

## Review Paper

# An Overview of the Association Between Smoking and Cartilage Disorders



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## ABSTRACT

**Background:** Although the harmful effects of smoking on the musculoskeletal system, especially bone effects, are well identified, the data on the relationship between smoking and cartilage disorders are limited. This review discovered associations between smoking and cartilage disorders.

**Materials and Methods:** A literature search was conducted in the following three databases in September 2023 for related articles in English without time limitation: Web of Science, Scopus, and PubMed. In the initial search, 285 documents were recorded. Eventually, 20 studies were involved in this review, and the required data were extracted from the full text.

**Results:** Our review study provided evidence for the association between smoking and different knee/spine cartilage disorders, such as augmented cartilage size, declined strain ratio, weak postoperative outcome, low fusion rate, and risk for spinal reoperation.

**Conclusion:** As the use of tobacco products is a crucial global public health concern, additional research to comprehend the mechanisms of the effects of smoking on musculoskeletal system disorders is highly recommended.

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## Introduction

U sing different tobacco products is well-known as a serious threat to health [1-7]. Tobacco smoke has about 7000 toxic chemicals that affect human health directly and or indirectly exposure [8, 9]. Tobacco smoking has adverse effects on different parts of the body, and previous studies have focused more attention on high-mortality diseases, for example, cancers and cardiovascular and respiratory diseases; however, other body systems, including the musculoskeletal system, have received less attention [10]. The musculoskeletal system is a basic human body system, and cartilage is one of its main components [11, 12].

Previous studies have examined the relationship between smoking and musculoskeletal disorders, and based on the surgeon general report, the association between smoking and rheumatoid arthritis, periodontitis, and hip fractures has been established [10]; nevertheless, there is a lack of sufficient evidence to support the connection between smoking and other musculoskeletal disorders [13]. This review study evaluates the role of smoking in cartilage disorders as a musculoskeletal disorder. This will be the first study to collect the recently published studies on the harmful effects of smoking on cartilage disorders. In addition, our review may direct the scientists' interest in the tobacco field about this issue to conduct more innovative studies. Our objective is to determine whether smoking is associated with the increase of cartilage disorders among the previously published original articles.

## Materials and Methods

A literature search was done in the following three databases in September 2023, covering all years in English: [Web of Science](#), [Scopus](#), and [PubMed](#). The search strategies comprised the following terms: (TITLE-ABS-KEY (Smok\* OR cigarette OR tobacco) AND TITLE-ABS-KEY ("cartilage disorder" OR "knee cartilage disorder" OR "spine cartilage disorder").

We recorded 285 documents in the initial search. Recorded papers from the initial search were chosen after eliminating duplicate papers and then screened based on the study's objective. Then, 223 papers were excluded based on the titles, abstracts, and screening. Among the remaining articles, the papers were filtered by selecting based on the following criteria: 1) Original articles that investigated the association between smoking and different cartilage disorders, and 2) Articles published in the English language. A total of 43 papers were removed

after the full-text review. Among the remaining studies, 19 studies reported the association between smoking and cartilage disorders and were included in this review. In addition, references of included papers were also reviewed to discover extra studies missed in the preliminary search. One study was found in this stage. Eventually, 20 studies were included in this review, and needed data were extracted from the full texts.

## Results

The primary reported results of included studies about the relationship between smoking and cartilage disorders are summarized in [Table 1](#). A total of 20 studies (retrospective=11, prospective cohort study=4, cross-sectional=3, case-control=1, and secondary data analysis=1) investigated the effect of smoking on knee/spinal cartilage. In a study, smoking was related to the size of the tibia cartilage [14]. In another study also, smoking was connected with the volume of femoral medial, intercondylar, and lateral cartilage, and there was a reverse relationship between smoking and cartilage strain rate [15].

## Discussion

In a study by Ding et al. (2007), smokers have a greater risk for medial and lateral tibiofemoral cartilage defects. This risk was associated with pack years and the number of smoking ( $P<0.05$ ) [16]. Although in a study, no association was observed between smoking and tibiofemoral cartilage defect [14], another study reported that smoking was associated with an annual loss of medial but not lateral tibia or patellar cartilage [17]. Furthermore, early meniscus repair failure [18], less improvement after autologous chondrocyte implantation surgery for defects of the knee [19], and a lower gratification rate after knee micro-fracture involvement [20] were other main differences between smokers and non-smokers. One study reported no association between smoking and disc degeneration and low back pain [21]. Some studies reported a relationship between smoking and risk of reoperation [22-24], more excellent infection rates [25, 35], higher risk of morbidity [25], and use of analgesic medication [26, 27]. Among the included studies, three studies reported a significant association between smoking and lower spinal fusion rate [26, 28, 35]; however, one study reported the opposite results [29]. In addition, one study reported an association between smoking and longer length of hospital stay [35], whereas in another study, no association was observed in these items [23, 30]. Meanwhile, one study reported that smokers had a more degenerated cartilage matrix than non-smokers [34].

**Table 1.** The main reported results of included studies

Type of Study	Population	Main Results	Reference
Prospective	297 healthy adult	Tibial cartilage size was associated with smoking and the number of pack-years smoked.	[14]
Cross-sectional	Non-smoking (n=45) and smoking (n=43)	Thicker medial, intercondylar, and lateral cartilage in smokers Lower strain ratio of medial distal femoral cartilage in smokers Thicker femoral cartilage in smokers	[15]
Case-control	325 subjects	Higher risk experienced for medial and lateral tibiofemoral cartilage defect in smokers	[16]
Prospective	272 adults	Increased annual loss of medial in smokers, but not lateral or patella cartilage volume	[17]
Retrospective	104 patients (52 smokers and 52 non-smokers)	Meniscus repair failure in more smokers (27%) than non-smokers (7%)	[18]
Retrospective	48 smokers, 66 non-smokers	Lower modified Cincinnati knee score in smokers Less improvement in the knee score after surgery in smokers Graft failures in smokers Negative correlation between the level of smoking and the outcome following surgery	[19]
Retrospective	396 patients	Lower gratification rate after knee micro-fracture intervention in smokers	[20]
Secondary data analysis	A total of 412 cases with 40 years of age	No association between smoking and disc degeneration and low back pain	[21]
Retrospective	500 patients	Smoking as a predictor of reoperation after a single and multi-level laminectomy	[22]
Retrospective	1038 patients	22.2% of patients would need reoperation, and smoking was a risk factor.	[23]
Retrospective	110 patients (82 non-smokers and 28 smokers)	Higher rate of reoperation in pseudarthrosis, instrumentation failure, or adjacent segment among smokers Reoperation among smokers higher than nonsmokers (odd ratio=4.75).	[24]
Retrospective	35 477 adult patients	Higher risk of superficial surgical site infection and overall wound complications in smokers Higher risk of total morbidity and superficial surgical site infections in smokers	[25]
Comparative clinical study	50 patients (34 non-smokers and 16 smokers)	Smokers showed a comparable pain reduction to non-smokers. Reduction in opioid use in non-smokers only one year after surgery Better fusion success in non-smokers	[26]
Prospective	4555 patients with central lumbar stenosis	Smoking was a primary predictor for results after surgery. Fewer development after surgery in smokers	[27]
Retrospective	148 patients	Association between smoking and lower spinal fusion rate	[28]
Retrospective	158 patients	No association between smoking and a lower spinal fusion rate	[29]
Retrospective	825 patients (619 non-smokers and 206 smokers)	No association between overall complication rate and longer length of hospital stay and smoking	[30]
Retrospective	902 patients	No association between smoking history and overall complication rate	[31]
Prospective	159 men	Higher cartilage loss and more severe knee pain in smokers	[32]
Cross-sectional	9064 participants who received knee or hip joint x-rays	No association between smoking and osteoarthritis prevalence A weak correlation between smoking and osteoarthritis.	[33]
Cross-sectional	2061 participants	More degenerated cartilage matrix in smokers	[34]

Results about the effects of smoking on different cartilage (knee, spinal, etc.) are contentious. According to an animal study, nicotine prevented cartilage degradation by reducing the serum level of TNF- $\alpha$  and the expression of TNF- $\alpha$  and increasing the expression of  $\alpha 7nAChR$  in the synovial tissue [36]. According to another study, physiological nicotine levels in cigarette smokers enthused collagen and protein production in chondrocytes; however, upper serum levels of this compound had an inhibitor effect on chondrocytes [37]. Consequently, more studies are required, including an extensive sample size from diverse age and gender groups, to assess the relationship between smoking and cartilage disorders. In addition to the effects of smoking on cartilage disorders, numerous socioeconomic features and other comorbidities may also affect cartilage construction, which should be considered in future studies.

## Conclusion

Our review documented the association between smoking and different knee/spinal cartilage disorders, such as increased cartilage size, diminished strain ratio, and weak postoperative result, as well as low fusion ratio and risk for spinal reoperation. As the use of tobacco products is a significant global public health concern, additional research to comprehend the mechanisms of smoking on musculoskeletal system disorders is highly recommended. Increasing awareness of health policymakers and the general population around the harmful effects of smoking on the musculoskeletal system is necessary.

## Ethical Considerations

### Compliance with ethical guidelines

This article is a review with no human or animal sample.

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### Authors' contributions

Data curation and methodology; Hadi Eshaghi Sani Kakhaki and Fariba Razmi; Formal analysis, investigation and writing original draft: Hadi Eshaghi Sani Kakhaki; Supervision, project administration, resources, review and editing: Farshid Soleimani.

### Conflict of interest

The authors declared no conflict of interest.

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