A Pedaling-Based Three Exercise Protocol Was Superior to a Non-Pedaling Ten Exercise Protocol for Post-Operative Rehabilitation After Total Knee Replacement in a Randomized Controlled Trial

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A Pedaling-Based Protocol was Superior to a Ten Exercise Non-Pedaling Protocol for Post-Operative Rehabilitation after Total Knee Replacement in a Randomized Controlled Trial

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Disclosure:

- **Larissa Sattler:** No conflicts to disclose
- **Wayne Hing:** No conflicts to disclose
- **Christopher Vertullo:**
  - Held shares in: Nil
  - Received royalties from: Nil
  - Done consulting work for: Nil
  - Given paid presentations for: Zimmer, Smith & Nephew

Background

- There is a lack in research into the optimal exercise protocols in both the acute inpatient setting and early period after discharge following Total Knee Replacement

- Pedaling is recommended by clinicians for TKR for rehabilitation, however, there has been no investigation into its utility in the acute postoperative setting.

- Therefore, we performed a RCT trial evaluating the efficacy of pedaling in the acute postoperative period

Methods

•Sixty TKR patients were randomized to receive postoperative physical therapy involving either a:

   3-exercise pedaling (pedaling-based) <u>OR</u>

   10-exercise, non-pedaling (multi-exercise) protocol

•Outcomes were assessed at 2 days, 2 weeks, and 4 months

•Including tests of physical function, patient-reported outcomes, and other perioperative measures.

Methods

Recruitment

60 TKR Patients

Randomised to a PT group

Pedaling N=30

Non-Pedaling N=30

Outcomes Superior

P=<0.05

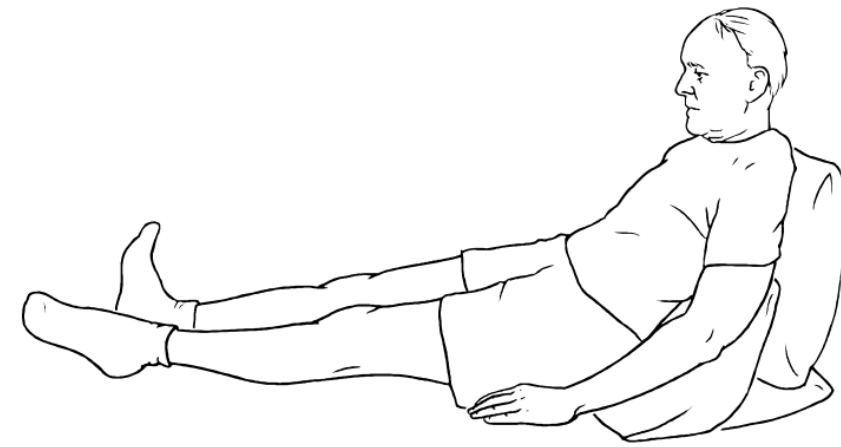6 Minute Walk distance

Timed Up & Go Speed

Oxford Knee Score

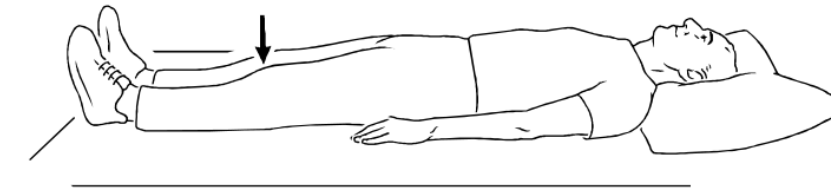Shorter Length of Stay

No superior outcomes

10 Exercise, Non-Pedaling (Multi-exercise) Protocol

ANKLE PUMPS

Bend ankles up and down, alternating feet.

Repeat __10__ times. Do __2__ sessions per day.

THIGH MUSCLE CONTRACTION

With leg out straight tighten quadriceps by pushing back of knee into surface. Hold 3-5 seconds.
10 reps per set, 2 sets per day

SEATED KNEE BENDS

Keeping feet on floor, slide foot of operated leg back, bending knee. Use other leg to assist if needed.

Hold 30 seconds.
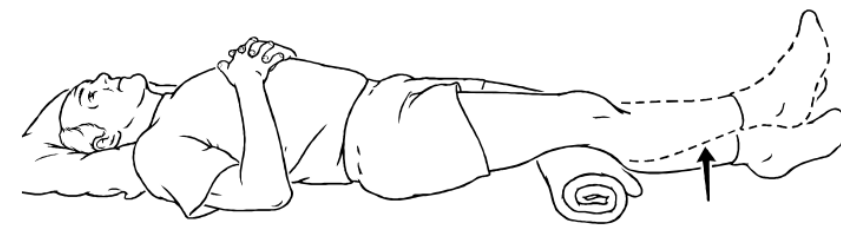
Repeat __10__ times.
Do __2__ sessions a day.

KNEE SEATED EXTENSION

Straighten operated leg and try to hold it 3-5 seconds.

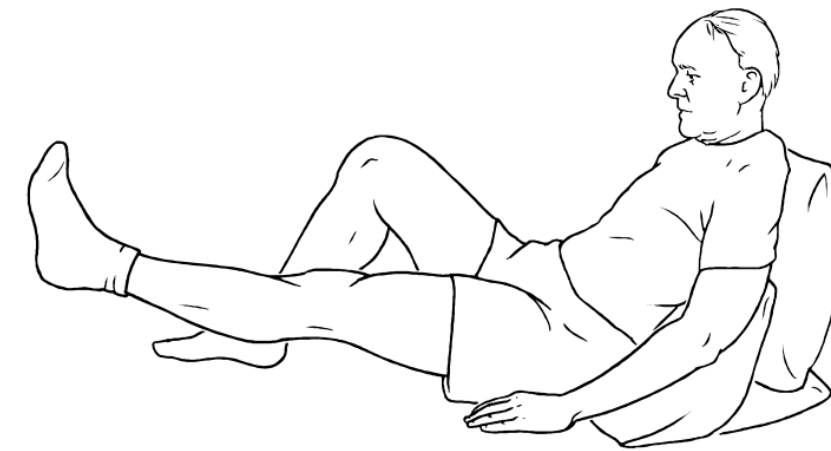Repeat __10__ times. Do __2__ sessions a day.

HEEL RAISE WITH TOWEL ROLL UNDER KNEE

Lying on back with rolled towel (about 6 inches wide) under knee, slowly straighten knee to fully extended (straight) position. Hold 3-5 seconds, then relax. Repeat with other knee.

Repeat __10__ times. Do __2__ sessions per day.

STRAIGHT LEG RAISE

Keep operated leg as straight as possible and tighten muscles on top of thigh. Slowly lift straight leg off the bed and hold 3-5 seconds. Lower it, keeping muscles tight. Relax.

Repeat __10__ times. Do __2__ sessions per day.

SUPPORTED MINI-SQUAT

Stand behind chair or table.
Stance: shoulder-width on floor.
Bend hips and knees.
Keep back straight.
Do not allow knees to bend past toes. Squeeze glutes and quads to stand.

10 reps per set,
2 sets per day,

STANDING HEEL RAISE

Standing, place feet apart. Hold arms out for balance or use support. Rise up on toes.

Repeat __10__ times.
Do __2__ sessions per day.

KNEE/CALF STRETCH
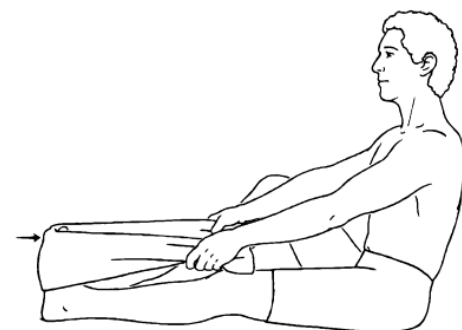
Sit with knee straight and theraband or towel looped around foot. Gently pull on towel and push knee down into bed until stretch is felt behind knee.

Hold 30 seconds.

Repeat 5 times
Do 2 sessions per day.

HEEL SLIDE KNEE BENDS
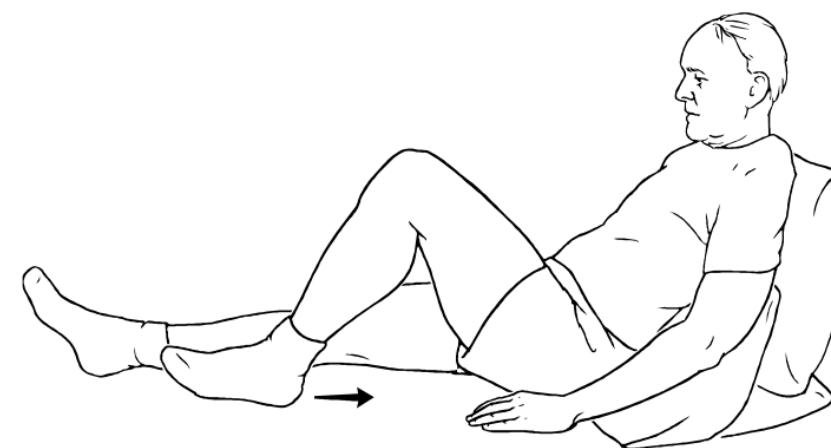
Bend knee and pull heel toward buttocks.

Repeat __10__ times. Do __2__ sessions per day.

3 Exercise Pedaling (Pedaling-based) Protocol

Heel - Toe Walking

Take a step and land with heel on floor.
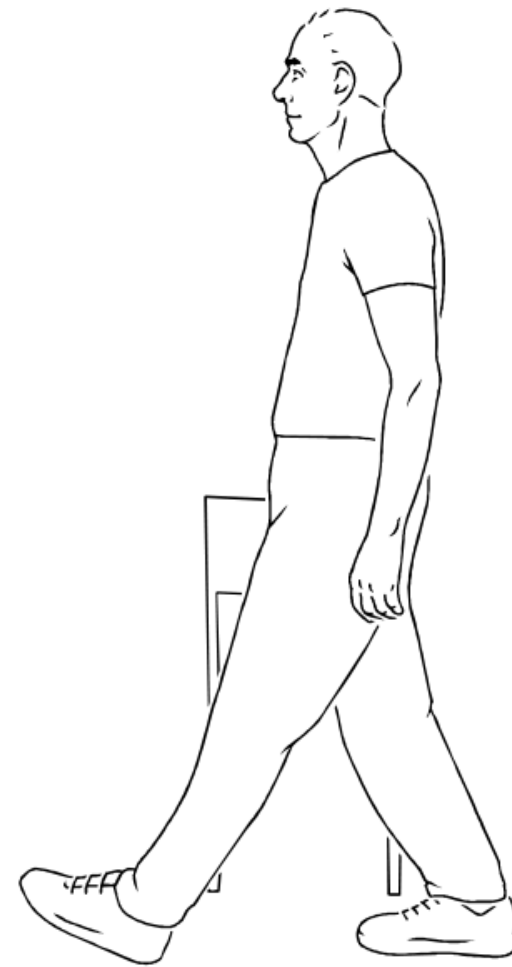
Stretching: Hamstring/Calf – Theraband
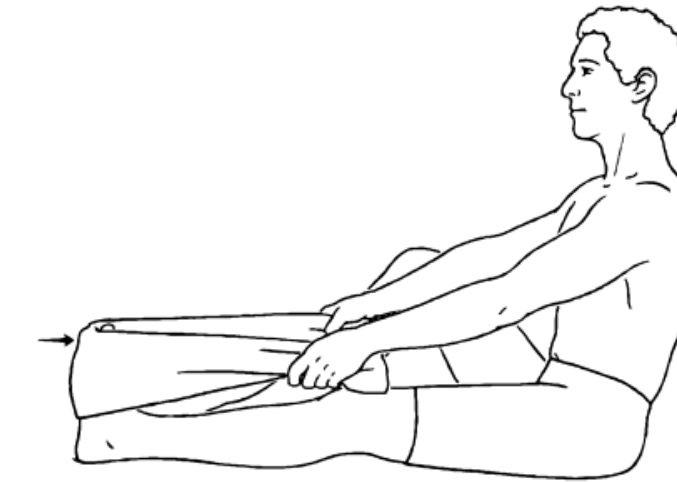
While lying safely in bed.
With knee straight, loop theraband around foot.
Gently pull on theraband until stretch is felt in hamstring/calf.
Hold __30__ seconds.

Repeat 5 times per set.
Do 2 sessions per day.

Bike Pedaling
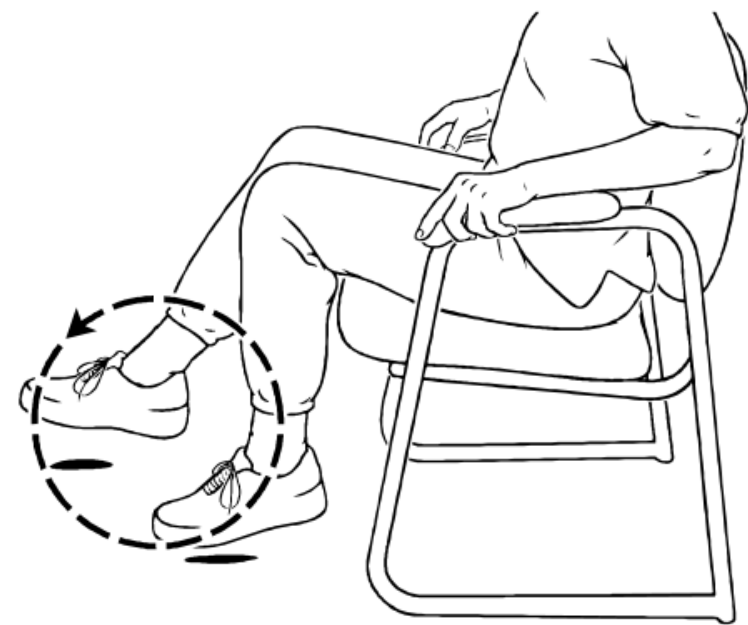
Place hands on seat or arms of chair for support and turn pedals backwards and forwards until able to comfortably achieve a full rotation.

Repeat 30 revolutions.
Do 2 sessions per day.

Baseline Preoperative Characteristics

Characteristic	Standard Multi-Exercise Protocol (N = 30)	Pedaling-Based Protocol (N = 30)
Age* (yr)	66.0 ± 8.7	66.8 ± 6.7
Sex†		
Male	18 (60%)	22 (73%)
Female	12 (40%)	8 (27%)
BMI* (kg/m^2)	29.4 ± 4.4	29.3 ± 4.3
Oxford Knee Score*	22.2 ± 5.4	25.8 ± 6.7
Lysholm score*	45.4 ± 13.9	50.6 ± 18.8
Knee flexion‡ (°)	110.0 (90.0-110.0)	110.0 (85.0-120.0)
ASA Physical Status classification†		
I	2 (7%)	2 (7%)
II	19 (63%)	21 (70%)
III	9 (30%)	7 (23%)

*The values are given as the mean and standard deviation.
†The values are given as the number, with the percentage in parentheses. ‡The values are given as the median, with the range in parentheses.

Results of *Functional Outcome Measures* (Physical and Patient-Reported) at All Time Points

Outcome	Multi-Exercise Protocol		Pedaling-Based Protocol		Mean Difference (95% CI)	P Value
	No.	Measured Value*	No.	Measured Value*		
6-min walk test† *(m)*						
2 days	30	187.0 ± 67.0	30	252.9 ± 73.5	65.8 (29.4 to 102.2)	0.001‡
2 wk	30	348.6 ± 81.8	30	390.2 ± 94.2	41.6 (4.0 to 87.2)	0.073
4 mo	28	488.3 ± 89.7	28	514.0 ± 78.5	25.7 (19.5 to 70.9)	0.259
10-m walk test *(m/sec)*						
2 days	30	0.60 (0.20 to 1.10)§	30	0.70 (0.50 to 1.50)§		0.016‡
2 wk	30	1.05 (0.70 to 1.70)§	30	1.15 (0.70 to 2.30)§		0.199
4 mo	28	1.50 ± 0.25	28	1.54 ± 0.24	0.04 (0.01 to 0.12)	0.592
Timed Up & Go test *(sec)*						
2 days	30	23.9 (12.6 to 54.3)§	30	19.3 (9.4 to 40.2)§		0.020‡
2 wk	30	10.7 (6.4 to 24.4)§	30	10.0 (5.7 to 18.5)§		0.662
4 mo	28	7.1 ± 1.3	28	6.9 ± 1.3	0.2 (−0.05 to 0.9)	0.578
Knee flexion *(°)*						
2 days	30	90 (50 to 110)§	30	90 (80 to 115)§		
2 wk	30	93 (70 to 150)§	30	95 (80 to 125)§		
4 mo	28	110.4 ± 9.1	28	113.0 ± 10.4	2.7 (2.6 to 7.9)	0.310
Oxford Knee Score						
2 days	30	20.2 ± 7.4	30	24.7 ± 8.5	4.5 (0.34 to 8.6)	0.034‡
2 wk	30	23.1 ± 7.9	30	28.8 ± 7.6	5.6 (1.6 to 9.7)	0.007‡
4 mo	28	37.6 ± 4.8	28	39.3 ± 6.1	1.7 (1.3 to 4.6)	0.259
EQ-5D score						
2 days	30	12.1 ± 3.1	30	11.1 ± 3.5	1.0 (−0.7 to 2.7)	0.244
2 wk	30	10.4 ± 2.6	30	9.0 ± 2.2	1.3 (0.1 to 2.6)	0.037‡
4 mo	28	7.0 (5.0 to 11.0)§	28	6.0 (5.0 to 11.0)§		0.263
EQ-5D VAS						
2 days	30	60 (10 to 95)§	30	80 (25 to 100)§		0.031‡
2 wk	30	75 (50 to 97)§	30	88 (40 to 100)§		0.050‡
4 mo	28	88 (50 to 100)§	28	90 (75 to 100)§		0.044‡

*The values are given as the mean and standard deviation, except where otherwise noted. †Primary outcome measure. ‡Significant difference (p < 0.05). §The values are given as the median, with the range in parentheses.

Results: *Functional Outcome Measures*

- For the primary outcome, the Six Minute Walk Test (6MWT), the Pedaling group walked further at 2 days postoperatively (mean difference, 66 m; p = 0.001).

- Secondary outcomes, the Timed Ten Meter Walk (10MWT) and the Timed Up and Go (TUG) tests were faster in the pedaling-based group at 2 days (p = 0.016 for 10MWT, and p = 0.020 for TUG), but did not differ significantly at 2 weeks or 4 months.

- The Oxford Knee Score was significantly better for the pedaling group at 2 days (mean difference, 4.5; p = 0.034) and at 2 weeks (mean difference, 5.6; p = 0.007)

- The EQ-5D score was also significantly better at 2 weeks (mean difference, 1.3; p = 0.037), and the VAS component of the EQ-5D was significantly better for the pedaling group at all time points (p = 0.031 at 2 days, p = 0.050 at 2 weeks, and p = 0.044 at 4 months).

Results of *Perioperative Measures and Pain and Satisfaction* Scales at Indicated Time Points

Outcome	Multi-Exercise Protocol		Pedaling-Based Protocol		
	No.	Median (Range)	No.	Median (Range)	P Value
LOS *(days)*	30	3.0 (2.0 to 6.0)	30	2.5 (2.0 to 5.0)	0.024*
Readiness for discharge† *(days)*	30	2.0 (1.0 to 4.0)	30	2.0 (1.0 to 4.0)	0.002*
As-needed analgesia *(mg oxycodone)*					
2 days	30	10.0 (0.0 to 40.0)	30	5.0 (0 to 60.0)	0.350
Pain threshold‡					
2 days	30	2.0 (1.0 to 4.0)	30	2.0 (1.0 to 5.0)	0.557
Satisfaction with protocol§					
2 days	30	1.0 (1.0 to 2.0)	30	1.0 (1.0 to 3.0)	0.115
2 wk	30	1.0 (1.0 to 2.0)	30	1.0 (1.0 to 3.0)	0.687
Compliance with home-exercise program					
2 wk	30	100 (55 to 100)	30	100 (50 to 100)	0.314

*Significant difference ($p < 0.05$). †Difference indicated by mean ranks: pedaling protocol (24.1) was better than standard protocol (36.9); U = 257.00. ‡Likert scale: high pain threshold 1 (strongly agree) to 5 (strongly disagree). §Likert scale: satisfaction with protocol 1 (very satisfied) to 5 (very dissatisfied).

Results: *Perioperative Measures, Pain and Satisfaction*

- Length of Stay (LOS) was shorter for the pedaling-based group, by a half-day (median of 2.5 compared with 3.0 days; p = 0.024).

- Analgesic consumption, home-exercise-program compliance, self-reported pain threshold, and satisfaction with the exercise protocol were similar between the 2 groups.

Conclusion

- A pedaling-based physical therapy protocol after TKR was superior to a standard multi-exercise protocol in the acute postoperative period.

- The multi-exercise protocol was not superior for any outcome measure at any time point.

References

- Kurtz SM, Ong KL, Lau E, Widmer M, Maravic M, Gómez-Barrena E, et al. International survey of primary and revision total knee replacement. International orthopaedics. 2011;35(12):1783-9.

- Molloy IB, Martin BI, Moschetti WE, Jevsevar DS. Effects of the Length of Stay on the Cost of Total Knee and Total Hip Arthroplasty from 2002 to 2013. The Journal of bone and joint surgery American volume. 2017;99(5):402-7.

- Lenssen A, De Bie R. Role of physiotherapy in peri-operative management in total knee and hip surgery. Injury. 2006;37:S41-S3.

- Harvey LA, Brosseau L, Herbert RD. Continuous passive motion following total knee arthroplasty in people with arthritis. The Cochrane database of systematic reviews. 2014(2):Cd004260.

- Artz N, Elvers KT, Lowe CM, Sackley C, Jepson P, Beswick AD. Effectiveness of physiotherapy exercise following total knee replacement: systematic review and meta-analysis. BMC musculoskeletal disorders. 2015;16(1):15.

- Naylor J, Harmer A, Fransen M, Crosbie J, Innes L. Status of physiotherapy rehabilitation after total knee replacement in Australia. Physiotherapy research international. 2006;11(1):35-47.

- McGrory BJ, Stuart MJ, Sim FH. Participation in sports after hip and knee arthroplasty: review of literature and survey of surgeon preferences. Mayo Clinic proceedings. 1995;70(4):342-8.

- Swanson EA, Schmalzried TP, Dorey FJ. Activity recommendations after total hip and knee arthroplasty: a survey of the American Association for Hip and Knee Surgeons. J Arthroplasty. 2009;24(6 Suppl):120-6.

- Kuster MS. Exercise recommendations after total joint replacement: a review of the current literature and proposal of scientifically based guidelines. Sports Medicine. 2002;32(7):433-45 13p.

- Liebs TR, Herzberg W, Ruther W, Haasters J, Russlies M, Hassenpflug J. Ergometer cycling after hip or knee replacement surgery: a randomized controlled trial. J Bone Joint Surg Am. 2010;92(4):814-22.

- Australian and New Zealand Clinical Trials Registry [Internet]: Sydney (NSW): NHMRC Clinical Trials Centre, University of Sydney (Australia); 2005 - Identifier ACTRN12617000647336. A pedaling-based three exercise protocol compared to a non-pedaling ten exercise protocol for immediate post-operative rehabilitation after total knee replacement in a randomized controlled trial; 2017 May 04 [cited 2018 July 07]; [1 page]. Available from www.anzctr.org.au/ACTRN12617000647336.aspx.

- Urbaniak GC, Plous S. Research Randomizer (Version 4.0)[Computer software]; 2013. Retrieved on April 24, 2017 from http://www.randomizer.org/

- Jakobsen TL, Kehlet H, Bandholm T. Reliability of the 6-min walk test after total knee arthroplasty. Knee Surgery, Sports Traumatology, Arthroscopy. 2013;21(11):2625-8.

- Bade MJ, Kohrt WM, Stevens-Lapsley JE. Outcomes before and after total knee arthroplasty compared to healthy adults. journal of orthopaedic & sports physical therapy. 2010;40(9):559-67.

- Ko V, Naylor JM, Harris IA, Crosbie J, Yeo AE. The six-minute walk test is an excellent predictor of functional ambulation after total knee arthroplasty. BMC musculoskeletal disorders. 2013;14(1):145.

- Dawson J, Fitzpatrick R, Murray D, Carr A. Questionnaire on the perceptions of patients about total knee replacement. The Journal of bone and joint surgery British volume. 1998;80(1):63-9.

- Petersen CL, Kjærsgaard JB, Kjærgaard N, Jensen MU, Laursen MB. Thresholds for Oxford Knee Score after total knee replacement surgery: a novel approach to post-operative evaluation. Journal of orthopaedic surgery and research. 2017;12(1):89.

- Giesinger JM, Hamilton DF, Jost B, Behrend H, Giesinger K. WOMAC, EQ-5D and knee society score thresholds for treatment success after total knee arthroplasty. The Journal of arthroplasty. 2015;30(12):2154-8.

- Liddle A, Pandit H, Judge A, Murray D. Patient-reported outcomes after total and unicompartmental knee arthroplasty: a study of 14 076 matched patients from the National Joint Registry for England and Wales. The bone & joint journal. 2015;97(6):793-801.

- Bruun-Olsen V, Heiberg KE, Wahl AK, Mengshoel AM. The immediate and long-term effects of a walking-skill program compared to usual physiotherapy care in patients who have undergone total knee arthroplasty (TKA): a randomized controlled trial. Disability and rehabilitation. 2013;35(23):2008-15.

- IBM Corp. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp. Released 2016.

- Rastogi R, Chesworth BM, Davis AM. Change in patient concerns following total knee arthroplasty described with the International Classification of Functioning, Disability and Health: a repeated measures design. Health and quality of life outcomes. 2008;6(1):112.

- Perera S, Mody SH, Woodman RC, Studenski SA. Meaningful change and responsiveness in common physical performance measures in older adults. Journal of the American Geriatrics Society. 2006;54(5):743-9.

- Kennedy DM, Stratford PW, Wessel J, Gollish JD, Penney D. Assessing stability and change of four performance measures: a longitudinal study evaluating outcome following total hip and knee arthroplasty. BMC musculoskeletal disorders. 2005;6(1):3.

- Beard DJ, Harris K, Dawson J, Doll H, Murray DW, Carr AJ, et al. Meaningful changes for the Oxford hip and knee scores after joint replacement surgery. Journal of clinical epidemiology. 2015;68(1):73-9.

- Australian Government Department of Health. Private Hospital Data Bureau: Annual Report 2016-17. Retrieved from: http://www.health.gov.au/internet/main/publishing.nsf/Content/health-casemix-data-collections-publications-PHDBAnnualReports