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The Investigation of Association between the Spino-Pelvic Sagittal Alignment and Knee Osteoarthritis in Middle-Aged and Elderly People: Protocol for a Systematic Review

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Review Article

Abstract

Introduction: Knee osteoarthritis is one of the most common chronic joint diseases associated with pain and decreased physical function in middle-aged and elderly people. Spino-pelvic sagittal alignment, similar to the knee, undergoes age-related changes. In adults, spino-pelvic sagittal alignment and lower limb joints are important for maintaining proper posture and standing balance. Knee flexion has been reported as the most important compensatory mechanism in response to sagittal changes in the spine. Based on preliminary evidence of knee-spine syndrome, recent studies have investigated the relationship between spino-pelvic alignment and knee osteoarthritis, but the effect of spino-pelvic sagittal alignment on osteoarthritis is unclear. This protocol aims to conduct a systematic review investigating the relationship between spino-pelvic sagittal alignment and knee osteoarthritis in middle-aged and elderly individuals.

Materials and Methods: This is a systematic review protocol following PRISMA-P. Searches will be conducted in international and national databases. All Persian and English studies performed in this field (from the first to the last relevant study, until the end of 2025) will be selected. Study quality will be assessed using NHLBI and JBI checklists. All steps will be performed independently by two investigators; in case of disagreement, a third investigator's opinion will be the determining factor. To ensure the initial analysis is unbiased, two research team members will extract data from each article separately. Afterward, in a consensus, data extraction forms will be analyzed and revised as necessary, and team members' opinions will be reviewed in these cases, and the final decision to include each article will be made with the research team's agreement. After this stage, final results of the systematic review will be presented in tables and text.

Keywords: Knee osteoarthritis; Sagittal alignment; Spine; Pelvis

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Introduction

One of the most significant challenges facing middle-aged and older adults is osteoarthritis. This is the most common chronic joint disease, which progressively destroys articular cartilage, bones, ligaments, and other connective tissues. This process may affect the knee,

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hip, or spine, resulting in disability and functional impairment (1). Its clinical manifestations include gradual onset of pain, morning stiffness, joint deformity, restriction of activities of daily living (ADL), and reduced quality of life (2-4). Given that the knee joint bears body weight and is subjected to repetitive loading, it is the most commonly affected joint in osteoarthritis (2, 5). Knee osteoarthritis, ranked as the eleventh most disabling disease worldwide, affects 22.9% of individuals over 40 years of age, and its prevalence in Iran was reported to be 15.5% in 2015 (6-8). To date, numerous risk factors—including age, sex, overweight, history of injury and trauma, genetics, and lifestyle—have been identified in association with this condition (3). Physiotherapists strive to apply evidence-based approaches to the treatment of knee osteoarthritis; therefore, further investigation into the factors influencing knee osteoarthritis can help advance prevention strategies and the design of rehabilitation programs.

One biomechanical factor that appears to be related to knee function is spinopelvic sagittal alignment, first proposed by Itoi in 1991 (9). In that study, the sagittal alignment of the spine and lower limb was examined in women with osteoporosis and thoracic hyperkyphosis, and a significant association was observed between reduced lumbar lordosis, posterior pelvic tilt, and reduced sacral slope with knee flexion posture during standing. This relationship was termed the knee-spine syndrome. In adults, spinopelvic sagittal alignment and lower-limb joint alignment are important for maintaining proper posture and standing balance (10). Following disruption in any of these segments, compensatory changes and mechanisms in other body segments are required to restore balance. The most important compensatory mechanism following reduced range of motion and age-related changes in spinal curvature is knee flexion (11). On the other hand, low back pain is common among individuals with knee osteoarthritis (12, 13).

Consistent with the initial evidence on knee-spine syndrome, several recent studies have examined the relationship between spinal or pelvic alignment and knee osteoarthritis. Some of these studies have identified reduced lumbar lordosis as a contributing factor (12, 14, 15). Limited interventional evidence has also reported improvement in spinal alignment following corrective surgery for knee osteoarthritis (16, 17). On the other hand, there is also evidence identifying other contributing factors, such as thoracic kyphosis (18), increased spinal slope (19, 20), increased pelvic tilt, and increased pelvic incidence-lumbar lordosis (PI-LL) mismatch (21).

Spinal alignment and its deformities are among the most debated topics in spinal disorders, given their significant impact on adults' quality of life (22). Changes in sagittal alignment affect not only the central axial skeleton itself but also the function of other body regions, including the knee joint, which may contribute to the onset or severity of knee osteoarthritis (9, 11, 23). Despite numerous studies on the relationship between spinopelvic sagittal alignment and knee osteoarthritis, the findings remain inconsistent regarding which spinal or pelvic variable is most influential, as well as regarding the relationship between spinal and pelvic variables and the severity of knee osteoarthritis. These discrepancies may stem from differences in alignment measurement methods, the variety of alignment variables measured, the use of different study designs (cross-sectional, longitudinal, or randomized controlled trials), and varying follow-up durations in longitudinal studies. Given these considerations, conducting a systematic review in this area is warranted. The question arises as to whether spinopelvic sagittal alignment is significantly associated with the onset and severity of knee osteoarthritis in middle-aged and older adults, and which of these alignment variables is the more important contributor to the development of knee osteoarthritis. Therefore, the present study aims to conduct a systematic literature review to examine the relationship between spino-pelvic sagittal alignment and knee osteoarthritis in middle-aged and older adults.

Materials and Methods

Study Design: This is a systematic review examining the relationship between spinopelvic sagittal alignment and knee osteoarthritis in middle-aged and older adults. The indices of this systematic review consist of the target Population and Exposure (PE). The target population of this study is adults aged 45 and older with knee osteoarthritis. The diagnosis of osteoarthritis must be based on a valid objective method, such as radiographic imaging, the osteoarthritis atlas, or the Kellgren-Lawrence index (score of 2 or higher). Additionally, the exposure of interest in this study consists of spino-pelvic sagittal alignment variables, measured using valid methods.

Procedure: This study follows the principles and guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for protocols 2015 (PRISMA-P 2015) (24). To identify English-language studies, the databases Scopus, Web of Science, ScienceDirect, ClinicalKey, Cochrane Library, PubMed, ProQuest, and Embase will be searched. Persian-language studies will be identified

through searches of the national online databases of the Iranian Research Institute for Information Science and Technology (IranDoc), the Scientific Information Database (SID), Magiran, the Islamic World Science Citation Center (I.S.C.), Ministry of Health theses (MOH theses), and Ministry of Health articles (MOH articles). All cohort, case-control, cross-sectional, and interventional studies, published in English or Persian, from the publication of the first article in this field through the end of 2025, conducted on women and men aged 45 years and older, will be included in this systematic review.

Study Inclusion and Exclusion Criteria: The inclusion criteria for studies are as follows: study participants must be adults aged 45 years and older (7, 25, 26). The diagnosis of knee osteoarthritis must have been made using a valid objective method, the Knee Osteoarthritis Atlas, or radiographic imaging, with a score of 2 or higher based on the Kellgren-Lawrence classification (27-29). In addition, access to the full text of the article must be available. If the full text is not accessible, the corresponding author, first author, or journal editor will be contacted up to three times. Regarding study type, cohort, case-control, cross-sectional, and interventional studies will be included. Finally, the study's aim must have been to examine the relationship between spinal and pelvic sagittal variables and knee osteoarthritis.

The exclusion criteria for studies are as follows: narrative reviews, case reports, case series, letters to the editor, and qualitative studies will not be included. Studies must be written in Persian or English. Studies involving individuals with osteoarthritis resulting from secondary causes, rather than gradual age-related changes, will be excluded. In addition, studies that did not measure the exposures of interest using valid methods, or in which changes in any of the exposures of interest resulted from secondary factors rather than gradual age-related changes, will be excluded from the list.

Search Strategy: A comprehensive search strategy will be developed with the assistance of a skilled librarian, based on author keywords and Medical Subject Headings (MeSH) terms related to knee osteoarthritis, spine, pelvis, and sagittal alignment.

The search will be conducted by two researchers (T.R. and M.A.), with the assistance of a skilled librarian, in the aforementioned databases to identify studies ranging from the earliest available to those conducted through the end of 2025 on adults aged 45 years and older. Based on the final approval of the research team, the following search strategy will be adopted to ensure comprehensiveness and precision in searching the target databases in this study:

((osteoarthritis OR arthrosis OR "Degenerative Arthritis" OR osteoarthrosis OR osteoarthritides OR arthroplasty) AND (knee OR "knee joint") AND ((sagittal AND (malalignment OR alignment OR axis OR plane or deformity OR "full body alignment" OR imbalance OR pelvic OR Pelvis OR spinal OR spinopelvic OR spine OR back OR trunk OR thorax OR torso OR lumbosacral OR Lumbopelvic OR thoracic OR lumbar OR cervical OR posture)) OR lordos* OR Kyphos* OR hyperkyphos* OR "knee spine syndrome" OR "spine pelvis leg" OR "Knee hip spine")) IN TITLE ((osteoarthritis OR arthrosis OR "Degenerative Arthritis" OR osteoarthrosis OR osteoarthritides OR arthroplasty) AND (knee OR "knee joint") AND (sagittal AND (malalignment OR alignment OR axis OR plane or deformity OR "full body alignment" OR imbalance OR pelvic OR Pelvis OR spinal OR spinopelvic OR spine OR back OR trunk OR thorax OR torso OR lumbosacral OR Lumbopelvic OR thoracic OR lumbar OR cervical OR posture)) OR lordos* OR Kyphos* OR hyperkyphos* OR "knee spine syndrome" OR "spine pelvis leg" OR "Knee hip spine") IN KEYWORDS/SUBJECTS/MESH

If the full text of an article cannot be located, the researcher will contact the corresponding author, co-authors, or the journal editor up to three times to obtain access to the article. To identify gray literature, the specialized databases http://www.proquest.com will be used for English-language studies, and https://www.irandoc.ac.ir for Persian-language studies.

Data Management: Relevant studies will be extracted from each database. The results of the initial search from all databases will be imported into EndNote 21 software (Clarivate, Philadelphia, PA, USA), and duplicate articles will be removed. Review articles will not be included in the final analysis; however, their reference lists will be examined through cross-referencing. Keywords will be updated throughout the research process, and the search will be repeated using the relevant updated keywords. A manual search of the reference lists of all articles will also be conducted. After reviewing the titles and abstracts of the articles, the total number of articles retrieved from each database will be reported, and a flowchart (Figure 1) summarizing these counts will be prepared. At this stage, irrelevant articles will be excluded.

Data Collection Process: The full text of the selected articles will be reviewed for inclusion in the systematic review, and relevant data will be extracted using a standardized data extraction form.

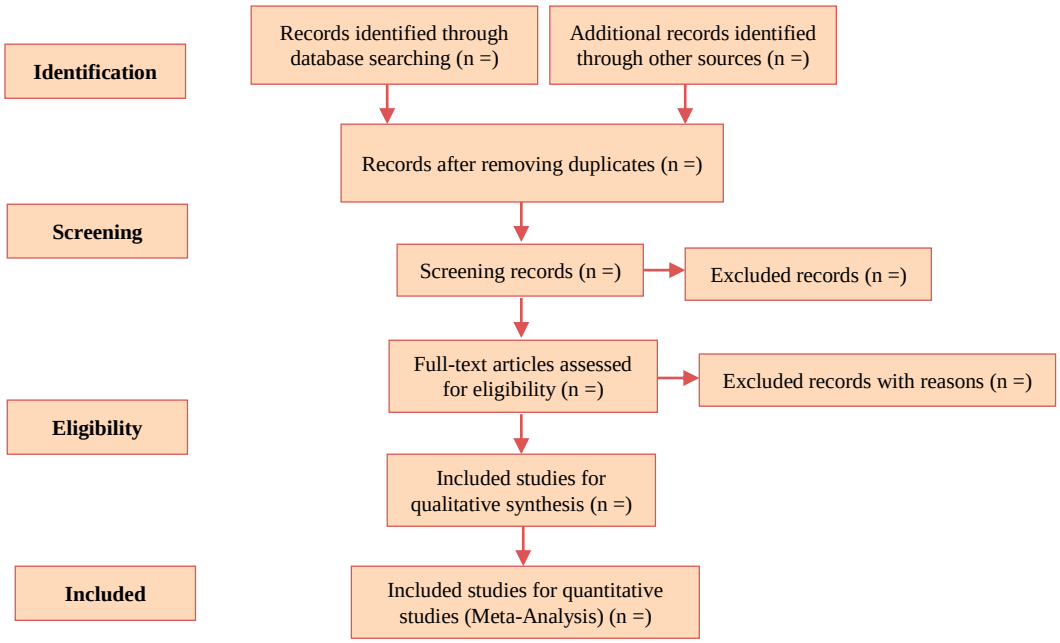

Figure 1. PRISMA flowchart

The standardized extraction form includes the main information from the articles: study type; participant age and grouping; presence of knee osteoarthritis and its measurement method; spinopelvic sagittal alignment variables and their measurement methods; and study results. In accordance with PRISMA-P, the extracted data will be collected by two independent researchers (M.A. and T.R.). After identifying and collecting articles related to the research topic, all their references will be systematically examined to identify additional relevant studies. Finally, through an extensive search in this field, individuals who are experts in studies related to our research topic and who have worked on this subject will be identified through article searches as well as databases such as Scopus and Web of Science, and will be contacted regarding related reports and studies that have not yet been published, with a request that they share any relevant information they may have with us, if possible.

Quality Assessment: The quality of the included studies will be assessed independently by two researchers (T.R. and M.A.), first on the abstract and then on the full text of the article, together. In this study, the National Heart, Lung, and Blood Institute (NHLBI) checklist (Appendices 2-4) will be used to assess the quality of the included studies, and the decision to include or exclude each study will be based on its score. Given the different types of included studies, the checklist specific to each study type (interventional, case-control, cross-sectional, and cohort) will be used to assess each accordingly. The NHLBI checklist is designed to assess the quality of observational studies (cross-sectional, case-control, and cohort) as well as interventional studies (30). The questions designed in this format focus on key concepts for assessing a study's internal validity (31). In the next step, the articles will be compared based on their total scores. Articles that achieve a quality score of 75% or higher will be classified as high quality, those between 50-75% as moderate quality, and those below 50% as low quality. Articles that obtain a total score of 50% or higher will be included in the study.

In the second stage, to ensure the absence of bias in the first quality assessment stage, a validated instrument and method will be used. The instrument consists of a data extraction table finalized by the research team. The procedure will be as follows: the first author will perform data extraction for all studies (all articles that were quality-assessed using the checklist in the previous stage); these articles will then be randomly divided among the other team members; subsequently, in a joint session, the data extraction forms—designed by the team based on similar previous studies (32, 33) and agreed upon by consensus of the research team—will be analyzed and revised as necessary, and the assessments of the first and second authors will be reviewed and discussed by all members, with the final decision regarding inclusion or exclusion of each study made by agreement of all members. After the extraction and careful evaluation of the articles, the main results of the systematic review will be presented in text and

table format. All stages will be carried out by two independent researchers (M.A. and T.R.), and a third researcher (J.M.) will supervise the results of their review; in the event of disagreement regarding the inclusion or exclusion of an article, the third researcher's decision will be final.

Ethical considerations regarding the rights of the authors of the studies used and proper citation of sources will be observed.

Limitations

This study faces several limitations. First, non-English and non-Persian articles have not been used. In addition, lack of access to the full text of some articles may compromise the comprehensiveness of the work; in such cases, the corresponding author, first author, or journal editor will be contacted up to three times. Furthermore, complete coverage of gray literature may be limited, an issue that will be addressed as much as possible with the assistance of skilled librarians.

Recommendations

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Conclusion

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Acknowledgments

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Artificial intelligence was used to assist in editing the Persian-to-English translation of this manuscript to improve grammatical accuracy and maintain textual coherence.

Authors' Contribution

Project design and ideation: Javid Mostamand, Tayebeh Roghani

Providing financial resources for the project: Javid Mostamand

Scientific and executive support of the project: Javid Mostamand, Mehrab Aghajan-Bozroudi, Tayebeh Roghani, Alireza Rahimi

Data collection: Javid Mostamand, Mehrab Aghajan-Bozroudi, Tayebeh Roghani

Analysis and interpretation of the result: Javid Mostamand, Mehrab Aghajan-Bozroudi, Tayebeh Roghani, Alireza Rahimi

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Manuscript preparation: Javid Mostamand, Mehrab Aghajan-Bozroudi, Tayebeh Roghani, Alireza Rahimi

Specialized scientific evaluation of the manuscript: Javid Mostaamand, Mehrab Aghajan-Bozroudi, Tayebeh Roghani, Alireza Rahimi

Confirm the final manuscript to be submitted to the journal: Javid Mostamand, Mehrab Aghajan-Bozroudi, Tayebeh Roghani, Alireza Rahimi

Maintaining the integrity of the study process from the beginning to the publication, and responding to the reviewer's comments: Javid Mostamand, Mehrab Aghajan-Bozroudi, Tayebeh Roghani, Alireza Rahimi

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Conflict of Interest

The authors did not have a conflict of interest.

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