

The Effects of Running on the Development of Knee Osteoarthritis: An Updated Systematic Review

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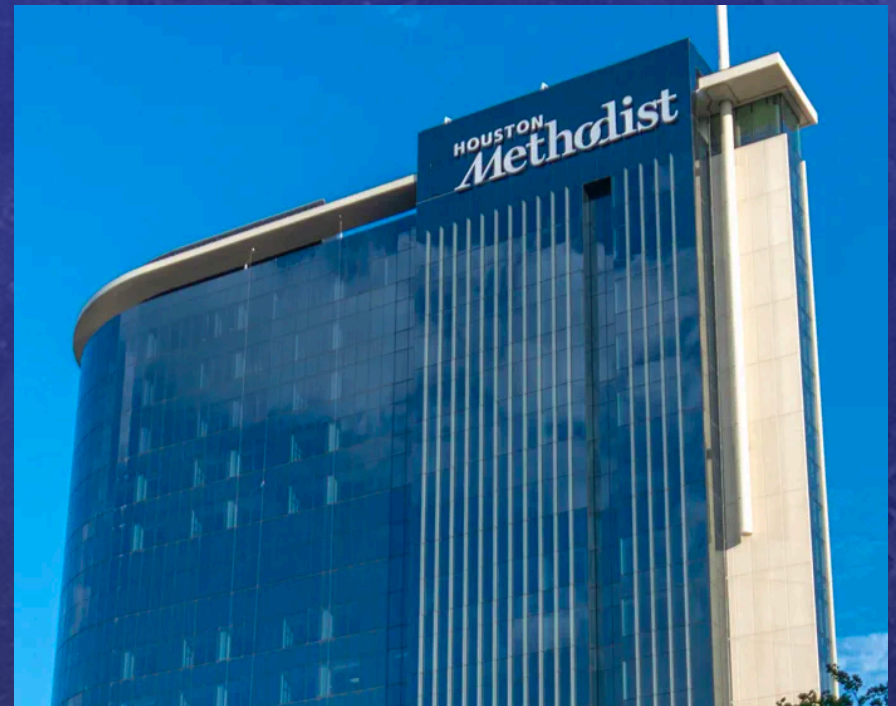
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Introduction

- Osteoarthritis (OA) is the most common joint disorder in the United States and is a leading cause of disability in the elderly population
- Several risk factors for knee OA have been identified including age, obesity, occupation, and trauma to the joint due to repetitive movements such as kneeling or squatting. Other factors including cytokines, leptin, and mechanical forces are pathogenic components of knee OA.
- However, the association between physical activity such as running and the development of knee OA is less transparent, as some believe running increases the risk of knee OA, while others believe it is actually protective.

Introduction

- A meta-analysis published in 2017 with a total of 6,197 patients found no significant differences in patient-reported outcomes (PROs) between runners and non-runners. While the authors reported mixed outcomes with regards to the presence of knee OA, there did appear to be a protective effect of running.
- The current systematic review builds upon this previous review with 7,944 additional patients included for a more robust set of clinical findings.

Running and Knee Osteoarthritis

A Systematic Review and Meta-analysis

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Purpose

- To perform an updated systematic review of the literature to determine the effects of running on the development of knee OA.



Methods

- Systematic review conducted according to PRISMA guidelines
- Searched PubMed, Embase, Cochrane Library
- Search terms used were: *knee AND osteoarthritis AND (run OR running OR runner)*
- Study inclusion criteria:
 - Clinical studies evaluating the effect of cumulative running on the development of knee OA or chondral damage based on imaging or patient-reported outcomes (PROs)
- Study exclusion criteria:
 - Non-human or non-comparative studies
 - Studies unrelated to the knee joint

Methods

- Outcomes assessed included:
 - Total knee replacements
 - PROs
 - Knee pain
 - Knee Injury and Osteoarthritis Outcome Score (KOOS)
 - Health Assessment Questionnaire Disability Index (HAQ-DI)
 - Radiological outcomes
 - Presence of radiographic knee OA using Kellgren-Lawrence Scale and Ahlback criteria
 - Magnetic resonance imaging (MRI)

Results

- 17 studies met inclusion criteria including a total of 14,141 patients
 - 7,194 runners and 6,947 non-runners
- Patient age averaged 56.2 and 61.6 years in the runner and non-runner groups, respectively
- Mean follow-up time was 55.8 months and 99.7 months in the runner and non-runner groups, respectively
- Mean body mass index was 26.7 kg/m² and the overall percentage of males was 58.5%

Results

| Study | Level of Evidence | n (Run, Non) | Patient Age (Run, Non), y (Range) | Follow-up (Run, Non), mos | BMI (Run, Non), kg/m ² | Gender, % male |
|--------------------------------------|-------------------|--------------|------------------------------------|---------------------------|-----------------------------------|----------------|
| Felson et al, 2007 ² | II | 1,279; 0 | 53.2 (26.0-81.0) | 8.8 ± 1.04 | 27.4 | 44.0 |
| Horga et al, 2019 ⁴ | II | 71, 11 | 44.0 ± 8.5, 44.0 ± 7.0 (25.0-73.0) | 7.5, 7.5 | 25.2 ± 3.6, 24.2 ± 2.2 | 50.2 |
| Kujala et al, 1994 ⁶ | II | 2,049; 1,403 | NR | NR | NR | 100.0 |
| Kujala et al, 1995 ⁷ | II | 117, 0 | 59.1 (45.0-68.0) | NR | 22.8, NR | 100.0 |
| Kujala et al, 1999 ⁸ | II | 269, 179 | 58.5, 60.3 (47.0-71.0) | 132.0, 132.0 | 23.2, 25.5 | 100.0 |
| Mosher et al, 2010 ¹³ | II | 22, 15 | 40.0, 37.0 | NR | 23.7, 25.4 | 47.8 |
| Chakravarty et al, 2008 ¹ | III | 45, 53 | 59.8 ± 1.0, 60.2 ± 1.0 (50.0-72.0) | 216.0, 216.0 | 22.3 ± 0.3, 24.0 ± 0.5 | 67.3 |
| Konradson et al, 1990 ⁵ | III | 27, 27 | 58.0, 57.0 (50-68) | NR | 22.9, 23.9 | 100.0 |
| Lo et al, 2017 ⁹ | III | 778; 1,859 | 62.0 ± 8.4, 65.3 ± 9.0 | 96.0, 96.0 | 27.9 ± 4.7, 28.8 ± 5.0 | 44.2 |
| Lo et al, 2018 ¹⁰ | III | 138; 1,065 | 62.9 ± 7.3, 63.2 ± 8.0 | 96.0, 96.0 | 28.4 ± 4.0, 29.6 ± 4.7 | 45.3 |
| Manninen et al, 2001 ¹¹ | III | 281, 524 | NR | NR | NR | NR |
| Muhlbauer et al, 2000 ¹⁴ | III | 9, 9 | 27.4 ± 3.3, 22.2 ± 1.9 | NR | 22.4 ± 1.1, 23.1 ± 3.1 | 100.0 |
| Sandmark et al, 1999 ¹⁵ | III | 1,173; 0 | NR | NR | NR | 50.2 |
| Spector et al, 1996 ¹⁶ | III | 81, 977 | 52.3 ± 6.1, 54.2 ± 6.0 (40.0-67.0) | NR | 22.1 ± 2.8, 25.6 ± 4.3 | 0.0 |
| Thelin et al, 2006 ¹⁷ | III | 825, 825 | NR (51.0-70.0) | NR | NR | 43.2 |
| Greaves et al, 2021 ³ | IV | 16, 0 | 30.8 ± 6.3 | 1.5 | 22.9 ± 1.6 | 56.3 |
| Miller et al, 2014 ¹² | IV | 14, 0 | 25.0 ± 11.0 | NR | 24.2 | 50.0 |
| Total | - | 7,194; 6,947 | 56.2, 61.6 | 55.8, 99.7 | 26.7, 28.0 | 58.5 |

Results

- Six studies^{7-10,16} assessed presence of knee pain at final follow-up
- One study found a significantly higher risk of knee OA progressing to total knee replacement (TKR) among non-runners (4.6% versus 2.6%, $p = 0.014$).

| Knee Pain | | | |
|-----------------------------------|--------------------------|----------------------------|--------------------|
| Study | Runner | Non-Runner | p-value |
| Lo et al, 2018 ¹⁰ | 33/123 (26.8%) | 293/1,009 (29.0%) | 0.61 |
| Lo et al, 2017 ⁹ | 274/775 (35.4%) | 1,093/1,859 (58.8%) | < 0.0001 |
| Kujala et al, 1995 ⁷ | 23/117 (19.7%) | - | N/A |
| Kujala et al, 1999 ⁸ | 27/264 (10.2%) | 24/179 (13.4%) | 0.30 |
| Spector et al, 1996 ¹⁶ | 27/81 (33.3%) | 248/994 (24.9%) | 0.096 |
| Total | 384/1,360 (28.2%) | 1,658/4,041 (41.0%) | < 0.0001 |

Results

| Radiographic Findings | | | | |
|--------------------------------------|------------------------|------------------|---------------------|-----------------|
| Study | Outcome Measure | Prevalence (Run) | Prevalence (Non) | p-value |
| Felson et al, 2007 ² | TF JSN | 222/2,259 (9.8%) | - | N/A |
| Lo et al, 2018 ¹⁰ | Medial JSN | 40/205 (19.5%) | 378/1,063 (23.6%) | >0.05 |
| Spector et al, 1996 ¹⁶ | TF JSN | 28/81 (34.6%) | 359/911 (36.7%) | >0.05 |
| Spector et al, 1996 ¹⁶ | PF JSN | 11/81 (13.6%) | 27/215 (12.6%) | <0.05 |
| Spector et al, 1996 ¹⁶ | Osteophytes (TF joint) | 18/81 (22.2%) | 145/977 (14.8%) | <0.05 |
| Spector et al, 1996 ¹⁶ | Osteophytes (PF joint) | 34/81 (42.0%) | 60/215 (28%) | <0.05 |
| Lo et al, 2017 ⁹ | ROA | 416/778 (53.5%) | 1,093/1,859 (58.8%) | >0.05 |
| Lo et al, 2017 ⁹ | SOA | 177/778 (22.8%) | 547/1,859 (29.4%) | >0.05 |
| Chakravarty et al, 2008 ¹ | ROA | 9/45 (20.0%) | 17/53 (32.1%) | >0.05 |
| Kujala et al, 1995 ⁷ | ROA | 31/117 (26.5%) | - | N/A |
| Kujala et al, 1995 ⁷ | Osteophytes (TF joint) | 11/117 (9.4%) | - | N/A |
| Kujala et al, 1995 ⁷ | Osteophytes (PF joint) | 22/117 (18.8%) | - | N/A |

TF = tibiofemoral, JSN = joint space narrowing, PF = patellofemoral, ROA = radiographic osteoarthritis, SOA = symptomatic osteoarthritis

Discussion/Conclusion

- Based on the results of our systematic review, we found a significantly higher prevalence of knee pain in the non-runner group.
- Multiple studies^{1,9,10,16} found no significant differences in the prevalence of radiographic knee OA (based on TF/PF JSN or Kellgren-Lawrence grade) between runners and non-runners.
- Two studies^{9,10} assessed the risk of progression of knee OA to TKR, with one⁹ finding a significantly lower risk of TKR among runners compared to non-runners.
- **Running is not associated with worsening of patient-reported outcomes or radiological signs of knee OA and may actually be protective against generalized knee pain.**

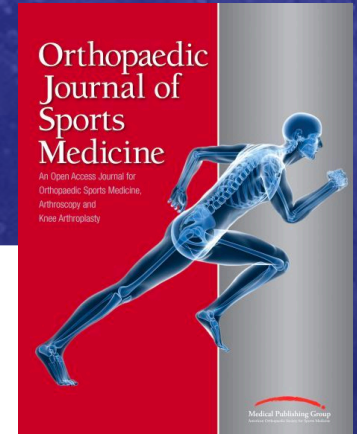
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Effects of Running on the Development of Knee Osteoarthritis

An Updated Systematic Review at Short-Term Follow-up

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