Original Article

Inaccurate Citations Are Prevalent Within Orthopaedic Sports Medicine Literature

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Purpose: To evaluate the peer-reviewed orthopaedic sports medicine literature for reference errors within 2 high-impact journals. **Methods:** In total, 769 references with 1,082 in-line citations were assessed from 20 randomly selected peer-reviewed articles published in 2 high-impact orthopaedic sports medicine journals, *Arthroscopy* and the *American Journal of Sports Medicine*. Full-text copies of references were obtained through online literature subscription databases. Two investigators evaluated each citation for agreement between the reference's study design, methods, data, discussion, and conclusion with the citing authors' claims. Error rates, interobserver agreement, and association between error rates and journal demographics were assessed. **Results:** Cohen's κ coefficient representing interobserver agreement was 0.61. The mean citation error rate across 20 articles from 2 orthopaedic sports medicine journals was 6.6%. The most common error was failure to support the authors' assertions within the citing article, accounting for 32% of errors. There was no significant association between error rate and journal impact factor, number of cited references or total references, ratio of in-line citations to cited references (citation ratio), and number of authors. There was no significant relationship between error rate and journal, study type, and level of evidence. **Conclusions:** Inaccurate claims and citations are common within the orthopaedic sports medicine literature, occurring in every reviewed article and 6.6% of all in-line citations. Failure to support the assertions of the article in which a reference is cited is a common error. Authors should take care to rigorously assess references with particular attention to accurate citation of primary sources. **Clinical Relevance:** This study highlights the prevalence of citation errors within a random sampling of high-level orthopaedic sports medicine articles. Given science is cumulative, these errors perpetuate inaccuracies and are at odds with evidence-based practice.

Citations are an essential component of scholarly research and academic writing, providing a means of acknowledging the contributions of others and building on existing knowledge. Sports medicine journals, like all academic publications, provide a vital platform for sharing the latest research and discoveries with the wider orthopaedic community. These journals uphold the scientific method, with reviewers and editors rigorously scrutinizing submitted manuscripts. However, peer-reviewed literature is not immune to errors. Many authors are not necessarily aware of citation best practices and may inadvertently contradict the cited source, make statements that are unsupported by the source, incorrectly cite reported data, or use secondary sources for citations instead of understanding the primary literature. The ramifications of these errors can be profound, not only casting doubt on the validity of the author's research but also contaminating the body of knowledge as a whole. Errors in citations can significantly impact the accuracy and reliability of research, potentially leading to the dissemination of misinformation and hindering scientific progress.

Despite the importance of accurate citations, previous studies have identified significant errors in citation practices across a range of disciplines. Prior evaluations of the orthopaedic peer-reviewed literature suggest citation error rates of 7.6% to 38%.[1-7] However, relatively little attention has been paid to citation errors in sports medicine journals specifically. Additionally, the methodology of reference review employed in the existing literature often relies on a subsample of references. Our study takes a novel approach to the

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methodology by reviewing all references for errors, thereby most accurately representing reference accuracy.

Therefore, the purpose of the current study was to evaluate the peer-reviewed orthopaedic sports medicine literature for reference errors within 2 high-impact journals. We hypothesized that there would be high rates of errors across both journals, with inaccurate or incomplete characterization of the referenced results.

Methods

All articles published in the December 2021 and January 2022 issues of the *American Journal of Sports Medicine* and *Arthroscopy* were organized by title and author. Editorials, editorial commentaries, and letters to the editor were excluded. Each remaining article was assigned a random number utilizing a random number generator. The first 5 articles assigned at random for each journal issue were selected for citation review. A total of 20 articles were selected (5 from each journal issue). Full-text copies of each article were collected utilizing a subscription journal database. Each article was then organized by author, title, study type, subject, level of evidence, and number of citations.

Full-text copies of each cited article's abstract were collected using a subscription journal database and reviewed by authors D.H. and M.A. to assess for quotation accuracy and applicability of the reference in the context it was used based on the reference's actual data and conclusions. If the reference abstract was insufficient to establish accuracy, a full-text copy was obtained and reviewed. The citation number of the erroneous reference was recorded in a database along with the corresponding page number, the error type, and a brief narrative note explaining the identified error. Each citation error was categorized as 1 of the 7 types of errors as utilized by Davids et al.[4] and outlined below. Prior to identifying errors, these error types were discussed by the authors so that there was agreement regarding what is meant by each error type and how to identify each error type. Additionally, to resolve discrepancies in error identification, 5 articles and the associated 311 in-line citations were reviewed by author D.C., who adjudicated consensus building on error identification. The error types were (1) contradicted assertion in article (the reference is related to the authors' claims but upon thorough reading of the reference, it comes to an antithetical conclusion), (2) reference failed to support assertion in article (the reference is related to the article but draws conclusions that are tangential or unsupportive but not contradictory and cannot be specifically categorized as one of the errors outlined below, such as incorrect patient numbers or percentages), (3) reference unrelated to assertions in article (the reference not only fails to support the assertions of the article but is frankly unrelated to the authors' claims), (4) incorrect patient numbers or percentages, (5) incorrect measurement numbers or percentages (in both instances erroneous quotation of reference specifics), (6) indirect references (the reference is not the primary source of a conclusion but in turn quotes the primary reference), and (7) unnecessary citation (use of a reference when none is needed, such as when the author explains novel methods).[4]

Mean error rate, defined as number of quotation errors divided by number of in-line citations, was calculated for each journal issue. Interval data for impact factor, number of references, total citations, citation ratio, and number of authors were found to be nonparametric. Spearman rank order correlation was utilized to evaluate the relationship between error rate and these data. Ordinal data, including study type, journal, and level of evidence, were found to be nonparametric. Kruskal-Wallis 1-way analysis of variance was utilized to evaluate the relationship between error rate and these data. $P < .05$ was considered significant. Cohen κ statistic, representing interobserver agreement, was also calculated.

The descriptive statistics and analysis were performed using RStudio (Version 2023.03.0+386; Posit Software, PBC).

Results

From the 20 articles randomly selected and reviewed for accuracy, 769 unique bibliographic references were identified. Since each in-line citation was assessed for accuracy, all repeated citations were reviewed for a total of 1,082 in-line citations. There was a mean of 7.5 (range, 4-11) authors per article, with 38.5 (range, 22-75) references per article and 54.1 (range, 30-100) total in-line citations per article. There were 5 retrospective comparative studies, 3 cohort studies, 3 case series, 3 cross-sectional studies, 2 randomized control trials, 2 case-control studies, 1 laboratory study, and 1 technique guide. Level of evidence ranged from I to V; there were 9 articles of level III evidence, 7 level IV, 2 level II, and 1 each of level I and V (Table 1).

The 2 reviewers agreed in their evaluation for 1,003 of 1,082 (92.6%) citations. Agreement between reviewers was moderate, $\kappa = 0.61$ (95% CI, 0.53-0.69).[8] In total, the citation error rate was 6.6% (71 errors in 1,082 citations; 95% CI, 4.9-8.5%), with a range of errors per journal issue from 5.2% for *Arthroscopy*-b to 8.9% for *Arthroscopy*-a (Table 2). The most common error was due to assertions that were unsupported by the cited reference, accounting for 32% of identified errors (Table 3).

We found no significant association between error rate and journal impact factor ($r = -0.015$, $P = .94$), number of cited references ($r = -0.024$, $P = .91$) or total in-line citations ($r = -0.14$, $P = .55$), citation ratio

Table 1. Article Demographic Information

Journal	Article Number	Number of Authors	Study Type	Level of Evidence	Number of Cited References	Total In-Line Citations
***AJSM*-a (Dec. 2021)**						
	1	8	Case control study	3	75	100
	2	5	Cohort study	3	33	42
	3	7	Randomized controlled trial	1	26	30
	4	5	Case series	4	43	56
	5	9	Cohort study	2	28	83
***AJSM*-b (Jan. 2022)**						
	1	9	Cross-sectional study	3	27	35
	2	11	Cross-sectional study	3	27	35
	3	6	Laboratory study	4	58	77
	4	5	Cohort study	4	27	48
	5	8	Cross-sectional study	3	58	75
***Arthroscopy*-a (Dec. 2021)**						
	1	11	Retrospective case series	4	22	32
	2	7	Retrospective case series	4	30	54
	3	7	Case series	4	54	79
	4	6	Case control study	3	45	53
	5	10	Retrospective comparative trial	3	37	51
***Arthroscopy*-b (Jan. 2022)**						
	1	7	Retrospective comparative study	3	34	50
	2	9	Case series	4	22	33
	3	4	Retrospective comparative study	3	29	41
	4	7	Randomized controlled trial	2	30	34
	5	9	Technique guide	5	64	74

AJSM, American Journal of Sports Medicine.

($r = 0.23$, $P = .31$), and number of authors ($r = -0.14$, $P = .54$). We found no significant relationship between error rate and journal ($P = .74$), study type ($P = .35$), or level of evidence ($P = .30$).

Discussion

In this study, we identified and characterized quotation errors in 2 high-impact orthopaedic sports medicine journals. We found errors to be prevalent, present in every reviewed article with an overall citation error rate of 6.6% among the 1,082 total in-line citations reviewed. We did not find any notable associations between journal characteristics and error rate. This finding was consistent with existing evaluations of the orthopaedic literature, although Buijze et al.[2] within their multivariate analysis found journal and type of study to be predictive of quotation error. Although in our analysis, we did not find specific demographic or reference characteristics to be associated with errors, we found some common error patterns. These are most easily identifiable by a sentence listing multiple citations yet only making a single claim:

> *"In a review of nearly 2,000 hip arthroscopy procedures, the most common reasons for revision hip arthroscopy were. . . .*[11-15]*"*

Table 2. Article Quotation Errors

Journal	Total In-Line Citations	Number of Quotation Errors	Error Rate, %
AJSM-a	311	18	5.8
AJSM-b	270	17	6.3
Arthroscopy-a	269	24	8.9
Arthroscopy-b	232	12	5.2
Total	**1,082**	**71**	

AJSM, American Journal of Sports Medicine.

Similarly, ranges of percentages for the prevalence of a condition were almost universally a sign of indirect referencing and inaccurate citations. This is most obvious when a range is cited, but only 1 citation is present. While this is acceptable if citing a systematic review, it more often indicated that the authors hastily cited another secondary source's introduction (which had also often cited a prior source's introduction), instead of verifying the primary literature and updating the range based on newer literature. Citation use such as this poses a challenge to the reader and reviewer and diminishes the utility of citations.

The most common error, accounting for one-third of all errors, was failure of the cited reference to support the article's assertions. The next most common errors were the cited reference being unrelated to the assertion of the article and indirect referencing. Collectively, these 3 error types accounted for 79% of errors. Notably, 7% of errors identified were citations that contradicted the findings of the cited article.

Our findings are consistent with previous investigations over the past decade within the orthopaedic trauma, hand, sports, foot and ankle, and pediatric specific literature, with identified quotation errors rates ranging from 7.6% to 38%.[1-7] More broadly within the biomedical literature, others have identified citation inaccuracy as a problem, including reference quotation errors within anatomy, neurosurgical spine, otolaryngology, and burn journals. Within this body of literature, quotation error rates have been found to range from 13.7% to 19%.[9-12] Jergas and Baethge[13] evaluated 28 medical journal articles on the subject of reference quotation errors, finding a median quotation error rate of 22.5%, with a range of 6.7% to 83.0%. Mogull[14] similarly evaluated 15 studies within the medical literature on the topic of reference errors and correcting for differences in methodology among studies found a total quotation error rate of 14.5%. A 2008 Cochrane review of the effects of technical editing evaluating 32 studies on the subject and 66 surveys on reference accuracy found a median quotation error rate of 20%.[15]

Although our findings fall within the low range within the exiting literature, our study shows that inaccurate citations continue to be prevalent within the sports medicine orthopaedic literature. Both the prevalence and nature of these errors are noteworthy as inaccurate citations, such as indirect referencing or contradictory referencing, may perpetuate inaccurate claims. In light of our study, it is our hope that authors will more rigorously assess references to ensure their citations support their claims, are relevant and concise, and cite primary literature accurately. Additional bibliographic rigor will help ensure effective scientific communication, which is vital to guiding future research endeavors.

A strength of our study was the number of citations reviewed, exceeding many of the comparable existing reviews within the orthopaedic literature. Our methodologic approach allowed us to review all of the references contained within the evaluated articles compared to the existing literature, in which often a relatively small portion of reference citations are reviewed for accuracy. Furthermore, utilization of randomization of journal article selection helped reduce bias.

Limitations

This study is clearly limited in its scope by its cross-sectional design, evaluating journal articles over a

Table 3. Quotation Error Type

Journal	Contradicted Assertions in Article	Reference Failed to Support Assertions in Article	Reference Unrelated to Assertions in Article	Incorrect Measurement Numbers or Percentages	Indirect Referencing	Unnecessary Citation
AJSM-a	0	8	4	0	4	2
AJSM-b	0	5	2	1	7	2
Arthroscopy-a	1	9	8	1	2	3
Arthroscopy-b	4	1	4	0	2	1
Percent total errors	**7**	**32**	**25**	**3**	**21**	**11**

AJSM, American Journal of Sports Medicine.

2-month period rather than over a range of years. Additionally, we did not evaluate the effect of a stand-alone in-line citation vs multiple clustered in-line citations (single vs string in-line citations). Both of these alterations to our study would have allowed analysis of additional possible citation error risk factors, the latter of which has been found to be significantly related to quotation error.[5] Furthermore, we analyzed only 2 sports medicine journals, providing a limited perspective when it comes to the entirely of the orthopaedic sports literature and the impact of journal characteristics on error rates. Lastly, although the determination of citation errors may be construed as subjective, especially in light of a κ coefficient of 0.61, suggesting only moderate reviewer agreement, our strict criteria and focus on the strict a priori criteria and focus on certain errors that were considered antithetical to evidence-based medicine, such as frank misquotation, allowed reviewers to remain objective. However, modifications to the methodology such as a use of additional reviewers, converting the error types to a scoring scheme, and averaging reviewer scoring would additionally assist in eliminating apparent subjectivity.

Conclusions

Inaccurate claims and citations are common within the orthopaedic sports medicine literature, occurring in every reviewed article and 6.6% of all in-line citations. Failure to support the assertions of the article in which a reference is cited is a common error. Authors should take care to rigorously assess references with particular attention to accurate citation of primary sources.

Disclosure

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