizing by educating patients on the importance of pain knowledge and activity.[23,24] The duration of all interventions was 30 min per session, and patients were educated about the need to exercise and the importance of physical activity even in the presence of pain.[23,24] In addition, both studies applied relaxation during the sessions.[23,24] One session required about 30 min of intervention time, and exercise that combine relaxation, physical activity, and education on how to cope with pain were found to be effective in improving pain catastrophizing. A possible mechanism for the improvement in pain catastrophizing could be explained by the fear avoidance model.[31] In two RCTs[23,24] in this study, patients were educated about the importance of exercise and physical activity and pain coping skills. In the fear avoidance model, it is clear that disuse leads to the experience of pain, which results in pain catastrophizing. Therefore, the combined exercise and CBT improved disuse, and the knowledge of pain coping skills might have led to a reduction in experiencing pain and an improvement in pain catastrophizing.

The combined exercise and visual or auditory interventions against depression was enhanced. However, it might require a certain period of time. RCTs[21,22] that combined exercise with visual and auditory interventions improved depression, with an intervention period ranging from 6 weeks to 3 months. Meanwhile, the combined exercise intervention and relaxation exercise therapy

Table 2
PEDro score.

Study	Eligibility criteria	Random allocation	Concealed allocation	Baseline comparability	Blind subjects	Blind therapists	Blind assessors	Adequate follow-up	Intention-to-treat analysis	Between-group comparisons	Point estimates and variability	PEDro score
Eymir, 2022[27]	Yes	Yes	Yes	Yes	No	No	Yes	No	No	Yes	No	5
Bhatia, 2020[26]	Yes	Yes	No	Yes	No	No	No	No	Yes	Yes	Yes	5
Kondo, 2022[25]	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	6
Sun, 2020[24]	No	Yes	No	Yes	No	No	Yes	No	Yes	Yes	Yes	6
Cai, 2018[23]	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	8
Russo, 2017[22]	No	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	7
Chen, 2016[21]	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	7

performed while listening to an audiotape did not improve depression, and this finding is attributed to the short intervention period (3 days).[27] Therefore, a combined exercise and visual and auditory intervention lasting 6 weeks or longer might be useful as a treatment option to improve depression in patients who underwent TKA.

There was no consensus regarding the combined effect of exercise and psychological interventions on anxiety among patients who underwent TKA. Eymir et al.[27] revealed that the relaxation intervention lasted for 3 days postoperatively, and that it did not improve anxiety at discharge and at 3 months after TKA. Kondo et al.[25] reported that auditory and visual feedback up to 14 days in patients who underwent TKA did not significantly differ in psychological factors compared to the control group, but anxiety scores were significantly reduced in the experimental group compared to the preoperative in the postoperative 2 and 3 weeks. Russo et al.[22] showed that the use of the Videoinsight® method at home three times a week for 3 months in patients who underwent TKA significantly reduced anxiety scores. These three reports about anxiety[22,25,27] differed greatly in the duration of intervention, the timing of outcome measurement, and the age of the participants. Since anxiety is a psychological factor correlated with persistent pain in patients who underwent TKA,[2] future studies should be conducted to elucidate the effects of combined exercise and psychological interventions to maximize anxiety reduction.

The current study has several limitations. First, the protocol design used in each study differed, and the duration and content of the interventions were inconsistent. Second, seven RCTs could not be included in the meta-analysis. More RCTs are needed to determine the effect size more accurately. Third, in this review, some type of exercise intervention was administered to all control groups, and whether the effect was a result of combined exercise and psychological interventions or psychological interventions could not be identified. Fourth, there were few RCTs included in this review, and we could not confirm whether there was publication bias. The Cochrane Handbook for Systematic Reviews of Interventions[32] states that tests for asymmetry in funnel plots should only be performed if at least 10 studies are included in the meta-analysis. Because of the small number of studies used in the analysis, the presence of publication bias could not be determined for this study. Therefore, the presence of publication bias could not be determined because of the small number of studies included in this analysis. If these items will improve, the effects of exercise and psychological interventions on psychological factors in patients who underwent TKA can be identified.

5. Conclusion

This review found that the effects of combined exercise and psychological interventions on psychological factors in patients who underwent TKA have been tested in RCT studies. Compared with exercise intervention alone, combined exercise and psychological intervention was suggested to have the potential to improve the pain catastrophizing after one month and depression after three months in patients who underwent TKA. Nevertheless, further RCTs should be conducted to validate the combined effects of exercise and psychological interventions.

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Declaration of any potential financial and non-financial conflicts of interest

The authors have no conflicts of interest to declare

Supplementary materials

Supplementary materials for this article can be found at http://www.sgecm.org.tw/ijge/journal/view.asp?id=25.

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