

# A Half-Century of Orthopedic Innovation: A Trend Analysis of Scientific Disruption in Core Literature

Shravya Balaji BA<sup>1</sup>, Sameer R. Khawaja MD<sup>1</sup>, Corey F. Hryc PhD<sup>2</sup>, Brenton Jennewine MD<sup>2</sup>, Michael C. Cusick MD<sup>2</sup>, Kaleb J. Patterson BSA<sup>1</sup>, Sai Prasada Rao K. Manikonda BS<sup>1</sup>, T. Bradley Edwards MD<sup>2</sup>

<sup>1</sup>Baylor College of Medicine, Houston, <sup>2</sup>Fondren Orthopedic Research Institute, Texas Orthopedic Hospital, Houston  
Email of Presenting Author: Shravya.balaji@bcm.edu

**Disclosures:** none

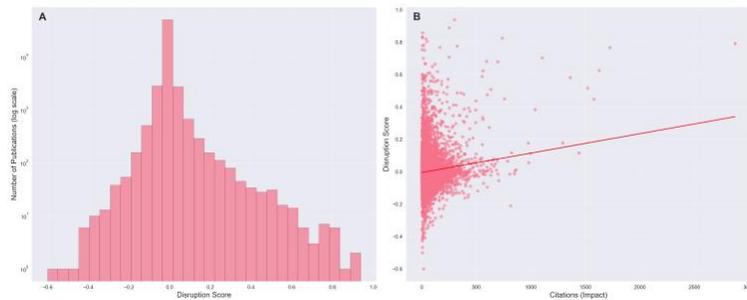
**INTRODUCTION:** The field of orthopedic surgery has seen profound advancements over the last 60 years, yet a quantitative method for distinguishing truly disruptive publications from those that merely consolidate existing knowledge has been lacking. The Disruption Index (DI) is a validated bibliometric tool that assesses whether a publication inspires a shift away from its foundational references (disruptive) or encourages further work that builds upon them (consolidating). This study applies this innovative framework to the entire body of orthopedic literature to identify the most transformative research and uncover macro-level trends in scientific innovation.

**METHODS:** A total of 58,052 publications were analyzed from the top 25 orthopedic journals, as ranked by the 2024 Journal Citation Reports (JCR) impact factor. The analytic window was restricted to 1954–2014 for two methodological reasons: first, to ensure a minimum ten-year citation accrual period for each publication, thereby reducing temporal bias in disruption index calculations; and second, because the validated disruption index dataset is available only through 2014. This journal-based selection method differs from prior sub-specialty analyses and ensures 100% orthopedic-relevant content. Disruption scores (D) were calculated for each publication using the established formula:  $D = \frac{Nf - Nb}{Nf + Nb + Nr}$ , where Nf represents papers citing the focal paper but not its references, Nb papers citing both, and Nr papers citing only the references. Temporal trends, team size, and citation data were analyzed using correlation testing and descriptive statistics.

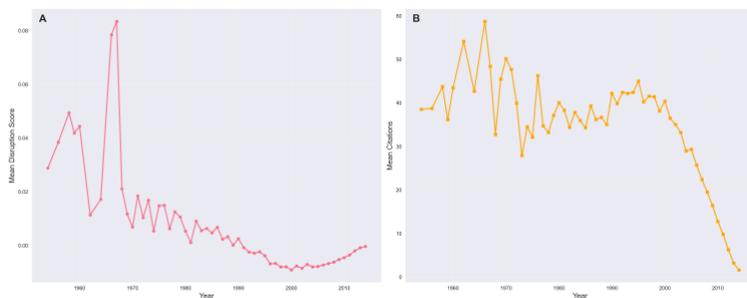
**RESULTS:** The analysis revealed a slight but significant consolidation bias across the field, with an average disruption score of -0.0026. A strong temporal trend was observed, with disruption decreasing over time; the most innovative decade was 1954-1963 ( $D=0.0374$ ), while the most consolidative was 1994-2003 ( $D=-0.0073$ ). In contrast to sub-specialty findings, smaller teams were found to be more disruptive, with solo authors exhibiting the highest average disruption score ( $D=0.0079$ ). The correlation between citation count and disruption was exceptionally weak ( $r=0.130$ ). The most disruptive paper ( $D=0.9389$ ) introduced a motor-assessment scale, while the most cited paper (2,872 citations), concerning traumatic hip arthritis, was also highly disruptive ( $D=0.7916$ ).

**DISCUSSION:** Our findings challenge conventional views on innovation within orthopedic surgery. The overall consolidation bias suggests that, as a whole, the field trends toward incremental improvement rather than disruptive shifts. The clear decline in disruption over time may reflect the increasing complexity and specialization of modern research. The finding that smaller teams are more disruptive on a field-wide level reinforces the theory that large teams are better suited for developing existing ideas, while small teams are catalysts for new ones. The weak citation-disruption correlation confirms that traditional metrics are insufficient for identifying truly innovative work. The scope of the findings is limited to innovation dynamics through 2014, given that the disruption index is validated only until that year. As a result, more recent shifts in orthopedic publishing trends are not captured in this analysis.

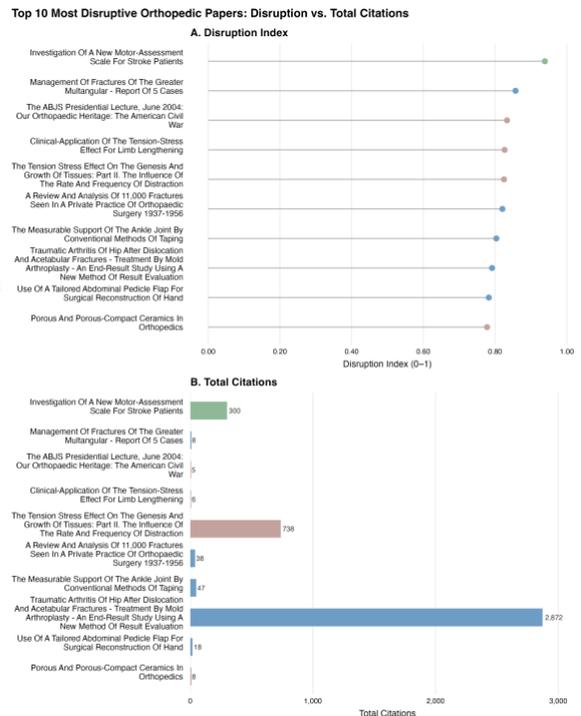
**SIGNIFICANCE:** This study provides the first large-scale, field-wide disruption analysis of orthopedics, offering unprecedented insights into innovation patterns. These findings can help guide research funding, shape collaboration strategies, and refine how the orthopedic community identifies and supports transformative science.



**Figure 1.** (A) Distribution of disruption scores across all orthopaedic publications from top 25 journals (1954-2024). (B) Correlation of citation count and disruption index.



**Figure 2.** (A) Mean disruption index per publication by year from 1954 to 2024. (B) Mean number of citations per publication from 1954 to 2024.



**Figure 3.** (A) Top 10 papers in orthopaedic surgery literature by disruption index and (B) corresponding citation count.