Applying and Contributing to Evidence in Sports Practice

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Purpose

• In order to stay on the cutting edge of sports medicine, current literature must be critiqued and applied to clinical practice.

  – How can we easily find relevant information?
  – Once found, is it worthy?
  – How can we contribute through publication of our own sports chiropractic papers?
Purpose

In this session we will review and apply current best evidence to sports practice and obtain writing tips from examples in the papers we review.

- Case report
- Literature review
- Randomized clinical trial

Do we need ‘evidence’?

- Who demands that what we do is backed up by research?

- Payers
- Other providers
- Patients
What is Evidence-based Practice?

Ask a clinical question

Evaluate how things went

Search for good info

Apply the good info

Critique the info
Levels of Evidence

Randomized Controlled Studies → Cohort Studies → Case Control Studies → Case Series → Case Reports → Ideas, Opinions → Randomized Controlled Double Blind

Levels of Evidence

Systematic reviews → Clinical trials (randomized, masked) → Observational studies (cohort, cross-sectional, case-control) → Case reports, case series → Anecdotal findings, opinions, ideas
Levels of Evidence
How to write a case report for publication

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The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, or the United States Government.

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ABSTRACT

Objective: This paper describes how and why to write a case report for publication in a peer-reviewed journal.

Methods: PubMed, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), and the Index to Chiropractic Literature were searched from 2000 through September 2006 using the following search terms: case report, authorship, peer review, and manuscript. Relevant manuscripts were retrieved and the results were used to update a previous narrative overview of the literature.

Discussion: Commensurate with the increased use of evidence-based health care and recent changes in publication requirements, new standards are expected of case reports. Case reports should present new information to the literature and be written succinctly. The types of case reports available are discussed. Steps for preparing a case report are described based upon the current available literature.

Conclusion: Case reports are important contributions to the health sciences literature. Proper preparation of this study design is necessary in order for it to be published. A self-evaluation check sheet for authors is included to assist in the writing process. (J Chiropr Med 2006;5:72–82)

Key Indexing Terms: Case Report; Authorship; Peer Review, research; Manuscripts.

INTRODUCTION

The clinical case report, which describes and analyzes the diagnosis and/or management of 1 or 2 patients, is the first line of evidence in health care.\textsuperscript{1,2,3} Case reports have been used for years as a means to teach health sciences students,\textsuperscript{2,4} are one of the best ways for authors to get started in scholarly writing,\textsuperscript{2,5,6} and can be a valuable learning experience for both author and reader.\textsuperscript{7}

As valuable as the case report might be, many journals no longer publish this study design for a variety of reasons. Past abuses in authorship\textsuperscript{2} culminated in the demise of the case report in some journals. Some journals no longer publish cases because of the low level of general application to the practice of evidence-based care since case reports have certain inherent limitations.\textsuperscript{2,8,9,10,11} Some cases add little to the body of scientific knowledge and this is cited as a reason for discontinuing the publishing of cases.\textsuperscript{12} Other factors include the limited page space within a journal that tends to be dedicated to experimental studies, and the diminutive effect case reports have on a journal’s impact factor.\textsuperscript{13} Thus,
those journals that do continue to publish case reports are receiving more of them, and if one desires to see his or her manuscript grace the pages of a peer-reviewed journal, it needs to be of high quality.\textsuperscript{14}

Getting a case report accepted for publication in a journal does not have to be difficult. Many troubles can be avoided by knowing the requisite properties and parts of a publication-worthy case report\textsuperscript{15,16} and having an understanding of the peer review and publication process. This article discusses reasons for writing a report, the styles of reports one may write, the limitations of case reports, and culminates with a step-by-step description of preparing the case report. A pre-submission check sheet is included to assist in the writing process. It is our intention to make the writing process more enjoyable for new and seasoned authors alike.

\textbf{METHODS}

This article is an update on an earlier paper that was created using a comprehensive review of the literature through mid-year 2000.\textsuperscript{17} Because much has changed in the requirements for case reports, we felt it was appropriate and necessary to update the previous review. For the current paper, we searched PubMed, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), and the Index to Chiropractic Literature for the years 2000 through September 2006. Search terms included the following words: case report, authorship, peer review, manuscripts. Relevant manuscripts were retrieved and further sources were found by reviewing related links provided in each database and by reviewing the references of the papers read. The results of the current literature review were then used to update our previous publication using a narrative overview of the literature.

\textbf{DISCUSSION}

\textbf{Why Write a Case Report?}

The increased value placed on science as an underpinning for health care in the era of evidence-based health care has certainly placed the randomized clinical trial at the top of the hierarchy for reliable health information that may be used in a health care decision.\textsuperscript{10} In this hierarchy, case reports are at the bottom, existing as descriptive reports and opinions of respected authorities.\textsuperscript{10} Thus, one may ask, is there a place for case reports in the scientific literature?

Many authors agree that case reports have their place in the published literature, and they should be written because they provide new knowledge to the field of health care.\textsuperscript{1,14,18,19} Cases remain as one of few ways to bring a new condition or new etiology to the attention of the scientific community.\textsuperscript{9,11} For example, in 1985, the American Medical Association reprinted 51 papers from the Journal of the American Medical Association that had significantly changed the science and practice of medicine during the 150 years of the organization’s existence. Interestingly, 5 of these papers were case reports.\textsuperscript{20} While case reports can be highly influential on their own merit, they may simply provide documentation of occurrence,\textsuperscript{3} which provides preliminary evidence necessary for designers of larger scale experimental studies\textsuperscript{1,21,22} or warns a profession of potential complications of care.\textsuperscript{8} A list of reasons to publish an interesting case is provided in Figure 1. Grimes and Schulz\textsuperscript{23} suggest that cases worth reporting have not been studied before.

There are additional reasons to write a case report. For instance, authors, students, and readers usually find case reports to be educational and interesting.\textsuperscript{2,7} Additionally, students may present a case in grand rounds and the next step in professional growth would be to get the case published.\textsuperscript{9} Furthermore, practitioners can report unique cases from their clinical practice to add to the evidence base.\textsuperscript{1,15,16,18,21} Lastly, the act of writing a report provides an opportunity for one to practice concisely written communication, to learn about a topic, and to think critically.\textsuperscript{2,8} While these secondary reasons are all noble, if a case does not add new knowledge, then there is little likelihood that the manuscript will be accepted for publication.

\textbf{Types of Case Reports}

Since case reports are typically educational and relevant to practice, there are 3 types that tend to be published, including diagnostic or assessment reports, treatment or management reports, and educational reports. Diagnostic case reports describe and discusses the diagnostic or analytic methods used to evaluate a patient. These cases present a diagnosis that is rare, confusing, or difficult to render, but often do not discuss treatment.\textsuperscript{18,26} Other case reports describe and discusses the full management of
1. To present an unusual or unknown disorder\textsuperscript{1,9,14,21,23}
2. To present unusual etiology for a case\textsuperscript{1,9}
3. To present a challenging differential diagnosis\textsuperscript{1}
4. To describe mistakes in health care, their causes and consequences\textsuperscript{1,3}
5. To describe an unusual setting for care\textsuperscript{1}
6. To present information that can not be reproduced due to ethical reasons\textsuperscript{1,21}
7. To illustrate a clinical hypothesis\textsuperscript{18}
8. To prompt a new hypothesis\textsuperscript{16,18,21,23}
9. To disconfirm an hypothesis\textsuperscript{24}
10. To support an hypothesis\textsuperscript{16,18}
11. To stimulate further research\textsuperscript{18}
12. To make an original contribution to the literature\textsuperscript{21,24}
13. To offer new insight into the pathogenesis of disease\textsuperscript{5,16,24}
14. To describe unusual or puzzling clinical features\textsuperscript{3,5,16}
15. To describe improved or unique technical procedures\textsuperscript{3,15}
16. To describe the historical development of a field or movement\textsuperscript{25}
17. To report unusual drug-drug, drug-food, or drug-nutrient interactions\textsuperscript{3}
18. To describe rare or novel adverse reactions to care\textsuperscript{3,11,14}
19. To study the mechanism of a disease\textsuperscript{9,14}

Figure 1. Reasons for submitting a case report for publication.

With prospective case reports the author plans out patient care and data collection ahead of time. For example, a practitioner may frequently care for patients with migraine headache. In preparation for writing a case report, the doctor reviews the literature to determine the best outcome measures to assess patient progress and determines how or if a case will contribute to the literature. Published treatment protocols are also discovered during literature review and will be used once the next patient presents with the condition. When the next case does arrive in the office, the clinician knows ahead of time exactly how to evaluate the patient and will deliver a specified predetermined management plan. Measurements of the patient’s condition are taken before, during and after care and can be tracked over time. Some authors avoid this type of case report because of the work involved in planning the case. However, it saves an inordinate amount of time in the writing of the manuscript because the literature already has been reviewed. An added bonus for the patient is that the early planning and preparation for this case report improves the patient management in practice.

A special kind of prospective design is the time series case report. In this design, a clinical hypothesis is generated by the doctor, tested over time, and documented with valid outcome measures\textsuperscript{27,28,29} Each part of the study is broken down into phases\textsuperscript{30} and a minimum of three measurements are taken on the patient’s condition during each phase, thereby decreasing the likelihood that an inaccurate measurement is taken. Taking a series of 3 measurements also helps the author identify the trend of the patient’s condition, something that can not be accomplished if only one measurement is taken before and after care, which is typical in retrospective and
prospective case reports. Authors interested in the time series case report should ensure that the study is approved in advance by an ethics review board are referred to other resources that thoroughly describe how to conduct a time series case report.

Limitations of Case Reports

While case reports are a valuable contribution to the literature, it must be kept in mind that they have certain limitations. First, the management of patients in an out-patient setting occurs primarily in an uncontrolled environment. There is little the clinician can do to prevent patients from introducing a variety of confounding factors into their lives that may affect the patient’s response to care; clinical results may not be due to the treatment rendered. For example, a patient may take pain relievers, lift a heavy object when not in the office, and may exhibit various levels of compliance with care, all which have an impact on the clinical picture seen by the clinician at the time of an office visit.

Because of these uncontrollable factors and the fact that the care rendered to one patient may not produce the same effect in another patient, case reports cannot be generalized beyond the context of the patient reported. This means that one can never conclude, based upon the observations of a single patient, that any particular management strategy will be effective for other patients with the same condition. One can hypothesize patient response, but it can only be tested using experimental clinical trials. However, authors of case reports may be encouraged to know that more elaborate experimental trials may be based on the very case reports that they write.

Results of patient responses to care are also limited by the natural history of the disorder under study. Some disorders may undergo spontaneous remission or phases of exacerbation and remission. Often times, one of these phases may correspond with the time when care is provided and could lead to a faulty conclusion. For example, a patient with chronic adhesive capsulitis may begin care at the peak of exacerbation. If the patient improves, it is difficult to determine if the patient improved because of the natural tendency for the capsulitis to enter remission or the condition improved because of the care rendered. Similarly, if the patient begins care just prior to the worst part of the inflammatory cycle and gets worse during care, it could seem as though the care actually worsened the condition when in fact it may be the natural process of the condition. Therefore the natural history must be kept in mind when managing patients and writing a report.

Lastly, when constructing a retrospective report, the author must rely upon data accumulated in the patient health care record. Since such records often are not complete, important data may be missing, which introduces a source of error into the report. Thus, those who maintain more detailed and accurate records are more likely to find it easier to write better case reports.

Writing the Case Report

A successful clinical case report should include the necessary design elements, be well structured, and convey a clear message. Elements of a case report are similar to those required for all forms of scholarly articles and we provide a suggested list in Figure 2. There are a few approaches to use in presenting a case report, from the “storied case report” to the evidence-based case report, however the traditional format is what we present here. Authors may find that worksheets and checklists are helpful in preparing a case report.

Most seasoned authors and editors would agree that the most important thing an author can do to enhance the chance for acceptance is to follow the journal’s instructions for authors when preparing a manuscript. There are 2 sources of instructions for manuscript preparation that one should follow. The first are the instructions for the journal to which one desires to submit a manuscript.

1. Title
2. Structured abstract
3. Introduction
4. Case report (methods and results)
5. Discussion
6. Conclusion
7. Acknowledgements (if applicable)
8. References
9. Tables
10. Figures and captions

Figure 2. Case report components listed in the typical order of appearance for a manuscript being prepared for submission.
script. These are usually available from the journal editor and posted on the journal website. Almost all biomedical publications follow another set of guidelines, the Uniform Requirements for Manuscripts Submitted to Biomedical Journals. These guidelines describe in detail how to prepare a manuscript for submission to a peer-reviewed journal. Conforming to these guidelines is essential to insure that submitted manuscripts are uniform in nature to increase one’s chances of acceptance. The Uniform Requirements can be found on the Internet at http://www.icmje.org/index.html. Thus, when formatting a paper, authors should be sure to satisfy both sets of instructions before submitting a paper. Manuscripts received by journals are often returned to authors immediately because they are not formatted correctly, a problem easily remedied by following the directions.

The presentation of a case report should be objective and devoid of fantastic claims or far reaching conclusions. It is essential that authors remember that the intention of a case report is to describe and discuss a clinical event, not to prove anything. Keeping in mind the major limitations of the case report design, one should avoid writing a case report that tries to prove causation and observations of the case should not be generalized to other patients.

**Authorship**

Determining who will be listed as authors on a paper, and in what order, is an important process. It is convention that the author who does the most work on the project is listed first and only those involved in a substantive way are listed as authors. Past abuses in authorship have created a need for clear authorship criteria, which have been provided by the International Committee of Medical Journal Editors. Since it is unlikely that a single case will be managed by a large team of providers, one would not expect to see more than a few authors on a case report. One paper titled “Does it Take a Village to Write a Case Report?” poignantly demonstrates that some have successfully used the case report as a means to enhance their curriculum vitae. One study has objectively demonstrated that case reports contain too many authors.

According to the International Committee of Medical Journal Editors guidelines, one may only be considered an author only if he or she meets all of the following 3 criteria: 1) has provided substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; 2) has drafted the article or revised it critically for important intellectual content; and 3) has given final approval of the version to be published. Anyone who does not meet all 3 criteria, but who has contributed to the paper, may be thanked for their contribution in the acknowledgements section of the manuscript.

**Patient Privacy**

Case reports tend to report on unusual situations and patient identity may be compromised because of the unique qualities of a case. Further, in the United States, the Health Insurance Portability and Accountability Act (HIPAA) requires that patients’ protected health information be secure. Before 2003, when HIPAA came into effect, patient consent to publish the case was not well observed. Because of these issues, many journals now require authors to obtain consent to publish from patients prior to publishing a case report and some journals require that the patient sign a specific consent form provided by the journal office. If a patient refuses to allow the information to be published, authors should respect the patient’s wishes.

If an author works for a hospital or institution, he or she should inquire with the institution’s privacy officer or institutional review board to find out the institution’s practices regarding patient privacy before submitting a manuscript to a journal. Prospective case report designs pose a special challenge. Since they inherently involve the premeditated planning and application of care, especially in the case of the time series design, authors should receive expedited review from an institutional review board prior to conducting the study. Summarily, it is common practice that journals will not accept a manuscript if it is unaccompanied by consent to publish the case from the patient or approval from an institutional review board or privacy officer or if all identifying information has not been removed during the preparation of the report.

**Length**

The literature we reviewed varied in its description of the expected length of a case report. Suffice it to say that case reports should be brief. Some journals impose word limitations on case reports; 1500–2500 words are recommended by Cohen. In a review of several top journals, Sorinola et al. found...
word restrictions to be between 500 and 2000 words with a median of 1000 words. Authors should verify that the length of their case report does not exceed the word count recommended in the journal instructions for authors.

It is essential that the author deliver a single message, based on the actual case presented and to not tangent. It is increasingly common for journals to not allow case reports to be used as an instrument to review the literature. Combining a case report and a literature review usually yields a lengthy and poorly executed hybrid. Modern literature reviews are important designs used in the application of evidence base health care and have a specific purpose and style. Therefore, case reports and literature reviews are separate study designs and should be published as such.

**Abstract**

The abstract is a summary of the article and offers the reader an organized, brief presentation of the paper, relating the most important highlights of the case. Abstracts are important; the information in the abstract and the title are entered into computer databases and indexing systems, and are essential for those conducting literature searches. A well-written structured abstract allows people searching the literature to find the information they are searching for and to discern whether or not they should retrieve the paper.

Abstracts should be short (100–250 words). In the past, narrative abstracts were often used by journals, but authors sometimes did not adequately report the necessary elements of the study in the abstract. Thus, most journals adopted the structured abstract format over 15 years ago. There is wide variance in the subsections required by journals. The instructions for authors for the journal to which authors are considering submitting their work should be reviewed for instructions pertaining to word count and structure. The most general structured abstract includes the following: introduction, methods, results and discussion. More on the content of these subsections can be found in Figure 3.

**Title**

The title should be an accurate, succinct description of the patient under study. Janicek suggests that 4 items be included in the “informative title” to enable rapid identification of the topic presented. These 4 items and an example are included in Table 1. Writers should not use titles that suggest a large-scale trial was conducted because they are misleading to the reader. For example, An endurance training regimen improves low back endurance associated with low back pain presents the case as if more than 1 patient was studied in a clinical trial for effectiveness. Clever or artistic titles (eg, ‘Stamina in the Office Worker’) should not be used unless they are a subtitle because it is confusing and makes it difficult for the reader to determine the focus of the paper.

**Table 1**

**Four Elements for the Informative Case Report Title. The Resultant Combination of These Elements Could be the Following Title:**

**Changes in Isometric Low Back Extension Endurance Times after an Endurance Training Regimen in an Office Worker with Low Back Pain**

<table>
<thead>
<tr>
<th>Element</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Intervention is named.</td>
<td>Endurance training regimen</td>
</tr>
<tr>
<td>2. Outcome of the intervention is identified.</td>
<td>Changes in isometric low back extension endurance times</td>
</tr>
<tr>
<td>3. Population under study is identified.</td>
<td>Office worker</td>
</tr>
<tr>
<td>4. The condition of interest is stated.</td>
<td>Low back pain</td>
</tr>
</tbody>
</table>

**Introduction**

The purpose of the paper should be clearly described in the introduction. In addition, background information should be provided to demonstrate how the case contributes to the literature. Information from a review of the literature allows the author to relate the context of this case in relation to previously published data. For example, the incidence of the disorder, the number of previously reported cases, or other information that helps provide context for the case could be provided. While it is important to provide enough background information to put the paper into context and establish the need for the paper, it is also important not to delve too deeply into the subject. It is essential that the author’s preparation for writing the manuscript include a comprehensive review of the literature; however, it is important to limit the amount of information in the introduction only to what is adequate to familiarize readers with the topic. In the introduction, the author should also define unusual terms or words that are essential to understanding information in the paper. For instance, if a case is
about phantom limb pain in a disabled athlete, it would be necessary to briefly define phantom limb pain and describe the athletic activity in which the disabled patient participates.

Case report (methods and results)

The part of the paper that describes the patient, outcome measures, assessment protocols, and treatment, if applicable, is sometimes called ‘case report’ or ‘case presentation’ in various journals. While this may seem confusing because the study design being used is essentially named the same, it is simply the part of the manuscript where the author describes how the patient was managed. It is important in this section to provide a detailed description of the case and management for a number of reasons. First, the reader should be provided sufficient information to understand the how the patient was assessed. Since other clinicians will read the paper, it is important to describe procedures in a clear manner so that other doctors may be able clearly understand the protocol. Third, it should describe the case in chronological order and with enough detail for the reader to establish his or her own conclusions about the validity of the case. Also, if future research will be based on this case report, researchers will need to have accurate descriptions from which to work. Photographs or illustrations of diagnostic procedures, radiographs, or treatment procedures can be helpful in conveying a clear message to readers and should be used when appropriate. However, authors should be judicious in their use of illustrations or figures, including only those that enhance clarity of the case presentation.

An extremely important part of the case report section is the reporting of patient data. It is important that all appropriate tests are ordered to confirm a diagnosis and provide a platform for a reliable publication. Primary outcome measures should be used that quantify the patient’s problem. Quality sources of data such as the visual analog pain scale, functional outcome measures (eg, neck disability index), vital signs, results of laboratory tests or imaging and other outcome measures provide more objective information than reporting that the patient had “severe pain”, was “disabled from a neck injury” or “had hypertension”. Other clinical information that may be difficult to quantify, such as nausea or dizziness, should also be reported. However, it is difficult to determine from this information how much clinical change occurred. Negative results should be restricted to those that are significant in their relation to the case.

The methods and results should report the outcomes of the management as measured by the primary outcome measures and other data. It should be concise and not contain any inferences from the author as to why the patient’s health situation may have changed. Inferences should be saved for the discussion section. Since it is often laborious for readers to sort through data embedded in paragraphs, tables that demonstrate before and after care measurements may help the reader better understand the outcome. Balanced against the need for enough information to establish the credibility of the case is the need for authors to be concise and to include only the information needed to convey
case. Authors should refrain from providing confusing and superfluous data, such as daily vital signs reported as normal, routine laboratory tests, etc.3

Discussion

The discussion is the part of the paper where the author explains and discusses the case and provide his or her opinion, thus opinions should not appear elsewhere in the paper.51 The discussion should compare the case with the published literature, evaluate the case for accuracy, and derive new knowledge and/or applicability to practice.3

Comparing the case to what is already known and to similar cases reported in the literature demonstrates the unique qualities of the case reported and the author’s vigilance in conducting a thorough review of the literature in preparation of the report.3,15,16,24 Salient differences between the case and what is known in the literature should be presented; authors should not report variance that is inconsequential. Wright and Kouroukis54 have presented a manner in which authors may use to search the literature for other pertinent cases or information. They suggest performing a broad search to garner as much as possible about the condition and also to search the literature by combining the topic in question with the search term “case report”. This helps to discover if the case is indeed unique (and should be published), identifies specific criteria necessary to confirm a diagnosis, and reveals any standards that may exist in treating the problem.54

The author needs to demonstrate that he or she is objective in a self-assessment of the case. A discussion of how the diagnosis was confirmed and the differential diagnoses considered establishes that the author fully understands the problem and provided an adequate evaluation. A rationale for the management of the patient may also be provided,15 especially if patient management could be considered controversial. If a previously published protocol was used to see if it would have an effect on the patient, this alone may be adequate. However, if there are other reasons for selecting one procedure over another, the rationale should be presented. The author should list the limitations of the case and describe the significance of each limitation.3 In addition, faults in the case or quality of reporting should be identified. Authors must include in the discussion other possible reasons for the outcome of the case, such as the natural history of the disorder or other factors. Since the case is subject to many unknown variables, the author should present some of these to the reader.16,24

The writer should provide suggestions or hypotheses regarding the significance or outcome of the case and why the care provided may or may not have been beneficial.8,24 Support from referenced materials is valuable and should be included. A final element for the discussion is some suggestion for future inquiry into the topic.16 Stating that “more research is needed” is inadequate.24 Prompting a specific directive for future patient care guides research and clinical endeavors. Authors write this section by integrating what they have learned from the case and the literature that is reviewed in order to prepare the manuscript.

Conclusion

The conclusion should focus on what has been learned from the case report, should relate to the purpose of the paper and should not offer far-reaching, unsupported or general statements.8,15 The conclusion should not be a re-hash of the entire case. Conclusions should be about 1 paragraph in length.3

Acknowledgements

If appropriate, one may briefly acknowledge the work of a colleague who has assisted the author(s) in the preparation of the manuscript, but who does not meet the 3 criteria necessary to be named as an author. Such a person may be a proofreader, a research assistant, a medical writer, or a person who has provided ideas for the manuscript. Most journals require that people acknowledged must give written consent for their name to appear in print. For more information on the protocol for writing acknowledgements, writers should read the journal’s instructions for authors and the Uniform Requirements.

References

References should be drawn primarily from peer-reviewed journal articles. Authors should use the most recent references possible, unless the history of scholarship in a topic area is being discussed. It is acceptable to use relevant references from books for information that is unlikely to change substantially over time; yet, journal articles provide current infor-
mation. Magazines and newspapers should not be used as sources of evidence for a peer-reviewed clinical manuscript, except under highly unusual situations.

References should be adequate to demonstrate that the author has surveyed the appropriate literature to provide appropriate substantiation for factual claims and should be selected for their relevance and quality. There is no recommended number of references because this depends on the content of the case report. However, some journals impose limits on the number of references allowed for case reports. A single authoritative reference for a factual statement may be adequate. A lengthy list of references published for the sake of documenting laborious scholarship may demonstrate a lack of understanding of the publication process and indiscrimination. References should be formatted appropriately, as described in the journal’s instructions for authors or in the Uniform Requirements.

Tables

Clinical outcomes or sets of information that aid in visually presenting information in an appealing manner (rather than listing information as text in a paragraph) are tables. Tables should not be used for small amounts of data that could be conveyed clearly and succinctly in a sentence. Authors should not reiterate in sentences the data shown in a table. A further caveat of tables is that horizontal rows and vertical columns of information are related to one another. Therefore, a laundry list of differential diagnoses for a given condition, for example, is a figure, and not a table. Tables should be simple and self-contained, needing no further explanation. If authors wish to use previously published tables, the publishing company of the original material must grant permission to do so and it is the authors’ responsibility to receive this permission before submitting the manuscript to a journal. Some journals limit case reports to a finite number of tables. Authors should consult the journal instructions for authors and the Uniform Requirements for further guidance.

Figures

Figures, graphs, photographs, or illustrations can make articles interesting to read and help greatly to describe clinical procedures or findings. Like tables, figures should be self-contained and fully interpretable on their own accord. Captions for each figure used in the manuscript should be provided; authors should not expect that journal staff will write the figure captions. When reporting figures, do not include identical information in a table. If authors wish to use previously published photographs or illustrations, permission must be granted by the publishing company of the material and it is the author’s responsibility to receive this permission before submitting a manuscript to a journal. If models or identifiable people appear in figures, the author should submit a signed release form for each person photographed, each person giving permission for their likeness to be published in the journal.

Journals change their requirements for figures with advances in technology. Authors should check the instructions for authors of the journal to determine what form of media is preferred by the journal staff. Similar to tables, the number of figures or illustrations may be restricted by journals. As mentioned before, authors should consult the journal’s instructions for authors and the Uniform Requirements before submitting a manuscript.

CONCLUSIONS

Case reports are the first line of evidence in documenting clinical phenomena in the peer-reviewed literature. Proper preparation of a case report is essential in order for it to be published. A pre-submission self-evaluation check sheet derived from this review of the literature is appended to this article (Appendix A) in an effort to assist aspiring authors.

REFERENCES

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### APPENDIX A. CASE REPORT CHECK SHEET

**This Check Sheet is for Authors to Use as a Form of Self-evaluation Prior to Submitting a Manuscript to a Journal to Determine if Further Work is Necessary before submission.**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>AUTHORSHIP</strong></td>
<td>All authors meet the ICMJE criteria for authorship</td>
</tr>
<tr>
<td></td>
<td>Authors are listed in the order of contribution to the paper</td>
</tr>
<tr>
<td></td>
<td>A reasonable number of authors are listed</td>
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Femoral neck stress fracture in a female athlete: a case report

Daniel Avrahami BPHE, DC, MSc, Jason A. Pajaczkowski DC, DACRB

Abstract

Objective: The purpose of this case report is to describe chiropractic rehabilitation of a master’s-level athlete with proximal femoral stress fracture and provide a brief discussion of stress fracture pathology.

Clinical Features: A 41-year-old female master’s-level endurance athlete presented with chronic groin pain later diagnosed and confirmed by magnetic resonance imaging as a stress fracture of the femoral neck. After diagnosis, the patient was referred to a doctor of chiropractic at week 1 of the non–weight-bearing physical rehabilitation process. At that time, the patient presented with sharp and constant groin pain rated 6/10 on a numeric rating scale.

Intervention and Outcome: This patient avoided weight-bearing activity for 8 weeks while cross-training and was able to return to her sport after this period. The patient was progressed through a series of non–weight-bearing strengthening exercises for the lower extremity. Myofascial release therapy was performed on the gluteal, hip flexor, and groin muscle groups to improve range of motion. Motion palpation testing the lumbar and sacroiliac joints was performed during each session, and manipulative therapy was performed when necessary. The patient was seen once a week for 8 weeks. Reevaluation was performed at week 8; at that time, the patient reported no groin pain (0/10). The patient was discharged from care and referred back to the supervising physician for clearance to return to sporting activities. One month after discharge, she reported that she was pain free and had fully returned to sport activities.

Conclusion: This case report demonstrates the importance of a through clinical history, physical examination, and magnetic resonance imaging in the accurate diagnosis of a patient with chronic groin pain and that chiropractic care can contribute to rehabilitation programs for these injuries.

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Introduction

Stress fractures can be commonly found in various female subgroups. One of the highest proportions of stress fracture incidence rates in women is found in military personnel. Another common group of women that have the tendency to develop stress fractures are endurance athletes that perform repetitive weight-bearing sports such as distance running. Stress fractures can also frequently occur in adolescent athletes with amenorrhea, eating disorders, and osteopenia, otherwise known as the female athlete triad.

Several locations in the lower extremity have a predisposition towards developing stress fractures, including the tibia, metatarsals, and fibula. Owing to the aforementioned subgroups and frequently reported sites of injury, clinicians will frequently screen athletes in these groups and add a differential diagnosis of stress fracture. However, it is still possible for healthy athletes to sustain stress injuries or fractures that can easily be overlooked.

It is typical for a clinician to manage an athletic patient with conservative therapy before sending them for advanced imaging. Therefore, the misdiagnosis and subsequent mismanagement of an athlete with groin pain may easily occur, compounded by the complexity of the anatomical structures in the hip. Delay in diagnosis and treatment may result in undesired complications and lost time from sport participation. It is important to have imaging evidence in combination with physical examination findings to appropriately manage these problematic patients. The differential diagnosis of femoral neck stress fracture through clinical history and physical examination needs to be confirmed by advanced imaging.

To date, there have been no reports in the scientific literature of chiropractic management or comanagement of a patient with femoral stress fracture. This case report describes chiropractic rehabilitation of a master’s-level athlete with proximal femoral stress fracture and provides a brief discussion of stress fracture pathology.

Case report

A 41-year-old female personal trainer who competed regularly in mountain biking and cross-country skiing competitions presented to 3 doctors of chiropractic and a physical therapist, on separate occasions, with groin pain during weight-bearing activity. She stated that the pain began as a dull ache only present at the end of a session of physical activity. Over the ensuing season, her symptoms became progressively worse to the point where she experienced constant pain with walking.

On each presentation, the patient was treated using multiple modes of therapy, which included soft tissue manipulation, rehabilitative exercises, and acupuncture. Each therapist treated this patient over the course of 4 months with no improvements in symptoms. After 4 failed treatment programs, the patient was seen by a sports physician. The patient was referred for a bone scan that revealed increased uptake in the right proximal femur. It was suspected that the patient had a fatigue stress fracture and was referred for magnetic resonance imaging (MRI). Various MR images were taken including a coronal T2-weighted fat-saturated image and a coronal T1-weighted image that demonstrated increased and decreased signal intensity at the lesser trochanter, respectively (Fig 1). The axial T2-weighted fat-saturated image of the right femoral lesser trochanter demonstrated increased signal intensity with a linear, low-signal fracture line with surrounding edema (Fig 2). Her medical physician recommended that she stop all weight-bearing activity for 8 weeks with a reevaluation at that time.

The patient was referred to a doctor of chiropractic at week 1 of the non-weight-bearing physical rehabilitation process. The patient presented with sharp and constant groin pain rated 6/10 on a numeric rating scale. There was no associated weakness or paresthesia reported. The patient did report that her lower extremity

Fig 1. T2 fat-saturated MRI in the coronal plane. There is increased signal intensity at the lesser trochanter of the right femur (arrow).
strength and endurance were significantly decreased because she has not been able to train or compete in her sports. Neurological evaluation revealed sensory, motor, and reflex testing to be within normal limits. Vibration testing did not aggravate her symptoms. Gait assessment revealed an antalgic gait pattern. Static palpation of this patient revealed pain in the groin region around the hip flexor insertion. Active straight leg raise was painful, and hip flexor muscle strength testing was rated 4/5.

The patient was progressed through a series of non–weight-bearing strengthening exercises for the lower extremity. Myofascial release therapy was performed on the gluteal, hip flexor, and groin muscle groups to ensure adequate range of motion. Motion palpation testing the lumbar and sacroiliac joints was performed during each session, and manipulative therapy was performed when necessary. The patient was seen once a week for 8 weeks.

A reevaluation was performed at week 8 of the non–weight-bearing physical rehabilitation process. At this time, the patient did not have any groin pain, rated 0/10 on the numeric rating scale. There was no associated weakness or paresthesia reported. Results of vibration testing and gait assessment were unremarkable. Static palpation of this patient did not reveal any pain in the groin region or around the hip flexor insertion. Active straight leg raise was asymptomatic, and hip flexor muscle strength testing was rated 5/5. At this point, the patient was discharged from care and referred back to the supervising physician for clearance to return to her sporting activities. The patient reported no adverse reactions to chiropractic care. Through e-mail communication with this patient, 1 month after her discharge from therapy, she stated that she had returned to her full sporting activities pain-free.

Discussion

Case discussion

This case describes the findings and chiropractic rehabilitation of a clinically suspected proximal femoral stress fracture in a master’s-level athlete confirmed by MRI. This patient avoided weight-bearing activity for 8 weeks while cross-training and receiving chiropractic care. The patient was able to return to her sport after this period. Non–weight-bearing cross-training exercises in combination with chiropractic care can help expedite the rehabilitation process and allow athletes to return to their sport within an earlier time frame.

Review of stress fracture pathology

Definition

Bone stress fractures can be defined as insufficiency or fatigue fractures. When injury resulted from normal stress applied to abnormal bone, an insufficiency fracture occurs. Elderly women with osteoporosis tend to develop these types of injuries; however, any disorder that results in diminished resistance to physical forces as a result of altered osseous health may result in an insufficiency fracture, including but not limited to Paget disease, hyperparathyroidism, rheumatoid arthritis, diabetes, scurvy, osteomalacia, osteogenesis imperfecta or rickets, and malignancy.

Conversely, normal bone that is subjected to excessive stress can develop fatigue fractures. Bone remodels in response to repetitive submaximal stresses. With increased stress, the bone does not remodel sufficiently to accommodate for the rapid bone breakdown that can eventually lead to microfractures and stress fracture.

Histology

The histology of fatigue stress fractures shows that repetitive response to stress leads to reparative osteoblastic bone formation activity that is outpaced by osteoclastic breakdown, resulting in temporary weakening of bone. Trabecular microfractures can
result if physical activity is continued under these circumstances, and they explain the early bone marrow edema seen on MRI scanning. Reinforcement is created by forming new periosteal bone. However, if the osteoclastic activity continues to exceed the rate of osteoblastic formation, a full cortical break will ensue.  

**Location**

Generally, there are 3 femoral locations susceptible to stress fractures. The distal shaft, between the distal one-third and the femoral condyles, is a common site. There is also a relatively high incidence of proximal shaft fractures that occur primarily on the medial surface. The highest incidence rates of femoral stress fractures occur at the femoral neck. Kiuru et al demonstrated that stress fractures in this area and along the proximal shaft of the femur were 50% more common than stress injuries of the pelvis.

Typically, during running activities, the femoral neck is subjected to large anteriorly and medially oriented shear forces. Edwards et al demonstrated that axial forces and moments at the neck were no larger than those experienced by the rest of the femur and occurred during the braking force delivered at heel strike during the gait cycle. The impact phase of running is associated with a high rate of loading, and microdamage to cortical bone increases proportionally to loading rate. Repetitive activities in conjunction with the small diameter of the femoral neck as compared with the rest of the femur will threaten the integrity of the bone.

It is possible that, in an in vivo situation, the difference between medial surface compressive stress and lateral surface tensile stress outweighs the difference in anisotropic strength. Because cortical bone is strongest in compression, the reason that proximal shaft fractures materialize on the medial surface is unclear. Edwards et al suggested that these differences may become more pronounced during excessive training where hip abductor muscles fatigue while resisting the anterior-posterior bending moment.

**Etiology**

Fatigue fractures that occur in young individuals are often a result of repetitive athletic activity. Distance runners, dancers, and military recruits are commonly affected and are at an increased risk to developing stress fractures in the hip. Insufficiency fractures occur in the elderly population with osteoporosis, osteomalacia, rheumatoid arthritis, diabetes, hyperparathyroidism, or radiation therapy.

Stress fractures occur because of increased load after fatigue of supporting structures, contractile muscular forces acting across and on the bone, or a combination of both factors. The most significant factor in producing a stress fracture is cited as an alteration in an athlete’s training program. A rapid change can have a profound effect on an athlete’s body. Increasing mileage, pace, volume, or cross-training activity that has been inserted into the program without adequate time for physiologic adaptation to accommodate the new forces can lead to stress fractures. Training surfaces that are too hard or too soft are also important precursors to lower extremity overuse injuries. Failure to follow intensive training days with easy ones also can contribute to injury.

Intrinsic risk factors that contribute to stress fracture injuries include female sex, amenorrhea, lower bone density, inadequate muscle function, and biomechanical features. Extrinsic risk factors that contribute to stress fracture injuries include overtraining, inadequate equipment, and the energetic nutrition deficit. Many patients may present with a coexistence of different risk factors, which makes the isolation of etiologic variables so difficult.

Research has also shown that cortical bone strength, cortical area, and muscle cross-sectional area are all lower in runners with a history of stress fracture. However, the lower strength was appropriate for the smaller muscle size, suggesting that interventions to reduce stress fracture risk might be aimed at improving muscle size and strength. Inadequate diet and nutrition can also contribute towards the development of stress fractures. Smith demonstrated an association between bone mineral density and veganism. Vegans tend to have a lower intake of calcium and vitamin D, as well as a lower overall bone mineral density.

**Examination**

The clinical diagnosis of bone stress injury is difficult and tends to be unspecific because symptoms are often insidious and pain is diffuse or radiating. Frequently, the diagnosis of stress fracture is clinically made through a thorough history and physical examination.

The primary presenting symptom of a femoral neck stress fracture is usually anterior groin pain. The pain is often exacerbated by training, such as jogging or running, and is relieved by rest. On physical examination, the most obvious feature is localized bony tenderness. Sometimes, redness, swelling, or periosteal thickening may be present at the site of the stress fracture. Other findings include limited range
Femoral neck stress fracture

of motion of the hip, pain on forced rotation or axial loading, and tenderness over the involved bone. A nonspecific test commonly used is the hop test. If the patient reproduces the pain by hopping on the involved extremity, the result is considered positive. The result of this test will be positive in approximately 70% of patients with femoral neck stress fractures. The fulcrum test is another test commonly used to detect femoral shaft stress fractures.\(^\text{24}\)

**Imaging**

Stress fractures of the femoral neck can result in hip pain, and it is often difficult to locate the origin of pain even with a thorough history and clinical examination.\(^\text{14}\) It is important to prevent complications resulting from delay in diagnosis and treatment of stress fractures of the femoral neck. Therefore, appropriate imaging strategies through evidence-based diagnostic imaging practice guidelines in decision making for the appropriate use of diagnostic imaging of lower extremity disorders are necessary to accurately diagnose stress fractures.\(^\text{25}\) There are various imaging techniques that can be used to confirm the diagnosis.

In the majority of stress fractures, there is no obvious abnormality on plain radiograph. Kiuru et al\(^\text{14}\) demonstrated that radiography is of no diagnostic value in assessment of sacral stress injury, most likely because of the three-dimensional geometry of the sacral alae and the possible overlying bowel gas.

Regarding stress fractures, the role of computed tomography (CT) is limited mainly to differential diagnosis.\(^\text{26}\) The CT scan can be used to visualize the fracture and distinguish between a stress reaction and stress fracture. Computed tomographic scans can demonstrate fracture lines in locations where radiography is not diagnostic. However, the diagnostic value of CT is lower than that of bone scintigraphy and MRI, except in longitudinal stress fractures.\(^\text{27}\)

A bone scan is extremely sensitive; but the fracture itself is not visualized, and it may be difficult to precisely locate the site.\(^\text{6}\) The scan will detect stress fractures during remodeling, so the findings must be closely correlated with the clinical picture. The characteristic bone scan appearance of a stress fracture is of a sharply margined area of increased uptake.\(^\text{6}\)

Magnetic resonance imaging is being used with increasing frequency for patients with stress fractures.\(^\text{14}\) Anderson and Greenspan\(^\text{26}\) (1996) claim that MRI is extremely sensitive in detecting early signs of bone stress injury. Short tau inversion recovery and other fat suppression techniques can be used to maximize the sensitivity of MRI and consequently to improve diagnostic accuracy.\(^\text{26}\) The typical findings on MRI are of periosteal and marrow edema, as well as fracture line.\(^\text{22}\) Abnormalities associated with the iliopsoas tendon and its insertion, including marrow edema at the lesser trochanter, periostitis around the lesser trochanter, and bone marrow edemas in the femoral neck, are common findings that may be associated with stress fracture near the lesser trochanter. Each of these findings in isolation is nonspecific and can occur in both stress reactions and enthesopathies. Therefore, it is important to take these findings with great prudence in the absence of a clear fracture line with imaging, as patient management differs significantly between these 2 diagnoses.\(^\text{28,29}\)

Magnetic resonance imaging or bone scintigraphy should be undertaken if the result of radiography is negative. Missing a stress injury of the femoral neck is feared because it can lead, through stress fracture, to a complicated displaced fracture and possibly avascular necrosis of the femoral head associated with displaced fracture of the femoral neck.\(^\text{4,14}\)

**Intervention**

Treatment depends on the severity and location of the fracture, but often involves long periods of rest followed by a gradual return to activity. It is important to ascertain the appropriate diagnosis in patients suspected with a stress fracture at the femoral neck, as the plan of management can vary if diagnosed with an iliopsoas insertional tendinopathy or enthesopathy. Initial therapy for musculotendinous injuries typically consists of stretching; strengthening exercises; and, in some cases, local corticosteroid injection.\(^\text{28}\) In addition, there are a growing number of peer-reviewed studies of manipulative therapy for lower extremity disorders.\(^\text{30}\) On the other hand, several months of reduced weight-bearing or nonambulatory activities along with close monitoring of patient progress may be necessary before training can be resumed in stress fracture patients.\(^\text{24,30}\)

Operative fixation is not frequently required in young athletes unless progression of pain or fracture is observed. Full recovery can be made after this rest period, and the patient may return to his or her original activity safely. Adequate diet and nutrition, especially in the young athlete, must be incorporated into the treatment plan.\(^\text{31}\)

**Prevention**

Clinicians should realize that the process of a stress fracture is on a continuum both physiologically and clinically. It is important to catch these cases early to accelerate rapid healing. Therefore, it is ideal to
intercept the patient during the stress reaction phase prior to the patient developing a stress fracture in which a distinct fracture line is visible on imaging.

Treatment of stress fractures revolves around rest from the aggravating activity. If treatment is prompt and the athlete adheres to activity modification, he or she can usually return to sport with no complications within 6 to 8 weeks. \textsuperscript{22} Return to activity should be based on the athlete’s symptoms and physical findings. Once the athlete is pain-free, the sport can be resumed at a slow progression. One of the most important aspects of the rehabilitation process involves maintaining fitness levels during the healing process. Examples of non–weight-bearing cross-training sports include cycling, swimming, upper body weights, and water running. \textsuperscript{22} Management of stress fractures also involves identification of the factors that have contributed to the injury. Once the culprit has been identified, correction and modification of these factors will reduce the risk of the injury recurring. \textsuperscript{22}

Nutritional preventative measures should also be considered for individuals who are thought to be at risk for developing stress fractures. Individuals with low calcium and vitamin D levels will tend to have lower bone mineral density overall. The addition of calcium-fortified foods (1300 mg/d of calcium) and extreme dietary changes along with sunlight and exercise may provide enough calcium to a growing adolescent without the addition of dairy. \textsuperscript{32}

Muscular strength, reactivity, and endurance can also play an important role in preventing stress fractures in the hip. Typically, the torque imposed on the medial aspect of the hip joint is counteracted by the gluteus medius and minimus muscles. \textsuperscript{18} These stresses are secondary to compression and bending. If the gluteal muscles are fatigued, their counterbalancing effects are minimized, and muscle fatigue is thought to result in more load transmission to bone, thereby increasing the risk of osseous injury. \textsuperscript{33} Therefore, the gluteus medius and minimus must be strong, reactive, and resistant to fatigue to avoid undue stress imparted on the femur. \textsuperscript{18}

It has also been postulated that, during repetitive athletic activity, chronic traction forces from the iliopsoas muscle can put stress on the femoral neck and increase axial bending strain on the medial aspect of the femoral neck. \textsuperscript{34,35} The flexor musculotendinous unit acts as a shock-absorbing spring during running. \textsuperscript{36,37} Because musculotendinous units are prone to injury, the iliopsoas musculotendinous unit can be injured by repetitive, excessive, or unbalanced contraction of the iliopsoas muscle during running. \textsuperscript{33} Muscular injury can expose the femoral neck to increased forces and reactive marrow edema at the lesser trochanter, and place forces at the femoral neck that expose this site to stress injury. Therefore, proper training programs and adequate rest are imperative to avoiding these problems in repetitive sport athletes.

Limitation

During the reevaluation examination at 8 weeks, no imaging was taken. Without this imaging, we are unable to confirm that there was complete healing at the femoral neck. In addition, we are not able to compare the original images with the condition of the femoral neck at the time the patient was discharged. Finally, after the patient was discharged, she was only contacted once via e-mail. A follow-up within the clinic at 1 month, 3 months, and 1 year would have been prudent for such a case.

As with all case reports, causation cannot be determined. It is possible that other factors were responsible for the patient’s response or that she may have responded regardless of care. The findings in this case may not necessarily be generalizable to similar patients; each patient’s case must be evaluated and managed according to that patient’s findings and needs.

Conclusion

This case summarizes the literature on repetitive stress fractures and provides insight into the importance of early detection through clinical history and physical examination, which can be confirmed by MRI. This case demonstrates the importance of the non–weight-bearing rehabilitation therapy process that can be supplemented with chiropractic care. Ascertaining the appropriate diagnosis and providing the necessary management for these patients are crucial to their rehabilitation process and helping them return to their sport.

Funding sources and potential conflicts of interest

No funding sources or conflicts of interest were reported for this study.

References


INSTRUCTIONS

Step 1 – Find an interesting topic that you are passionate about. Work with a co-author (never try to write alone).
Step 2 – Find, retrieve, and read full articles that have been published on this topic. Keep a list of the articles that you find using this format:
Here are 2 of many search engines you may use:
www.ncbi.nlm.nih.gov/pubmed
www.chiroindex.org
Consider using a reference management software program (eg, EndNote) to help you keep your references in proper format. This is a huge timesaver.
Step 3 – Identify a patient in your practice that fits the purpose of a case report that relates to the topic you are passionate about (see list on the right).
Step 4 – Fill in the content into the case report form below. Use complete sentences.
Step 5 – Review and refine your rough draft. Share with your co-author. Get feedback on how the case could be improved. Use the case report check sheet from the “How to write a case report” article below to check each other’s work. Format the material into a case report form (remove from the table and put into text) in a Word document.
Step 6 – Submit to the journal (to be completed after the above steps are complete)

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<td>13. To offer new insight into the pathogenesis of disease</td>
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# Case Report Form

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<td>Introduction</td>
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<td>Conclusion</td>
<td>State the overall conclusion learned from the study. This should match the purpose statement and your findings (do not extrapolate).</td>
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Helpful Information for Authors and Students

All items below are open access

**Submitting manuscripts to biomedical journals: common errors and helpful solutions.**
Johnson C, Green B.

This article reviews common errors that authors may make when submitting to a healthcare–focused, biomedical journal. This paper offers suggestions for how to improve quality of manuscripts, provides suggestions for how to avoid making errors, and recommends effective writing and submission strategies. This article includes a checklist that authors may use before submission and that peer reviewers may use for general critique of a manuscript. The goal of this article is to assist authors with successful manuscript submission and eventual publication.
http://download.journals.elsevierhealth.com/pdfs/journals/0161-4754/PIIS016147540800362X.pdf

**How to write a case report for publication.**
Green BN, Johnson CD.

This paper describes how and why to write a case report for publication in a peer-reviewed journal. Steps for preparing a case report are described based upon the current available literature. A self-evaluation check sheet for authors is included to assist in the writing process.

**Writing narrative literature reviews for peer-reviewed journals: secrets of the trade.**
Green BN, Johnson CD, Adams A.

This article describes and discusses the process used to write a narrative review of the literature for publication in a peer-reviewed journal. Publication of narrative overviews of the literature should be standardized to increase their objectivity.

**How to write a letter to the editor: an author's guide.**
Johnson C, Green B.

A letter to the editor provides a means of communication between the author of an article and the reader of a journal, allowing continued dialog about journal content to take place. Although not original research per se, a letter may provide new insight, make corrections, offer alternate theories, or request clarification about content printed in the journal. By providing additional information, the evidence may be strengthened. This paper provides first time writers some insight into the process of writing a letter to the editor.

**Conflict of Interest in Scientific Publications: A Historical Review and Update.**
Johnson C.

This article provides a discussion about COI, a brief historical review of requirements, and an update of policy for the Journal of Manipulative and Physiological Therapeutics that includes the alignment of the International Committee of Medical Journal Editors new COI form requirement. This article reviews types of COI and suggests that professions (eg, chiropractic, physical therapy, acupuncture) not directly affiliated with pharmaceutical and device companies, though they may be faced with different circumstances, should still comply with current COI reporting standards.
http://download.journals.elsevierhealth.com/pdfs/journals/0161-4754/PIIS0161475410000229.pdf
Repetitive, duplicate, and redundant publications: a review for authors and readers.
Johnson C.

Repetitive, duplicate, and redundant publications are an important concern in the scientific literature. Their occurrence affects science and carries with it sanctions of consequence. This editorial provides a brief review of the definitions, classifications, impact, sanctions, and prevention strategies regarding repetitive, duplicate, and redundant publications.
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Transparency of research methods: proud to be a Naked Emperor.
Johnson C.

This article discusses disclosure of research methods and use of clinical trial registries.
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Questioning the importance of authorship.
Johnson C.

This article provides a brief review on what is required to earn the role of “author” and other issues surrounding authorship.
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On the subject of human subjects.
Johnson C.

This article reviews the topic of human subjects research and the need for all such studies to be properly reviewed by an Ethics Review Board or Institutional Review Board (IRB).
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Evidence-based practice in 5 simple steps.
Johnson C.

This editorial provides a brief review of Sackett’s 5 steps of evidence-based practice.
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Highlights of the basic components of evidence-based practice.
Johnson C.

This editorial provides a brief review of the basic components of evidence-based practice.
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Keeping a Critical Eye on Chiropractic
Johnson C.

This article discusses the importance of professional self-regulation and critical appraisal. A checklist of red flags is provided that could be used when analyzing information, scientific articles, or attending educational events.
http://download.journals.elsevierhealth.com/pdfs/journals/0161-4754/PIIS0161475408002546.pdf
Patient Consent for Publication of Material in the JMPT/JCM

The following information must be completed in order for this form to be processed accurately.

Title of manuscript (type):
_________________________________________________________________________________________

Author(s) name(s) (type):
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Patient to fill in items below:

I hereby give my consent for images or other clinical information relating to my case to be reported in the Journal of Manipulative and Physiological Therapeutics (JMPT) or Journal of Chiropractic Medicine (JCM).

I understand that my name, initials, or any protected health information such as my identification number, billing information, address, etc. will not be published and that efforts will be made to conceal my identity, but that anonymity cannot be guaranteed. Images, such as distinctive body markings and/or diagnostic images may be published.

I understand that the material may be published in the JMPT/JCM, on JMPT/JCM Web site and in products derived from the JMPT/JCM. As a result, I understand that the material may be seen by the general public.

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Name of patient (print)

Signature of patient (or signature of the person giving consent on behalf of the patient) Date

Only complete this section if you are not the patient. What is your relationship? (The person giving consent should be a substitute decision maker or legal guardian or should hold power of attorney for the patient.)

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Why is the patient not able to give consent? (e.g., is the patient a minor, incapacitated, or deceased?)

Authors are to upload this completed form at the time of initial manuscript submission to the journal website.
April 2013
Writing narrative literature reviews for peer-reviewed journals: secrets of the trade

Bart N. Green, DC, MSEd, DACBSPa, Claire D. Johnson, DC, MSEd, DACBSPb, Alan Adams, DC, MS, MSEd, DACBNc

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Sources of support: This article is reprinted with permission. Its original citation is: Green BN, Johnson CD, Adams A. Writing narrative literature reviews for peer-reviewed journals: secrets of the trade. J Sports Chiropr Rehabil 2001;15:5–19.

ABSTRACT

Objective: To describe and discuss the process used to write a narrative review of the literature for publication in a peer-reviewed journal. Publication of narrative overviews of the literature should be standardized to increase their objectivity.

Background: In the past decade numerous changes in research methodology pertaining to reviews of the literature have occurred. These changes necessitate authors of review articles to be familiar with current standards in the publication process.

Methods: Narrative overview of the literature synthesizing the findings of literature retrieved from searches of computerized databases, hand searches, and authoritative texts.

Discussion: An overview of the use of three types of reviews of the literature is presented. Step by step instructions for how to conduct and write a narrative overview utilizing a ‘best-evidence synthesis’ approach are discussed, starting with appropriate preparatory work and ending with how to create proper illustrations. Several resources for creating reviews of the literature are presented and a narrative overview critical appraisal worksheet is included. A bibliography of other useful reading is presented in an appendix.

Conclusion: Narrative overviews can be a valuable contribution to the literature if prepared properly. New and experienced authors wishing to write a narrative overview should find this article useful in constructing such a paper and carrying out the research process. It is hoped that this article will stimulate scholarly dialog amongst colleagues about this research design and other complex literature review methods. (J Chiropr Med 2006;5:101–117)

Key Indexing Terms: Review Literature; Authorship; Peer Review, research; Manuscripts; Meta-analysis
INTRODUCTION

Background

The purpose of this article is to describe and discuss the research design known as a review of the literature and to delineate how to write a particular variety of this research design, the narrative overview of the literature. Another intention of this article is to provide educational information and assistance for those who have not yet published a literature review and to decrease potential author frustration that can arise during the peer review process. It is important to note that the general classification of ‘literature review’ has three varieties: narrative review, qualitative systematic review and quantitative systematic review. Each will be addressed in this article. However, the primary focus of this article will be on the writing of a narrative review.

A literature review is a type of research article published in a professional peer-reviewed journal. The purpose of a literature review is to objectively report the current knowledge on a topic and base this summary on previously published research. A literature review provides the reader with a comprehensive overview and helps place that information into perspective.

The literature review research design is different from other research designs because rather than patients, data to write the report are collected from the published literature. These full length articles provide a new conclusion to the literature, not the brief summary of literature that is given typically in the introduction or discussion sections of other research designs. In creating a literature review, the author searches through the literature, retrieves numerous sources of information and synthesizes the findings of all relevant sources into one article. Thus, a vast amount of information is brought together and written in a manner in which the reader can clearly understand the topic.

There are several reasons to read reviews of the literature. For the clinician, they can save valuable time when reviewing or searching for information about patient care by condensing a great amount of information into a few pages. The clinician can read one paper instead of sifting through the whole of the literature to find the answer to a clinical question; the author of the literature review has already done most of this work for him. Literature reviews also provide information for decision makers and are used by researchers to identify, justify and refine hypotheses and to recognize and avoid pitfalls in previous research. Additionally, reviews of the literature provide a basis for validating assumptions, provide insight into the dynamics underlying the findings of other studies and may offer more conclusive results than a single primary research study. Depending on the variety of literature review, they may provide a very high level of evidence for making clinical practice decisions.

One of the cautions that one must consider with literature reviews is the bias that is often associated with them. As an author, it is important to attempt to reduce bias as much as possible through appropriate writing and research techniques. An increase in objectivity leads to improved utility and credibility in publications. While certain criteria for literature reviews have been published, little has been accomplished in terms of standardizing and verifying the validity of the criteria proposed. Indeed, many changes have taken place in recent years regarding publication standards for literature reviews and it is important for authors to keep current with these changes. This paper clearly states the minimum acceptable criteria they pertain to narrative overviews of the literature.

METHODS

Information used to write this paper was collected from the sources listed in table 1.

DISCUSSION

Three Varieties of Reviews of the Literature

The three basic types of literature reviews are narrative reviews, qualitative systematic reviews, and quantitative systematic reviews.
quantitative systematic reviews (meta-analyses). The amount of clinical evidence afforded by each of these designs increases as the methods employed to conduct them become more detailed and elaborate. In this section, the emphasis will be placed on narrative reviews, since they are the subject of this article; a brief description of qualitative and quantitative systematic reviews will also be given.

**Narrative Literature Review**

There are three types of narrative reviews of the literature: editorials, commentaries, and overview articles.4,15

**Editorials**, typically written by the editor of the journal or an invited guest, may be a narrative review if the author retrieves and synthesizes information about a particular topic for the reader. Usually these types of narrative reviews are based upon a short, select and narrowly focused review of only a few papers.15 However, editorials may be no more than the editor’s comments regarding a current issue of the journal or a current event in health care. Therefore, editorials do not automatically qualify as narrative reviews.

**Commentaries** may also be written as a narrative review, however they are typically written with a particular opinion being expressed.4 In these articles research methodology is usually not presented and the author’s synthesis of the articles demonstrates bias. Commentaries are usually shorter than a full length review article and it is expected that the author possesses expertise in the content area of the commentary. In short, a commentary is a biased narrative review that draws upon the wisdom of the commentator. Usually the purpose of a commentary is to provoke scholarly dialog among the readers of the journal.

**Narrative overviews**, also known as an unsystematic narrative reviews,16 are comprehensive narrative syntheses of previously published information. The details of how to prepare this type of article are presented in this paper. This type of literature review reports the author’s findings in a condensed format that typically summarizes the contents of each article.1 Some researchers suggest that a proper narrative overview should critique each study included,2,17 but other authors write that this is not necessarily a property of overviews.1 It is up to the author to determine which of these two paths to take when writing the article.

There are many good reasons to write a quality narrative overview. Narrative overviews are useful educational articles since they pull many pieces of information together into a readable format. They are helpful in presenting a broad perspective on a topic and often describe the history or development of a problem or its management.2,10 Faculty like to use overviews in the classroom because they are often more up to date than textbooks, provide a single source for students to read from, and expose students to peer reviewed literature. Narrative overviews are also used as educational articles to bring practitioners up to date with certain clinical protocols.7,11 Some journals, publish quizzes related to such articles; these quizzes can be submitted to regulating boards for continuing education credit.

Often discussing theory and context, narrative overviews can serve to provoke thought and controversy. For this reason, these reviews may be an excellent venue for presenting philosophical perspectives in a balanced manner. Philosophical articles can be excellent for stimulating scholarly dialog amongst readers. Readers can participate in this process by writing to the letters to the editor section of the journal and present their opinions and critical appraisal. The letters to the editor section can be a dynamic part of a journal; several times in the history of health care tremendous insight into patient management and research design has been presented in this forum.7

Authors of narrative overviews are often acknowledged experts in the field and have conducted research themselves.6,7,15,18 Editors sometimes solicit narrative overviews from specific authors in order to bring certain issues to light.18 Authors must be careful to avoid a common pitfall of the overview design, which is to present an opinion oriented argument based upon a myriad of references,3 rather than objective conclusions based upon the literature reviewed. For this reason, some studies have determined that some experts are less likely to adhere to high levels of methodological rigor when writing these papers than non-experts.14 Therefore, whether one is a novice or expert, the critical factor in writing a good narrative review is to use good methods.

Once quite common, overviews are slowly falling into disfavor in some journals due to a lack of
systematic methods that should be employed to construct them. Rarely have the methods used in creating the paper been divulged to the reader, which is a problem identified as early as 1987. Usually the number of sources employed to find the literature are incomplete, possibly creating an insignificant knowledge base from which to draw a conclusion. In this rather unsystematic approach, selection of information from primary articles is usually subjective, lacks explicit criteria for inclusion and leads to a biased review. The author’s interpretation and synthesis of information should take into account major differences between studies, such as if patients samples in one study are completely different than in another or that research designs are not comparable. Without identifying these differences, one takes the risk of providing faulty conclusions or incorrect information. All of these potential pitfalls are avoidable if the author is aware of them and takes the appropriate steps to avoid them.

In the past, many reviews of the literature were constructed based upon the personal papers of the author, creating a bias that was slanted to what that author found interesting or controversial. When this occurs it is difficult to discern if the author has constructed an objective review of the literature or a lengthy commentary. Biased writers will draw conclusions based more on opinion than data, which is not a truthful representation of the research. Often times this faulty synthesis is then repeated by other authors and the mistakes are handed down from one study to the next, thus perpetuating the errors. The aforementioned problems related to literature reviews are a potential danger in health care if readers make patient health care decisions based upon faulty reviews.

While narrative overviews are great papers to read to keep up to date, receive continuing education credits, or challenge your way of thinking, they are not a form of evidence that should be used frequently when making decisions about how to solve specific clinical patient problems. Narrative overviews are one of the weakest forms of evidence to use for making clinical decisions in regard to patient care, primarily because they deal more with broader issues than focused clinical problems. Additionally, there is a higher degree of bias involved in overviews than some other research designs. Nevertheless, narrative overviews constitute an important component in the literature base.

**Qualitative Systematic Literature Review**

A systematic review is a type of literature review that employs detailed, rigorous and explicit methods. A detailed search of the literature based upon a focused question or purpose is the hallmark of a systematic review. Since the review is structured around a focused clinical question, it allows the researcher to develop criteria that determine if a research publication should be included or excluded in the final synthesis. Step-by-step methodology used in the research is described. Authors of systematic reviews attempt to obtain all original (primary) research studies published on the topic under study by searching in multiple databases, performing hand searches and contacting authors of previously published research. Additionally, authors will attempt to locate articles that may not have been published because the results of the study did not support the research hypothesis.

Each paper is reviewed in a systematic and consistent manner, usually by several independent reviewers, and usually rated using a scoring system by the authors. Each piece of evidence drawn from a paper for the literature review is extracted in the same fashion to help decrease the bias that occurs when this information extraction is done subjectively, such as in a narrative overview. Authors create data, or evidence tables, in order to tease out the differences in the results of different studies. These reviews of the literature are called qualitative because the process by which the individual studies are integrated includes a summary and critique of the findings derived from systematic methods, but does not statistically combine the results of all of the studies reviewed.

Because of the rigorous methods employed in conducting qualitative systematic reviews, they are a more powerful evidence-based source to garner clinical information than narrative reviews, case reports, case series, and poorly conducted cohort studies.

**Quantitative Systematic Literature Review (Meta-analyses)**

A systematic review that critically evaluates each paper and statistically combines the results of the studies is called a quantitative systematic review of the literature, also known as a meta-analysis. Introduced in 1976, meta-analyses...
aim to make an objective science out of research synthesis.\textsuperscript{10} Meta-analyses employ all of the rigorous methodology of qualitative systematic reviews.

In addition to the inherent strengths of the systematic review process, the major benefit of a meta-analysis is the pooling of data between studies. In this process, the authors of a meta-analysis will gather the original patient data from each of the studies under review, pool it all together in a database, and perform the appropriate statistics on this larger sample size. This is especially useful when clinical trials exist in the literature but possess low sample sizes that prevent the authors from making conclusions that can be generalized to the population at large.\textsuperscript{1} This can be particularly powerful if the studies under review are very similar in their construction because several studies can be combined as one larger base of data leading to more powerful conclusions.\textsuperscript{23}

The pooling of data that can be analyzed statistically, which is the strength of the meta-analysis,\textsuperscript{25} can also be a drawback because it is difficult to find studies that are similar enough to one another to draw valid comparisons.\textsuperscript{4,25,26} There is disagreement amongst experts about the most appropriate methods to combine the data from studies with different variables (eg, patient populations, clinical outcome measures, treatments).\textsuperscript{25,26,27}

Meta-analyses are considered to be a very high form of evidence for making clinical decisions because the results of the review are produced from a rigorous critical appraisal and pooling of data from the studies reviewed.\textsuperscript{11,12,16,26} This leads to a more generalizable conclusion.\textsuperscript{21}

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**Writing a Narrative Review of the Literature, Step By Step**

**Preparation**

Before involving oneself completely in the research endeavor, it is important to observe a few tips that will sustain the author during the process of the project. These pearls of wisdom, presented in table 2, are gathered from experienced authors and are useful for novice as well as experienced writers.

The first step in writing a narrative overview is to perform a preliminary search of the literature.\textsuperscript{24} In this endeavor, the author should search the literature to see what other work in the area of interest has already been published.\textsuperscript{5,17} This initial work should help the author to refine the topic and objective of the overview being written. For example, if one wishes to publish a review of the literature about the effect of chiropractic adjustments on cervical spine pain, the initial search should reveal if someone has recently published such a study. In addition, this initial work will also give the author a preview of the number of articles available on the topic. If an article is already published on the very same topic that the author wishes to write about, then it may be better to select a slightly different topic or to slightly modify the focus of the objective. On the other hand, if there has never been a review published about the topic, then this helps to establish the need for this particular contribution.\textsuperscript{5,17}

Once armed with a refined topic, it is time to proceed with the next steps.

**General guidelines**

The text that follows delineates what would probably be acceptable in many journals. These recom-

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**Table 2**

**Words of Wisdom for Authors Writing Narrative Overviews**

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<td>Interesting Topic</td>
<td>Select a topic that you are very interested in, lest you do a lot of work and then lose momentum to finish the project. There are many half-finished papers collecting dust on shelves because authors lost the drive and interest to complete the task. Select an enticing and engaging topic that will keep you fascinated throughout the process.</td>
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<tr>
<td>Doable Project</td>
<td>Select a topic with a feasible focus. A narrative review on ‘headaches’ is an impossible task, whereas ‘chiropractic management of muscle tension headaches’ can be a manageable narrative review. Keep the focus clear and defined and you will be able to complete the paper.</td>
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<td>Get Help</td>
<td>Get help early and often. Call upon people around you who have writing experience, such as colleagues or faculty who have published narrative reviews. Consider asking them for their opinions before you begin the paper and then ask them to review drafts of your paper before submitting it. Some journal editors can direct you to others that may be of assistance and may be able to help you themselves when time permits.</td>
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mendations follow the approach put forth by Robert Slavin, which is called a "best-evidence synthesis". However, there are no rigid published guidelines designating exactly what should or should not be included in a quality narrative overview. A successful narrative review should do the following: present information that is written using the required elements for a narrative review, be well structured, synthesize the available evidence pertaining to the topic, and convey a clear message.

An objective and scientific approach on behalf of the author should be conveyed and the paper should follow the formatting guidelines published in the *Uniform Requirements for Manuscripts Submitted to Biomedical Journals*. These guidelines describe in detail what is necessary in order to prepare a manuscript for submission to a peer reviewed journal. Preparing a manuscript using these guidelines is essential to insure that manuscripts are uniform in nature, as objective as possible, and can be processed by editors in an expeditious manner, thus providing the author with a better chance for earlier acceptance. The *Uniform Requirements* can be found on the Internet at http://www.icmje.org/index.html.

The presentation of a narrative review should be as objective as possible. It is essential that prospective authors remember that the intention of a narrative review is to describe and synthesize the available literature on a topic, providing a conclusion from this evidence. The necessary elements of a narrative review are similar to those required of any form of scholarly article (Table 3). A detailed rating scale for narrative reviews of the literature is also included in this article as Appendix A.

Table 3

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<td>5. DISCUSSION</td>
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<td>6. CONCLUSION</td>
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<td>7. ACKNOWLEDGEMENTS (IF APPLICABLE)</td>
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The title of the article should be interesting and clearly describe the topic being reviewed. It is also helpful to readers if the words “literature review” or “review of the literature” appear somewhere in the title to make it clear to readers what research design is being used. The reader instantly knows what the major topic is and that previous publications about the topic are being synthesized. A good example of a title is *Injuries Associated with Soccer: A Review of Epidemiology and Etiology*. A bad example of a literature review title might be *The Epidemiology of Soccer Injuries*. This title would infer that a population based study was performed to determine the kinds and frequency of soccer injuries, which would be misleading to the reader.

Abstract

The abstract is a structured summary of the article that offers the reader a brief presentation of the review and relates the most important information. The abstract and the title are entered into computer databases and indexing systems, and are essentials for those conducting literature searches. A well written abstract allows people searching the literature to find the information in their search and discern whether or not they should retrieve the paper.

Abstracts should be written in a structured format. Structured abstracts are required in order to assure that all necessary information for an abstract is reported for the reader. In the past, narrative abstracts were often used by journals, but authors sometimes did not adequately report the necessary elements of the study in the abstract. Thus, most journals adopted the structured abstract format over ten years ago. Subsections for abstracts of narrative overviews of the literature typically consist of the following, further described in table 4: objective, background, methods, discussion; conclusion, key words.

Introduction

Early in the introduction, the author should clearly state the research purpose or focus. Clearly stated aims tell the reader that the study was planned out in advance, usually resulting in a well outlined study that presents useful information.

Next, the author must make a case for the need or importance of the study. This is essential in order to relate the importance of this research to the reader. This usually requires that the author has already reviewed the literature pertaining to the topic and
has discovered a deficiency of a well written review of the literature in the area. Authors can use the results of their preparatory literature search discussed previously as well as further reading unveiled during the course of conducting the formal literature review, described later, for this purpose. This information should be written in the introduction to state why the study is important and place it in context with other published information.10,24

The author should also define any unusual terms or words that are essential to understanding the information in the paper.10 For example, if the paper is about isometric low back extension endurance tests, it would be paramount that the author clearly define what these tests are and what they do.

**Methods**

The methods section of the article should describe step by step how the study was performed.11,14,18,24

**Sources of information:** The most efficient way to begin a literature search is to use electronic databases. There are many different databases available for searching and it is important that the appropriate databases are searched, depending on the objective and topic of the paper.9 Unfortunately, many people think that only searching MEDLINE is adequate, but it is not.4 This is especially true in when writing on topics pertaining to chiropractic and allied health disciplines because many journals from these professions are listed, or indexed, in databases other than MEDLINE. It is usually necessary to search at least two databases appropriate for the area of study in order to provide a reasonable breadth and depth on a topic. Searches through the references of articles that are retrieved, authoritative texts, personal contacts with experts, and reviews of unpublished primary research may also be warranted and important to include.17 The breadth and depth of searching is dependent on the topic and objective. Summarily, the author should look in all the locations that are appropriate for finding the information they need.

Examples of common databases used in the health sciences and their areas of focus are listed in table 5. Some of these databases are free of charge while others are not. If an author wishes to avoid paying to perform searches in some of these databases, they are often available in health science libraries for students and alumni to use at no cost. Consult a local chiropractic or other health science library to find out which databases they carry and also to inquire about search fees.17 Authoritative texts may also be found at college libraries or even in your own personal library. At college libraries there are usually computerized databases that catalog all of the books in the library’s holdings. These too can be searched using search terms.24

It is crucial to divulge the databases that were searched in the article.3,7,13 This means that it is important for the author to keep track of the databases searched and the terms used, in order to report them to the readers. Some authors also like to keep track of how many `hits’ or article citations that are found with each search. A sample tracking sheet is provided in table 6. Minimum requirements for narrative reviews are that authors should state the database searched, a starting year, and the ending year and month of the search. The following example is adequate, “MEDLINE was searched using the terms ‘low back pain’ and ‘manipulation’ from 1966 through June, 2000.” Stating, “We searched MEDLINE from 1980

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</table>
to the present.” is grossly insufficient because the reader is not told what the word “present” actually means. Months can slip away between the day of the search and publication, so it must be defined.

Search terms & delimiting: Setting the specific parameters for the literature search is necessary in order to make the project feasible since it is not reasonable to review every single paper that has even the most minute relation to the topic of study.\textsuperscript{17,24} The boundaries set in this step must be comprehensive enough to insure that the author may retrieve all relevant studies, but narrow enough to focus the effort.\textsuperscript{13,17}

### Table 5

<table>
<thead>
<tr>
<th>Name of Database</th>
<th>How to Access</th>
<th>Internet Site</th>
<th>Pay Site?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index to Chiropractic Literature MANTIS</td>
<td>Online software</td>
<td><a href="http://www.chiroindex.org">http://www.chiroindex.org</a></td>
<td>No</td>
</tr>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Online search software or CD-ROM</td>
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</tr>
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<td></td>
<td></td>
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</tr>
<tr>
<td>ERIC (Educational Resources Information Center) AMED (Allied and Complementary Medicine Database)</td>
<td>Online search software</td>
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<tr>
<td></td>
<td>Online search software, CD-ROM, disc, print</td>
<td><a href="http://www.bl.uk/collections/health/amed.html">http://www.bl.uk/collections/health/amed.html</a></td>
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</tr>
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<td>Current Contents</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cochrane Database of Systematic Reviews</td>
<td>Online search software</td>
<td><a href="http://www.cochrane.org/reviews/en/">http://www.cochrane.org/reviews/en/</a></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DARE (Database of Abstracts and Reviews of Effectiveness)</td>
<td>Online search software</td>
<td><a href="http://www.york.ac.uk/inst/crd/crddatabases.htm">http://www.york.ac.uk/inst/crd/crddatabases.htm</a></td>
<td>No</td>
</tr>
</tbody>
</table>

Emphasis: Database of abstracts of systematic reviews assessed for effectiveness.

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**Table 5**

Databases to Consider When Performing a Literature Search

<table>
<thead>
<tr>
<th>Name of Database</th>
<th>How to Access</th>
<th>Internet Site</th>
<th>Pay Site?</th>
</tr>
</thead>
<tbody>
<tr>
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<td>No</td>
</tr>
<tr>
<td>Index to Chiropractic Literature MANTIS</td>
<td>Online search software or CD-ROM</td>
<td><a href="http://www.healthindex.com">http://www.healthindex.com</a></td>
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</tr>
<tr>
<td>ERIC (Educational Resources Information Center) AMED (Allied and Complementary Medicine Database)</td>
<td>Online search software</td>
<td><a href="http://www.ericsp.org/">http://www.ericsp.org/</a></td>
<td>No</td>
</tr>
<tr>
<td>ERIC (Educational Resources Information Center) AMED (Allied and Complementary Medicine Database)</td>
<td>Online search software, CD-ROM, disc, print</td>
<td><a href="http://www.bl.uk/collections/health/amed.html">http://www.bl.uk/collections/health/amed.html</a></td>
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<tr>
<td>SPORT Discus</td>
<td>Online software vendors</td>
<td><a href="http://www.sirc.ca/products/sportdiscus.cfm">http://www.sirc.ca/products/sportdiscus.cfm</a></td>
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<td>Current Contents</td>
<td>Online search software</td>
<td><a href="http://scientific.thomson.com/products/ccc">http://scientific.thomson.com/products/ccc</a></td>
<td>Yes</td>
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<td>Online search software</td>
<td><a href="http://www.cochrane.org/reviews/en/">http://www.cochrane.org/reviews/en/</a></td>
<td>Yes</td>
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<tr>
<td>DARE (Database of Abstracts and Reviews of Effectiveness)</td>
<td>Online search software</td>
<td><a href="http://www.york.ac.uk/inst/crd/crddatabases.htm">http://www.york.ac.uk/inst/crd/crddatabases.htm</a></td>
<td>No</td>
</tr>
</tbody>
</table>

Emphasis: Database of abstracts of systematic reviews assessed for effectiveness.
single words, which can be used as search terms. In addition, insure that the search terms used are recognized by the vocabulary of the computer database. This is usually easy to do since most computerized indices have a key word search function within them that will find synonyms in its database for the word that you enter. Most journals use the MeSH vocabulary system adopted by the National Library of Medicine. These key words will be the ones that you will also list in the key terms section of the abstract.

It is not necessary to search databases using solely key words of the database. Most databases will allow you to search using additional words that you find appropriate. This is sometimes helpful in finding more articles since the databases usually search through title, abstract and key words of the articles indexed. If the right terms are not used during the literature search, then chances are high that some important studies will be missed. General terms, such as ‘pain’ may result in so many articles to search through that the authors miss studies. Likewise, highly focused words may narrow the search down too far, revealing no research. Just as with reporting the databases used, each search term used to conduct the search ought to be divulged to the reader. How terms are connected together would also be useful to know.

When writing papers using terms unique to a profession, it is important to recognize that the term may have a different meaning in various database. For example, the term “subluxation” in the medical literature has a distinctly different meaning than in the chiropractic literature. The spelling of words should also be considered, based upon the database being searched. Exemplary is that in the Index to Chiropractic Literature database, a search using the spelling “technique” will provide different results than a search with “technic”. This occurs because the chiropractic profession historically used the latter term to describe different chiropractic adjusting procedures and the indexing system continues to use this term. This is also an excellent example of why it is important to verify the key words vocabulary of each database. Therefore, to properly delimit a literature search, authors need to select key words, including MeSH, keep track of the terms and search strings used, and report this information to the reader when writing the paper.

**Selection criteria employed:** It is important to briefly describe what selection criteria were used to include or exclude a study from the review. This helps keep the paper focused and helps to insure that papers are included because of their relevance to the topic rather than how much the author agrees or disagrees with the study. Exclusion criteria should be identified that the authors used to eliminate studies from consideration that were not pertinent to the focused purpose of the study. Reasons for exclusion may be old data (early research) or inappropriate topics. For example, researchers studying the use of isometric muscle endurance of the lumbar spine would exclude papers found that discuss standard orthopedic muscle testing of the low back because it is not the type of muscle testing being reviewed.

Inclusion criteria should tell the reader what factors the authors considered in order to include a paper in the review. This should include articles published in various languages, and other factors pertinent to the purpose of the paper. Be careful not to place too many limiting exclusion criteria or have inclusion criteria that are too wide; papers outside the domain of the purpose of the study may be included inadvertently or inappropriately if this occurs.

Summarily, when writing the methods section, the author should ask him or herself, “Can the reader replicate the search that was done based upon what I have written in the methods section?” If the answer is “Yes” then this section has been adequately written.

---

**Table 6**

<table>
<thead>
<tr>
<th>Date of Search</th>
<th>Database</th>
<th>Years Searched</th>
<th>Search Terms</th>
<th>Strings of Terms</th>
<th># Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/12/99</td>
<td>PubMed</td>
<td>1975–12/1998</td>
<td>Health promotion; chiropractic, preventive medicine, chiropractic</td>
<td>None used</td>
<td>11330</td>
</tr>
<tr>
<td>1/12/99</td>
<td>Cinahl</td>
<td>1966–12/1998</td>
<td>Preventive medicine, chiropractic</td>
<td>Preventive medicine and chiropractic</td>
<td>0</td>
</tr>
</tbody>
</table>

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109
Discussion

Synthesis: The part of conducting a narrative overview that takes the most mental energy is synthesizing all of the information retrieved in the literature search into comprehensive paragraphs. Since this is the primary use of reviews of the literature it is imperative that this section be written as clearly and as objectively as possible.\textsuperscript{18} It is here that readers should find the information that they want in one location.\textsuperscript{10}

How to structure this section and summarize the information into a comprehensible synthesis depends on what is being reviewed. If an author is writing a review pertaining to the current best approaches in assessing and managing patients with a particular disorder, it may be a good idea to write the synthesis in the order that the clinical encounter normally takes place (eg, history, examination, special studies, management). As another example, for this paper we synthesized the literature in the order that we felt readers would find it most useful when they decided to write their own overview. There is no single way to write this section. Therefore it requires the author to think clearly about what is being conveyed according to the objective of the overview.\textsuperscript{18}

Before attempting to write the synthesis authors should read through each of the papers that will be included in the overview and take notes on each one. Most authors prefer to use a word processing system for taking notes because it is simple to add new information. Once all of the notes are complete, authors can then easily organize common themes together. Other authors prefer to take notes on index cards since they can be shuffled around and notes can be taken regardless of whether or not the author is near a computer.

It is recommended that notes include the following: the purpose of the study reviewed, a synopsis of the content, the research design or methods used in the study, a brief review of the findings.\textsuperscript{9,17} If an author plans to objectively evaluate, or critically appraise, each article, then it is also a good idea to take notes for this part as well. Regardless of the technique that you use it is essential to always write the complete reference down for each set of information that you extract from a study. It is horrifying to find out late in the writing process that a reference for a bunch of information was lost and have to spend hours trying to find it.\textsuperscript{17}

Tables of information may make it easier for some authors to organize their thoughts when constructing the synthesis.\textsuperscript{17,24} Tables are easy to make and categorize information by topic. For example, the references for each paper reviewed can be written down one side of the paper and categories of information extracted from each paper can be written along the top. This is best done using a computer, as it allows for easy arrangement or additions of information. An example of part of a table is presented in table 7.

### Table 7

**Example of a Part of an Evidence Table**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Sample Description</th>
<th>Test Description</th>
<th>Design</th>
<th>Results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biering-Sorensen,</td>
<td>Denmark; 30–60 yo, 449 men, 479 women</td>
<td>Sorensen's method</td>
<td>Postal survey 12 months after exam</td>
<td>Prognostic for 1st time LBP in men; women had insig. Opposite trend</td>
<td>Some women omitted from analysis</td>
</tr>
<tr>
<td>1984</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gibbons et al.,</td>
<td>Finland, 35–63 yo, 43 men who had no LBP</td>
<td>Modified Sorensen's</td>
<td>Compared static back endurance time between</td>
<td>Men who reported LBP had slightly shorter times; they did not come close to stat. significance. No association between static back endurance and future LBP</td>
<td>Difference in groups may suggest either a difference in condition of subjects, or a research error</td>
</tr>
<tr>
<td>1997</td>
<td></td>
<td></td>
<td>group with no LBP to group with incidence of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LBP in preceding 12 mo.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If papers under review contain a lot of data that the author feels would be beneficial to include in the manuscript, then data can be collected using a table and easily be placed in the final paper.
When writing the synthesis for the manuscript, the author integrates the findings elicited from the note taking or table making process. It is important for authors to keep the reading audience in mind when writing this section; the audience is less familiar with the topic under review, necessitating a clear, clinically relevant and easy to read synthesis.

Major areas of agreement and disagreement in the literature should be discussed. The discussion should tie the study into the current body of literature, provide its clinical significance, and make logical interpretations from the literature reviewed. If there is no discussion of the relevance of the overview to other work in the field, it may signal that the author has not thoroughly investigated the topic. Since the synthesis is the crux of the overview design it is important to insure that a meaningful integration is accomplished.

The author’s interpretation of the literature should also be provided; it is for this reason that it is helpful if the author has some content expertise in the area under study. Often times it is appropriate for the author to offer some critical appraisal of the papers reviewed in the discussion. As mentioned earlier, this is an area of overviews that some authorities feel may or may not be necessary in an overview. One of the reasons for this disagreement is that the appraisal process can be extremely subjective without the use of explicit critical appraisal criteria. Since the narrative overview already includes the biases of the author, there is a limit to how much more bias may actually enhance the credibility of the overview.

It is helpful if the author uses check sheets or guides when critically appraising the articles. These check sheets are available from a wide variety of sources. Some of these critical appraisal aids focus on specific research designs while others are made for assessment of articles in general. In addition to many worksheets available in the references used for this paper, a small sample of additional sources for critical appraisal check sheets are identified in table 8.

When performing critical appraisal, it is best to use a check sheet that is specific to the research design being appraised. For example, Appendix A in this article is a check sheet for a narrative overview of the literature. A case report or clinical trial should be reviewed using a completely different check sheet.

Limitations to the overview: Authors should address weak points of their own study and mention areas for improvement. No paper is perfect. If limitations are not included in an honest fashion, it warns

| Table 8 Examples of Critical Appraisal Check Sheets |
|------------------------------------------|----------------|----------------|
| Centre for Evidence Based Medicine | Articles on therapy, systematic reviews, diagnosis, prognosis, harm/etiology, economic analysis | http://www.cebm.net/using_ebm.asp |
| Critical Appraisal Skills Programme | Randomized controlled trials, economic analyses, qualitative research | http://www.phru.nhs.uk/casp/critical_appraisal_tools.htm |
| Greenhalgh T. How to read a paper: Papers that summarise other papers (systematic reviews and metaanalyses). BMJ 1997;315:672–675. | Systematic reviews | http://www.bmj.com |
the reader that the paper may contain more bias than is acceptable for an overview. The inability to discuss the merits and demerits of a paper may demonstrate that the author has strayed from the focus of their purpose.

Because authors are deeply involved in the creation of the literature review and the writing process, it is not always easy to recognize the paper’s limitations. One method that is helpful in writing this section is to write it as the study evolves. Every time the author recognizes an area that could be improved in the study, he or she can simply write those thoughts down at the time. If the weakness can be corrected during the research process then the writing related to it can be deleted. For limitations that are inherent to the design of the paper or ones that are not correctable, then this text can remain for the final paper.

Another method that most experienced authors use is to have trusted colleagues review the paper before it is submitted to a journal. It is important to select colleagues who have expertise in the topic under study as well as those who have writing experience. These peers will usually be able to see areas of weakness not immediately apparent to the author and they can provide suggestions for improvement. These suggestions can then be incorporated into the paper and help provide comments for the discussion. Be sure to select assistants who will be honest in their feedback, will provide the comments in a timely manner, and who will respect the confidentiality of your work. In receiving feedback from peers, it is important for the author not to take the criticism personally, but to see it as a method for improving the paper.

**Conclusion**

The conclusion should provide a tie in to the purpose, the major conclusions drawn from the overview, and directions for future research.

A clear and concise summary of the major findings of the overview should be provided.\(^{10}\) This is not merely a rehash of the entire paper, but a statement about what is now known as a result of the publication of the overview that was not known or observed before. The conclusion should be drawn from and supported by the papers reviewed.\(^{1,10,14,18}\) the absence of systematic methods should temper the conclusion.\(^3\) Specific implications to the practice environment should also be mentioned.\(^3\) Authors who derive conclusions that are irrelevant to the initial purpose have lost the focus of the review and may inadvertently infuse bias into the study. If any major conclusion is not supported by the literature synthesis, then it is a faulty conclusion and your suspicion about the validity of the paper should be heightened. Therefore, conclusions that are made must be supported by the literature reviewed.

Specific directives for new research initiatives should be proposed. After reviewing the literature on a topic the author possesses a vantage point that may provide valuable guidance for future research endeavors. Suggestions for new areas of inquiry and specific study designs are an important outcome of a thorough review; it is often from these recommendations that researchers begin new studies.

**Acknowledgements**

It may be appropriate to acknowledge the work of a colleague who has assisted the author in the preparation of the manuscript, such as a proofreader or a person who has provided ideas for the manuscript. These people can be acknowledged briefly in this section. People mentioned in this section must give consent for their name to appear in print, which can be obtained by asking them to sign a brief statement that they know that their name will be listed in the acknowledgements section of the article.\(^{28}\) For more information on the protocol for writing acknowledgements, see the Uniform Requirements.

**References**

References are an absolute necessity for any research paper, but especially for a review of the literature. It is extremely important that authors cite each of the studies reviewed in order to demonstrate exactly what research was appraised.\(^{11}\) All of the papers included in the review should be referenced. Authors should also cite all supporting research used to write the report. References used to support the work should come from peer-reviewed journals, texts, government documents or conference proceedings.\(^{17}\) For the majority of literature reviews, the use of magazines is not appropriate because these periodicals are not peer reviewed and the articles in them are not written with the same scientific rigor as peer reviewed journal articles.

References should be formatted appropriately. Instructions for how to write out the references appro-
priately for a given journal are usually found in the journal’s instructions for authors or in the Uniform Requirements. Proper formatting of references is essential, as it costs time and money on behalf of journal staff members to send this information back to authors for correction. All the information needed to correctly list a reference can usually be found with the abstract when conducting a literature search, or on the pages of the actual journal article.

Tables

Tables are lists of information that aid in visually presenting information in an appealing manner rather than listing information as text in a paragraph. Such a table in an overview may be the extraction table used during the synthesis. Tables should be simple and self-contained, needing no further explanation. If authors wish to use previously published tables, the publishing company of the original material must grant permission and it is the authors’ responsibility to receive this permission. Appropriate formatting for tables can be found in the Uniform Requirements.

Figures

Figures or illustrations are a necessity to make articles interesting to read. Since an overview is a review of text, it is especially useful to use pictures and tables in order to keep the paper interesting to read. Most people do not like to read an article that is nothing but text from the beginning of the title to the last letter of the references. Pictures can also help make the paper easier for readers to understand. If authors wish to use previously published photographs or illustrations, permission must be granted by the publishing company of the material and it is the author’s responsibility to receive this permission.

Complete requirements for preparing illustrations or photographs for submission are detailed in the Uniform Requirements. Captions for each figure used in the manuscript should be provided. Authors should not expect that editors will write the figure captions. Some journals accept electronic images. Be sure to scan images at a sufficient resolution to enable quality printing in the journal. Find out from the journal which formats are accepted, such as tiff or jpg files, and whether the journal accepts PC or Mac formatting.

CONCLUSIONS

Narrative overviews can be a valuable contribution to the literature if they are prepared properly in an effort to minimize the author’s biases. Further reading on reviews of the literature is available in a suggested bibliography located in Appendix B of this article. Authors wishing to submit narrative overviews should find this article useful in constructing such a paper and carrying out the research process. Given the controversy surrounding the review of the literature research design, it is our aspiration that this article will facilitate some scholarly dialog in the pursuit of creating more valid reviews of the literature and striking a balance between a the unsystematic overview and the complex meta-analysis.

REFERENCES

32. Willis JC. Notes for authors. Chiropr Hist 2000;20:5.
Appendix A
Narrative Overview Rating Scale

Circle the number that you feel is appropriate for the paper that you are reading:
1 = Absent  2 = Present but not complete  3 = Present and complete

Initial Impression
1 2 3 Does the review appear to be relevant to an issue of interest (18, 30)?

Abstract
1 2 3 Is the specific purpose of the review stated (3, 15)?
1 2 3 Is context for the overview provided?
1 2 3 Is the type of research design stated?
1 2 3 Are the search methods clearly summarized?
1 2 3 Are the important findings clearly discussed?
1 2 3 Are the major conclusions and recommendations clearly outlined?

Introduction
1 2 3 Is the specific purpose of the review clearly stated based upon a brief review of the literature (1, 3, 18, 24)?
1 2 3 Is the need/importance and context of this study established (2, 11, 24)?
1 2 3 Are novel terms defined (10, 29)?

Methods
1 2 3 Were the electronic databases used to conduct the literature searches identified (MEDLINE, CINAHL, etc.) (3, 13, 17)?
1 2 3 Were the search years stated?
1 2 3 Were the search terms stated (3)?
1 2 3 Were standard terms used as search terms, including Medical Subject Headings (17)?
1 2 3 Were the guidelines for including and excluding articles in the literature review clearly identified (10, 18, 22)?

Discussion
1 2 3 Were the results summarized in a comprehensible manner (3, 10)?
1 2 3 Was the critical appraisal of each study the same and reproducible (11, 13, 22)?
1 2 3 Was the quality of the included articles assessed objectively (3, 11, 13)?
1 2 3 Was the variation in the findings of the studies critically analyzed (1, 10, 13, 22)?
1 2 3 Were the meaning of the results addressed (3)?
1 2 3 Do the authors tie in the results of the study with previous research in a meaningful manner (1, 3, 10)?
1 2 3 Were the weak points and untoward events that occurred during the course of the study addressed by the authors (1, 3)?

Conclusions
1 2 3 Was a clear summary of pertinent findings provided (10)?
1 2 3 Were the authors’ conclusions supported by the evidence provided (1, 3, 13, 18)?
1 2 3 Were specific directives for new research initiatives proposed?
1 2 3 Specific implications to the practice environment are addressed (3).
References

1  2  3  Are references relevant, current and appropriate in number (11)?
1  2  3  Are all papers reviewed cited in the references (1)?

Overall Impressions

1  2  3  Do the merits of this review of the literature outweigh the flaws?
1  2  3  Were the authors unbiased in their approach to the review (11, 18)?
1  2  3  Will the results of the paper help me in my philosophical or evidence based approach to patient care (18, 22)?

Comments & Notes:
Appendix B
Additional Suggested Readings on Literature Reviews
Compiled by Alan Adams, DC, MS, MSEd

Books


Journal Articles

Epidemiology of concussion in sport: a literature review

Michael B. Clay DC a,⁎, Kari L. Glover PT, DPT b, Duane T. Lowe DC c

a Clinical Lead, Chiropractic Clinic, Naval Hospital Camp Lejeune, Camp Lejeune, NC
b Staff Clinician, Bodies in Balance Physical Therapy, Wilmington, NC
c Staff Clinician, Inter-Disciplinary Pain Management Clinic, Madigan Army Medical Center, Fort Lewis, WA

Received 7 August 2012; received in revised form 19 November 2012; accepted 30 November 2012

Key indexing terms:
Concussion;
Sport;
Incidence;
Epidemiology;
Traumatic brain injury

Abstract
Objective: The purpose of this study was to summarize sport concussion incidence data, identify sports that present higher injury frequency, reveal the degree of risk in some lesser-known sports, and outline specific details within the sports literature that raise additional concerns, such as helmet-to-helmet contact and player positions that experience frequent impact.

Methods: A systematic literature review of Pub Med using keyword search on injury, concussion, and sports was performed through May 2012. Abstracts were identified, selections were made based upon inclusion criteria, and full-length articles were obtained. Additional articles were considered following review of reference sections. Articles were reviewed and tabulated according to sport.

Results: Two hundred eighty-nine articles were screened, and 62 articles were reviewed. The overall incidence of concussion in sport ranged from 0.1 to 21.5 per 1000 athletic exposures. The lowest incidence was reported in swimming and diving. Concussion incidence was highest in Canadian junior ice hockey, but elevated incidence in American football remains a concern because of the large number of participants.

Conclusions: The literature reviewed included incidence of concussion on the field of play under real-world conditions and influenced by the current culture of sport. The studies examined in this article show that there is risk of concussion in nearly every sport. Some sports have higher concussion frequency than others, which may depend upon the forces and roles of the positions played in these sports. Younger athletes have a higher incidence of concussion, and female incidence is greater than male in many comparable sports. Headgear may reduce concussion in some sports but may also give athletes a false sense of protection.

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Introduction

According to the Centers for Disease Control, from 2001 to 2009, the estimated number of visits to hospital emergency departments for sports- and recreation-related concussions increased 62%, from 153,375 to 248,418, in persons 19 years or younger.1 The increasing frequency of sport-related concussion and the emerging possible long-term health risks continue to raise concern in the health care community, in the general public, and to those who set public policy. Although it has been widely believed that athletes are fit to return to play when observed symptoms resolve, researchers are also examining the possible prolonged effects of concussion, subconcussive impacts, and repeated concussions on cognitive difficulties, emotional disturbances, depression, and behavioral issues as well as chronic or recurring physical symptoms, such as headache.2-5

An increased awareness in concussion has caused changes in how organized sports are played. In response to recent concussion research, Pop Warner Football, the largest and oldest youth football league in the United States, adopted rule changes for the 2012 season that limit contact during practices. In 2012, Kentucky became the 38th state to enact a youth concussion law when their governor signed legislation mandating training for coaches and concussion monitoring for players.6 In June of 2012, a lawsuit was filed against the National Football League (NFL) on behalf of more than 2000 former players suffering from long-term effects of concussions sustained during their careers in the NFL.7 More than 13 scientific articles concerning the epidemiology of concussion in sport have been published in the last year alone.

There are variations in the definition of concussion, and various guidelines have been proposed.8 Current evidence-based guidelines for sport were developed in 2008 by international consensus.9 The guidelines state that “Concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces.” The diagnosis is based on symptoms and examination of the patient/player. Neurological imaging and laboratory tests have not revealed corresponding abnormalities. This underscores the importance of training first responders in recognizing the signs and symptoms of concussion.

Health care professionals and those involved with sport such as coaches, officials, and lawmakers must understand the frequency of this injury in various athletic activities. They also need to be cognizant of factors that improve recognition of mild concussions to diminish the risk to players. Accurate knowledge of the incidence of concussion in athletes and the factors affecting the risk of concussion will be instrumental in evaluating current rules, regulations and safety equipment and in guiding future changes in various sports.

The purpose of this article is to summarize current sport concussion incidence data, highlight sports that present higher injury frequency, reveal the degree of risk in some lesser-known sports, and outline specific details within the sports literature that raise additional concern, such as helmet-to-helmet contact, player positions that experience frequent impact, and limitations of study methods. This article also discusses the difficulty in evaluating and determining the true rate of concussion across multiple sports and demographics.

Methods

Our methods followed the Meta-analysis of Observational Studies in Epidemiology and the Preferred Reporting Items for Systematic Reviews guidelines that cover systematic reviews of the type of studies that explore concussion in sport.10,11

Search

National Center for Biotechnology Information Pub Med keyword searches were conducted without restriction of date until May 18, 2012. Only published articles were used. Medical Subject Headings (MeSH) terms pertaining to epidemiology of concussion in sport were used as search terms and are listed in Appendix A.

Abstract exclusion criteria

Studies included described epidemiology or incidence of accidental concussion in sport. Athletes who train specifically to render opponents unconscious as in boxing or other martial art sports were excluded from our search. No constraints were placed upon language. One abstract written in Dutch was excluded because of lack of sport specificity. Translation was arranged with a Dutch speaker for this article.

Full-length article criteria

Full-length articles were obtained and read by all authors. Studies that listed “sport injury” as the cause of concussion, and no specific sport, were excluded. Prospective or retrospective cohort studies, cross-sectional studies, or interventional studies were included. Systematic reviews were excluded. Data were extracted independently based upon an agreed upon format for the tables. Incidence of concussion was the primary finding sought, along with target population, sport, study...
design, author, date of publication, and study strengths and weaknesses. Concerns of bias were recorded under weaknesses, but no analysis tool was used. The primary measure of incidence was concussions per 1000 athletic exposures (AEs), but risk ratios were included as available and appropriate. Contact with author Christy Collins clarified surveillance methods and national high school (HS) sports database use.

Results

Overview

Screening of 289 abstracts resulted initially in 52 articles. Reference review resulted in 10 additional articles that were added to the full-length review, for a total of 62 articles. Exclusion criteria based upon study type and sport specificity were applied, and 17 articles were eliminated (Fig 1).8,12-27 The 45 studies were summarized, divided by sport, and placed in Tables 1 to 5. Multiple sport studies were separated and placed in Table 6, with incidence data in Table 7. These tables allow for ease of comparison but do not represent meta-analysis or resynthesis of data.

Multisport incidence data was converted to concussions per 1000 AEs. The concussion/1000 AEs reporting method facilitated ease of comparison.

Tables 8 and 9 reprint the 2007 tables of Gessel et al63 and demonstrate the most recent overview of sport-related concussion incidence and mechanisms at both HS and collegiate levels in the same study.

Bias

Cochrane risk of bias tool was considered, but we felt that it was not appropriate to the studies included.
Nearly all of the studies used open cohorts, somewhat ambiguous diagnosis, and depended upon participants’ “self report.” These methods frequently result in self-selection, non-respondent, insensitive measurement, recall, loss of follow-up, attention, and withdrawal biases.

**Overall incidence of concussion**

Overall incidence of concussion ranged from Schulz’s reported 0.17 concussion/1000 AEs 95% confidence interval (CI) (0.13-0.21) in HS to the 0.43/1000 AEs 95% CI (0.27-0.28) college figure from Gessel et al. Caution should be exercised when interpreting this information in that none of these studies used the exact same sports, methods of reporting differed, and the reports span a 10-year period in which concussion research was evolving.

**Football**

High school incidence ranged from an estimated 0.48/1000 AEs to a reported 1.03/1000 AEs and college incidences ranged from an estimated 0.52 to a reported 0.81/1000 AEs. An NFL incidence estimated at 4.56/1000 game AEs did not include practice data.

Concussion incidence from the multisport studies ranged from 0.33/1000 AEs CI (0.25-0.41) in HS to 0.64/1000 AEs. The highest incidence in collegiate football was 0.61/1000 AEs.

**Rugby and Australian rules football**

Amateur Australian footballers’ concussions comprising 15% of all injuries were the most frequent injury. Incidence in male nonprofessional rugby players was 7.97/1000 player hours. Hollis et al reported an incidence of 14% per 20-hour season in experienced rugby players. Haseler et al reported community rugby club player incidence at 1.8/1000 player hours. Shuttleworth-Edwards et al reported annual rugby concussions between 4% and 14% at school level and between 3% and 23% at adult level.

**Hockey**

Concussions ranged from 21.52/1000 AEs in junior hockey to 1.55/1000 AEs in collegiate players. Agel and Harvey reported lower incidence in collegiate men at 0.72/1000 AEs than women at 0.82/1000 AEs.

The report of Echlin et al of 21.52/1000 AEs in junior hockey is 7 times higher than previously reported in the NHL.

Multiport studies incidence ranged from 0.41/1000 AEs CI (0.37-0.44) in collegiate male hockey to 0.54/1000 AEs in HS males. Hootman et al reported collegiate female hockey incidence at 0.91/1000 AEs CI (0.71-1.11).

**Lacrosse**

Dick et al reported an overall incidence in collegiate men of 1.08 CI (0.92-1.25)/1000 AEs and 0.52 CI (0.41-0.64)/1000 AEs in women. Concussion was 8.6% of all game injury in men and 9.4% in women. Lincoln et al reported an incidence in HS males of 0.28/1000 AEs and 0.21/1000 AEs in females, and college males at 0.87/1000 AEs and females at 0.32/1000 AEs.

Multiport study incidences ranged from 0.26/1000 AEs CI (0.23-0.29) in collegiate males to 0.40/1000 AEs in HS males. Concussion spanned from 0.25/1000 AEs CI (0.22-0.28) in collegiate females to 0.35/1000 AEs in HS females.

**Soccer**

Concussion in the multisport studies ranged from 0.13 CI (0.0-0.27)/1000 AEs in HS females to 0.41 CI/1000 AEs (0.38-0.44) in college females. Male incidence spanned from HS at 0.17 to college at 0.49/1000 AEs.

**Discussion**

**Problems defining concussion**

Acceptance of the Third Zurich consensus statement definition of concussion for use by medical professionals, coaches, and others involved in the care of injured athletes at the recreational, elite, or professional level allows examination of concussion from a uniform perspective. This definition of concussion is not uniformly used throughout the 46 studies reviewed from 1999 to 2012.

Associated variables such as headache following observed head trauma, loss of consciousness, loss of playing time, missing school, and missing sport activities have all been used to define reporting criteria, but a change in definition changes the data that are
<table>
<thead>
<tr>
<th>First author and year</th>
<th>Target population and sport</th>
<th>Design and source of information</th>
<th>Findings</th>
<th>Study strength</th>
<th>Study weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guskiewicz et al, 2000</td>
<td>17,549 football players from 249 HSs and Div 1-3 colleges from 1995 to 1997.</td>
<td>Prospective cohort study. Data recorded by 1 trainer immediately after injury occurred for each school.</td>
<td>Overall incidence of 0.71 concussion/1000 AEs HS = 1.63/1000 AEs Div 1 = 0.94/1000 AEs Div 2 = 1.34/1000 AEs Div 3 = 1.31/1000 AEs.</td>
<td>Large sampling of players. Used Cantu guidelines for definition of concussion. Games and practices were considered for AE calculations. 14.7% of the concussed sustained a second concussion during the same season. Grade 1 88.9% Grade 2 10.6% Grade 3 0.4%.</td>
<td>Only 62% (242 out of 392) of trainers provided complete data. Only schools with athletic trainers participated. AE to contact and noncontact events was determined by telephone interview and mailed surveys from a subsample of 45 schools.</td>
</tr>
<tr>
<td>Langburt et al, 2001</td>
<td>HS football players in Pennsylvania and Ohio after the 1996-1997 season.</td>
<td>Retrospective questionnaire data reported by players. Only 234/450 responses were returned, and 1 was excluded.</td>
<td>47.2% players reported evidence of concussion. 34.8% reported multiple concussions. 87.8% were classified as Cantu Grade I. Most did not stop playing.</td>
<td>Anonymous questionnaires. Did not use term concussion but used head injury to avoid misconception that unconsciousness was required.</td>
<td>Self-reported, retrospective, questionnaire at the end of the season could produce recall and self-selection bias. Only slightly more than half of players responded, but no effort to characterize nonrespondents.</td>
</tr>
<tr>
<td>Delaney et al, 2002</td>
<td>328 football and 201 soccer athletes reporting to 1999 Canadian university fall training camps. Study included 110 females and 9 undetermined.</td>
<td>Retrospective survey. Players reporting on 1998 season. Response rate was 86% for football and 84% for soccer.</td>
<td>70.4% of football and 62.7% of soccer players reported symptoms of concussion during the previous year. Soccer players had over 3× greater chance of concussion if they had previous concussion.</td>
<td>Only 23.4% of the football players and 19.8% of the soccer players realized that the symptoms they had suffered represented a concussion. Goalies were most likely to be concussed in soccer and tight-ends and defensive linemen in football. Female soccer players had 2.6× greater odds of concussion.</td>
<td>Retrospective design increases recall bias, and self-selection bias is also a concern when self-report is used and nonreports are not examined.</td>
</tr>
<tr>
<td>Guskiewicz et al, 2003</td>
<td>2905 Division 1, 2, and 3 collegiate football players.</td>
<td>Prospective cohort study collected by ATCs.</td>
<td>0.81 concussion per 1000 AEs overall. 3.81/1000 AEs in games and 0.47 in contact practice. Linebackers had highest incidence of concussion at 0.99/1000 AEs.</td>
<td>Used graded symptom checklist to quantify symptoms at baseline and postinjury. Increased risk associated with concussion incidence established at 0.66 for 0 concussions, 0.96 for 1 concussion, 1.85 for 2 concussions, and 2.23/1000 AEs for 3+ concussions.</td>
<td>Exposure data were estimated.</td>
</tr>
<tr>
<td>Pellman et al, 2004</td>
<td>Entire population of NFL league players from 1996 to 2001. Adult, male, professional football players.</td>
<td>Prospective, 6-y epidemiology study. Data gathered by team physicians of the NFL ISS.</td>
<td>Concussion incidence of 0.41 concussion/game could be converted to concussions/AEs by assuming an active roster of 45 equates to 90 AEs.</td>
<td>Standardized form used. Multiple years of data. Player position, type of play, and impact object data available. Detailed symptom analysis. Most vulnerable</td>
<td>Methodology changes several times throughout the study. No data on practices. May not be generalizable to nonprofessional populations.</td>
</tr>
</tbody>
</table>
for the 2 teams, and this suggests a concussion incidence of 4.56/1000 AEs. 8.1% of players had concussion involving 7+ d out from play, and highest frequency occurred in quarterbacks at 14.8%.

Establishes a gradient of disability and leads to a discussion of postconcussion syndrome.

Players could have sustained a concussion, but not have been included because of a lack of cooperation or transient and unrecognized episode.

Wisniewski et al, 2004

0.73 concussion per 1000 AEs in 791 games, 2839 contact practices, and 1708 noncontact practices. No advantage found in wearing a custom mouthpiece.

Large size. Differentiated concussions in contact (0.39/1000 AEs) and noncontact (0.02/1000 AEs) practices from games (5.49/1000 AEs). Relates greatest frequency of concussion to player position (linebacker), as well as mechanism of injury (head to head contact). Clear definition of concussion given to ATCs and physicians present at time of injury. “International return-to-play standards” were followed.

Sample of Revolution athletes were older by 0.4 y and had a higher number of prior concussions than the traditional helmet group. Athletes’ concern of prior concussion may have created self-selection bias based upon the perception that the Revolution helmet was safer. Author Ide, as a vice president for Riddell, may have had conflict of interest.

Shankar et al, 2007

0.48/1000 AEs HS and 0.68/1000 AEs. NCAA rate was not calculated by authors, but could be calculated from data on concussions, head/face injuries, and AE for HS and college.

Large national sample of varying sizes of HSs and multiple NCAA divisions. Used only trained reporters to improve data quality. Running plays were the leading cause of HS concussion. HS concussions were a greater proportion of practice injuries (13%) than in the NCAA (10%). Only schools with certified ATCs participated. Study data are not specific to concussion and is difficult to interpret in context. Reported data required 1 d missed because of injury.

Yard et al, 2009

0.52 concussion/1000 AEs were not calculated by authors, but are 12% of 1880 reported injuries/431,242 exposures.

ATCs did not attend all practices or competitions. Use of AEs limits comparison between other sports, as AEs will not be an equivalent measure.

(continued on next page)
Lack of uniformity in selection criteria may result in deviation from reporting the true number of concussions.

Players, coaches, and providers do not always recognize the spectrum of posttraumatic symptoms that identify concussion. Ignorance of symptoms may be complicated by fear of exclusion from the game or a "win at all costs" attitude, and researchers should be aware of this complication to reporting consistency.

Concussion incidence trends

Several multisport studies report incidence of concussion ranging from 0.01/1000 AEs in track and field to 0.91/1000 AEs in women's ice hockey. The general consensus is that concussion incidence is rising. However, one study reported that concussions can be expected to decline by 2.5% annually in football accounts for the highest proportion of concussions. Data capture

The much higher hockey incidence of Echlin et al. appears to be related to independent physicians diagnosing concussions and using multiple trained data collectors compared with other studies who did not. Lincolnl et al. attributed an increase in concussions reported across all sports and sexes in 2005 to a 50% increase in Certified Athletic Trainer (Crisco et al., 2010) coverage. This demonstrates that increased training and observation may result in greater capture of concussions.

The use of trained data collectors to be related to independent physicians diagnosing concussions and using multiple trained data collectors compared with other studies who did not. Lincolnl et al. attributed an increase in concussions reported across all sports and sexes in 2005 to a 50% increase in Certified Athletic Trainer (Crisco et al., 2010) coverage. This demonstrates that increased training and observation may result in greater capture of concussions.

Articles can be divided into 2 groups: surveillance studies like the National Collegiate Athletic Association (NCAA) Injury Surveillance System (ISS) or High School Reporting Information Online (RIO; National High School Sports-Related Injury Surveillance Study) and more traditional cohort studies.

Data capture

- The much higher hockey incidence of Echlin et al. appears to be related to independent physicians diagnosing concussions and using multiple trained data collectors compared with other studies who did not. Lincolnl et al. attributed an increase in concussions reported across all sports and sexes in 2005 to a 50% increase in Certified Athletic Trainer (Crisco et al., 2010) coverage. This demonstrates that increased training and observation may result in greater capture of concussions.

Confidence interval: 95% unless otherwise stated.

AE, athletic exposures; ATC, certified athletic trainer; CI, confidence interval, 95% unless otherwise stated; HS, high school; IPR, injury proportion ratio; ISS, injury surveillance system; NCAA, National Collegiate Athletic Association; NFL, National Football League; RIO, reporting information online, National High School Sports-Related Injury Surveillance Study; US, United States.
Table 2  Hockey concussions

<table>
<thead>
<tr>
<th>First author and year</th>
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<th>Design and source of information</th>
<th>Findings</th>
<th>Study strengths</th>
<th>Study weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benson et al, 1999⁴⁰</td>
<td>642 male Canadian university hockey players 1997-1998 with mean age 22 y.</td>
<td>Prospective cohort study. Data recorded by team doctor or therapist.</td>
<td>Concussion incidence 1.55/1000 AEs was not impacted by players wearing half- or full-face shields, but time lost to concussion was greater than that of half shields.</td>
<td>Suggests that the additional protection of a full shield that reduces facial and dental injuries did not increase risk of concussion. Weekly recording of data by team therapists present at every game or practice.</td>
<td>Potential for nondifferential misclassification reporting bias due to no method of verifying completeness of reporting for injuries that did not result in time lost from play. Data may not be generalizable to HS or younger players.</td>
</tr>
</tbody>
</table>

| Dick et al, 2007⁴¹ | Collegiate women’s field hockey using NCAA ISS data from seasons 1988-1989 through 2002-2003. | Descriptive Epidemiology study 15-y review of data recorded by ATCs. | Concussions were >5.4% of severe game injuries. Game concussion risk was 6× higher than practice (rate ratio= 6.1 95% CI (4.3-8.7). 9.4% of game injuries and 3.4% in practice were concussions. Game injury rates declined an average 2.5% annually over 15 y. | NCAA ISS data on field hockey injuries used standardized case definitions for injuries or exposure classification in a clearly defined population of collegiate athletes for a prolonged period. Study advocated need for helmets. Pointed out that mouth guards were the only above-the-neck equipment required for nongoalies. 17.6% of schools sponsoring varsity women’s field hockey programs participated in annual NCAA ISS data collection. |

| Benson et al, 2002⁵¹ | 642 male Canadian university hockey players 1997-1998 with mean age 22 y. | Prospective cohort with multivariate analysis. Data collected by team therapists and doctors. | Incidence of concussion was 1.5/1000 AEs. ½ shields missed 2.4× practices and games than those with full shields. | Injury report form filled out on each eligible injury. Suggests that concussion severity can be mitigated through use of protective equipment. | Study reuses data from 1999 article and may be susceptible to same bias. |

| Cusimano et al, 2009⁵² | Players, coaches, trainers, and parents of 10-to 14-y-old hockey players. | Questionnaire was self-reported. | Significant confusion regarding concussion in hockey, its treatment symptoms, and safe return to play suggests that underreporting is likely. | Suggests that people associated with concussed athletes should not be relied upon for data and should be properly trained in appropriate care. | No proposal for improvement in training of people involved with concussion care. |

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</tr>
</thead>
<tbody>
<tr>
<td>Agel et al, 2010</td>
<td>NCAA men’s and women’s hockey.</td>
<td>Retrospective ISS database reported by ATCs.</td>
<td>Concussion incidence of 0.72/1000 AEs for men and 0.82/1000 AEs for women.</td>
<td>Large study size included 7 seasons. Rate remained stable over the study. Player contact was the cause of concussions in games for 41% of women and 72% of men.</td>
<td>Concussion rates reported here may be artificially low because of a requisite of time loss for data reporting.</td>
</tr>
<tr>
<td>Echlin et al, 2010</td>
<td>67 male Canadian 4th-tier ice hockey players 16-21 y old, during the 2009-2010 season.</td>
<td>Prospective cohort study observed by physicians.</td>
<td>Concussion incidence of 21.52/1000 AEs in 4th-tier junior hockey was 7× higher than the highest rate previously reported. The 36.5% rate of concussion observed per game was far higher than the 3.1% previously reported in the National Hockey League.</td>
<td>Suggests that concussion incidence may be significantly higher than previously reported and accurate data require independent data collection. Assumption that athletic trainers that work with HS teams are free of bias may be inaccurate. Trained data collectors, independent of the teams, are much less likely to introduce bias.</td>
<td>Small study size. Loss of significant data due to failure of team to comply with study.</td>
</tr>
<tr>
<td>Cusimano et al, 2011</td>
<td>Male hockey league players aged 6-17 y for 10 seasons.</td>
<td>Retrospective study.</td>
<td>Rule change to allow body checking in 10- and 11-y-olds resulted in an increased odds ratio to 2.27 CI (1.42-3.65) of ED visit due to concussion in the 10- to 11-y-olds.</td>
<td>10-y study was 5 y before rule change and 5 y after. This allows the impact of rule changed to be examined.</td>
<td>ED data capture was limited, and concussion was only counted because of body checking. League participation was not captured, so injury rate is unknown.</td>
</tr>
<tr>
<td>Brainard et al, 2012</td>
<td>88 NCAA hockey athletes: 37 male and 51 female.</td>
<td>Prospective cohort data were collected by helmet sensors.</td>
<td>Female players sustain fewer impacts and lower head acceleration than males.</td>
<td>Eliminates frequency of impact as the source of greater incidence of concussion in female hockey players.</td>
<td>Study size and scope limited by having only 2 teams. Concussion data not collected.</td>
</tr>
</tbody>
</table>

AE, athletic exposures; ATC, certified athletic trainer; CI, confidence interval, 95% unless otherwise stated; ED, emergency department; HS, high school; ISS, injury surveillance system; NCAA, National Collegiate Athletic Association.
**Table 3** Rugby concussions

<table>
<thead>
<tr>
<th>First author and year</th>
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</thead>
<tbody>
<tr>
<td>Shawdon et al, 1994⁴⁷</td>
<td>80 amateur Australian rules footballers.</td>
<td>Single season cohort data recorded by team doctor in 1993.</td>
<td>Concussion comprised 15% of all injuries and was the most frequent injury. 14.4 concussions/1000 player hours can be calculated.</td>
<td>A single team doctor recorded all injuries. Use of hours in method allows for comparison to other sports.</td>
<td>Small size of study. Concussion not specifically defined. Injury required missing a game to be reported.</td>
</tr>
<tr>
<td>Collins et al, 2008⁴⁸</td>
<td>HS rugby players in the US in 2005-2006 sample of 121 boys and girls.</td>
<td>Descriptive epidemiology study. Data collected by a mix of personnel, but 77.7% coaches.</td>
<td>Incidence of match concussions was 4.1/1000 player hours. Incidence of concussions by players not wearing headgear was significantly higher than those wearing headgear.</td>
<td>Concussion was associated with tackling head-on (28%), collisions (20%), and being tackled head-on (19%). Incidence of concussions sustained by players not wearing mouth guards did not reach statistical significance.</td>
<td>Only 22.3% of data reporters were medically trained. Clubs self-selected inclusion. Reportable injury required “restriction of the HS rugby player’s participation in regular school or rugby activities for 1 or more days beyond the day of injury.”</td>
</tr>
<tr>
<td>Kemp et al, 2008⁴⁹</td>
<td>757 English male rugby union players over 3 seasons.</td>
<td>Prospective cohort study data collected by team medical personnel.</td>
<td>Incidence of match concussions by players not wearing headgear was significantly higher than those wearing headgear.</td>
<td>Concussion was associated with tackling head-on (28%), collisions (20%), and being tackled head-on (19%). Incidence of concussions sustained by players not wearing mouth guards did not reach statistical significance.</td>
<td>Players only included while considered 1st team. Relied upon player and medical recall. 17% of concussed players were not removed during match play.</td>
</tr>
<tr>
<td>Shuttleworth-Edwards et al, 2008⁵⁰</td>
<td>1366 South African rugby union players from 5 boys’ HS (2 private and 3 public), 1 university, 1 premier club, and 1 group of provincial players.</td>
<td>Retrospective statistical analysis data collected by psychologists working with team doctors, coaches, players, and other sports personnel between 2002 and 2006.</td>
<td>Annual rates of concussion varied from 4% to 14% at the school level and between 3% and 23% at adult level.</td>
<td>Compared HS age, collegiate, club-level, and professional players.</td>
<td>No homogenous standard of reporting concussions. Some institutions relied on player reporting. Problems with player follow-up due to successive concussion. Article admits that incidence of concussion cannot be accurately implied from the article. Authors have conflicting interest.</td>
</tr>
<tr>
<td>Hollis et al, 2009⁵¹</td>
<td>3207 Australian male nonprofessional rugby players aged 15+.</td>
<td>Prospective cohort study data collected by a mix of doctors, coaches, and other trained recorders.</td>
<td>Incidence of mTBI 7.97/1000 player hours CI (6.94-9.11).</td>
<td>Established benefit of wearing protective head gear at IRR 0.57 CI (0.40-0.82) and additional risk of 1 mTBI in the year before recruitment at IRR 1.75 CI (1.11-2.76)</td>
<td>Mix of data reporters. Despite being a 3-y study, data collection per athlete was only 1 season long for 85% of players.</td>
</tr>
<tr>
<td>Haseler et al, 2010⁵²</td>
<td>2008-2009. 1636 player hours of an English community rugby club. 210 male players in U9-U17 age groups.</td>
<td>Prospective cohort study data collected by coach or first aid personnel.</td>
<td>Concussion incidence of 1.8/1000 player hours.</td>
<td>Observers were trained and concussion defined.</td>
<td>Data collectors were not independent. Study not specific to concussion.</td>
</tr>
<tr>
<td>Hollis et al, 2011⁵³</td>
<td>3207 Australian male community rugby players ages 15-48 in 2005-2007.</td>
<td>Prospective cohort data collected by a mix of doctors, coaches, and trained recorders.</td>
<td>10% of overall cohort had an mTBI. 14% of population experienced an mTBI in a 20-h season.</td>
<td>Established increased likelihood of concussion when BMI &lt;median HR=1.7 CI (1.30-2.42) and if training &lt;3 h/wk HR 1.48 CI (1.06-2.08).</td>
<td>Mix of data reporters. 1249 participants removed from cohort were 1.5 y younger</td>
</tr>
</tbody>
</table>

*BMI*, body mass index; *CI*, confidence interval, (95% unless otherwise stated); *HR*, hazard ratio; *HS*, high school; *IRR*, incidence rate ratio; *mTBI*, mild traumatic brain injury; *U9-U17*, under age 9 to under age 17; *US*, United States.
<table>
<thead>
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<tbody>
<tr>
<td>Dick et al, 2007(^{54})</td>
<td>Collegiate Division 1-3 men’s lacrosse using NCAA ISS 1988-1989 through 2003-2004.</td>
<td>Descriptive epidemiology study of 16 y. Data collection by ATCs.</td>
<td>Overall incidence of concussion 1.08 CI (0.92-1.25)/1000 AEs. Concussion was 8.6% of all game injury and 9× more likely in games than practice. 1.08 vs 0.12/1000 AEs; rate ratio = 9.0, 95% CI (7.1-11.5).</td>
<td>Concussion rate rose after introduction of a new helmet in the 1996-1997 season. Large sample of NCAA ISS data. 78.5% of concussion related to player-to-player contact.</td>
<td>ISS only looks at 18% of NCAA institutions participating in the annual data collection for this sport. Intro and methods in separate article.</td>
</tr>
<tr>
<td>Dick et al, 2007(^{55})</td>
<td>Collegiate Division 1-3 women’s lacrosse using NCAA ISS 1988-1989 through 2003-2004.</td>
<td>Descriptive epidemiology study of 16 y. Data collection by ATCs.</td>
<td>0.52 CI (0.41-0.64)/1000 AEs overall incidence of concussion. Concussions were 9.4% of game injuries.</td>
<td>Participants had 6× the risk of concussion in games as in practice. 0.52 vs 0.09 per 1000 AEs, rate ratio = 6.1, 95% CI (4.3-8.7). Concussions increased after new helmet in 1996-1997.</td>
<td>Only 23.1% of schools sponsoring varsity women’s lacrosse programs participated in the NCAA ISS data collection.</td>
</tr>
<tr>
<td>Lincoln et al, 2007(^{56})</td>
<td>5072 male and 3566 female lacrosse players in 23 Virginia HS and national collegiate ISS data.</td>
<td>4-y prospective epidemiology study in 2000-2003 using ISS for college data collected by ATCs.</td>
<td>Concussion incidence of 0.28/1000 AEs HS males, 0.21/1000 AEs in HS females, 0.87/1000 AEs college males, and 0.32/1000 AEs in college females.</td>
<td>Comparison of male and females as well as HS to college. Identified highest concussion frequency due to player-to-player contact in males and player-to-stick contact in females.</td>
<td>Definition of concussion not specified by study. May not capture concussions not brought to ATC’s attention. AE is not equivalent between sports or sexes. Injury counted differently in college and HS.</td>
</tr>
</tbody>
</table>

*AE*, athletic exposures; *ATC*, certified athletic trainer; *CI*, confidence interval, 95% unless otherwise stated; *HS*, high school; *ISS*, injury surveillance system; *NCAA*, National Collegiate Athletic Association.
### Table 5  Soccer concussions

<table>
<thead>
<tr>
<th>First author and year</th>
<th>Target population and sport</th>
<th>Design and source of information</th>
<th>Findings</th>
<th>Study strength</th>
<th>Study weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matser et al, 1999&lt;sup&gt;57&lt;/sup&gt;</td>
<td>33 amateur soccer players and 27 amateur swimming and track athletes in 1997-1998.</td>
<td>Cross-sectional study data via interview of players and their physicians.</td>
<td>Self-reported amateur soccer concussion was associated with impairment in memory and planning functions. 62.7% of soccer players had concussion symptoms in the previous year. Players had over 3× greater risk of concussion with history of previous concussion.</td>
<td>Data adjusted for level of education, alcohol intake, number of times under general anesthesia, and the number of concussions not due to soccer play. Only 19.8% of the soccer players realized that the symptoms they had suffered represented a concussion. Goalies were most likely to be concussed in soccer. Female soccer players had 2.6× greater odds of concussion.</td>
<td>Concussion questionnaire data based on memory of players.</td>
</tr>
<tr>
<td>Delaney et al, 2002&lt;sup&gt;30&lt;/sup&gt;</td>
<td>201 soccer athletes and 328 football players reporting to 1999 Canadian university included 110 females.</td>
<td>Retrospective survey. Players self-reported on 1998 season. Response rate was 84% for soccer.</td>
<td></td>
<td>Retrospective design increases recall bias, and self-selection bias is also a concern when self-report is used and nonreports are not examined.</td>
<td></td>
</tr>
<tr>
<td>Yard et al, 2008&lt;sup&gt;58&lt;/sup&gt;</td>
<td>HS male and female soccer players 2005-2007.</td>
<td>Descriptive epidemiology study using RIO data.</td>
<td>Concussion made up 10.8% of injuries in 637,446 total AEs. Comparison of competition to practice resulted in an IPR of 3.25 CI (1.99-5.31). Differentiates the incidence of various mechanisms of injury in practice and competition, but not specific to concussion. Boy’s result of 9.3% and girl’s 12.2% concussion proportion of injury are higher than previously reported.</td>
<td>Rates of injury vary from similar studies and suggest that either injuries are decreasing or differences in injury definition resulted in the decrease in the injury rate.</td>
<td></td>
</tr>
</tbody>
</table>

AE, athletic exposures; CI, confidence interval, 95% unless otherwise stated; HS, high school; IPR, injury proportion ratio; RIO, reporting information online, National High School Sports-Related Injury Surveillance Study.
<table>
<thead>
<tr>
<th>First author and year</th>
<th>Target population and sport</th>
<th>Design and source of information</th>
<th>Findings</th>
<th>Study strength</th>
<th>Study weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powell and Barber-Foss, 1999</td>
<td>235 US HS males and females in 10 varsity sports during 1 or more of 3 academic years 1995-1997.</td>
<td>Observational cohort study data recorded by 246 ATCs.</td>
<td>5.5% of all injuries were mTBIs. Football accounted for 63.4% of cases, wrestling 10.5%, girl’s soccer 6.2%, boy’s soccer 5.7%, girl’s basketball 5.2%, boy’s basketball 4.2%, softball 2.1%, baseball 1.2%, field hockey 1.1%, and volleyball 0.5%.</td>
<td>Demonstrates that practice concussion rates are substantially lower than game rates. Establishes football as the sport with most concussions by a large margin.</td>
<td>Loss of athletes from the study was not detailed. Characterizing the lost athletes for differences from the study group would be beneficial.</td>
</tr>
<tr>
<td>Schulz, 2004</td>
<td>100 North Carolina HS with male and female athletes in 12 sports from 1996 to 1999.</td>
<td>Prospective cohort study using data collected by 1 ATC or athletic director per school.</td>
<td>Overall rate of concussion was 17.15 CI (13.30-21.00)/100,000 AEs. Concussion rates ranged from 9.36 CI (1.93-16.80) cheerleading to 33.09 CI (24.74-41.44) in football.</td>
<td>Cheerleading was the only sport for which the practice rate was greater than the game rate. Initial screening and follow-up performed. Used North Carolina HS Athletic Injury Study data.</td>
<td>No postseason data collection. Only 1/3 of data collected by ATCs. Volleyball listed as a sport, but not found in results.</td>
</tr>
<tr>
<td>LaBotz et al, 2005</td>
<td>93 male and 79 female athletes participating in collegiate contact or collision sports.</td>
<td>Retrospective survey with self-report.</td>
<td>71% reported symptoms consistent with concussion but were not identified as having a history of head injury on the PPE form.</td>
<td>Recognizes difficulty in properly identifying concussion via single, self-reported, preparticipation questionnaires and advocates symptom-specific inquiries.</td>
<td>Supplanted by the 2008 Zurich convention’s use of SCAT2.</td>
</tr>
<tr>
<td>Dick et al, 2007</td>
<td>NCAA male and female athletes.</td>
<td>Methodology summary for NCAA ISS.</td>
<td>NA</td>
<td>Provides more detail on methodology than would be present in an average study.</td>
<td>Separate methodology article for multiple NCAA studies.</td>
</tr>
<tr>
<td>Gessel et al, 2007</td>
<td>Male and female US HS and collegiate athletes.</td>
<td>Descriptive epidemiology study data collected by ATCs via the RIO and NCAA ISS systems.</td>
<td>Overall HS concussions occurred at 0.23/1000 AEs and college 0.43/1000 AEs. Concussions represented 8.9% of all HS athletic injuries and 5.8% of all collegiate athletic injuries.</td>
<td>Uses data from very large national databases for HS and collegiate athletes. Estimates national practice and game rates of concussion.</td>
<td>Only time loss injuries coming to the attention of ATC were captured. Data from schools without an ATC may differ.</td>
</tr>
<tr>
<td>Hootman et al, 2007</td>
<td>NCAA male and female athletes for 16 y in 15 sports.</td>
<td>Retrospective cohort study day reported by ATCs.</td>
<td>Concussion rate was 0.28/1000 AEs. 55% of all concussions reported were for football at 0.54/1000 AEs. Women’s ice hockey had the highest incidence at 0.91/1000 AEs.</td>
<td>Large study population over a longer period. Has data on practices as well as games.</td>
<td>Injuries reported that required medical attention and at least 1-d time loss. Concussions on Friday may not have been reported because of weekend eliminating 1 d lost.</td>
</tr>
<tr>
<td>Study</td>
<td>Description</td>
<td>Results</td>
<td>Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swenson et al, 200965</td>
<td>HS sports injury data for the 2005-2008 academic years.</td>
<td>Concussions were 3rd most common diagnosis of recurrent injury at 11.6%. Specific data on concussion incidence not reported.</td>
<td>Large study. Percentages of concussion injury and reinjury rates for each sport were recorded.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yard et al, 200937</td>
<td>Male and female athletes in 18 HS sports.</td>
<td>Participating ATCs submitted 96.7% of expected exposure reports, but coaches submitted only 36.5%. All ATCs reported AEs correctly as opposed to only 2 of 3 coaches.</td>
<td>Numerous discrepancies in coach injury reports were not found in ATC reports, which suggested benefit in using ATCs for data collection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meehan et al, 201066</td>
<td>US male and female HS athletes in 9 sports.</td>
<td>68.5% of concussions occurred during competition as opposed to practice. 89% were first concussion, and 10.5% were recurrent.</td>
<td>ATCs work for team and gather data for the RIO. In 13- to 18-y-olds, age 16 had the greatest number of concussions at 28%.</td>
<td></td>
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</tr>
<tr>
<td>Castile et al, 201267</td>
<td>US male and female HS athletes from 2005 to 2010 in 9 sports of the National High School Sports-Related Injury Surveillance Study.</td>
<td>The overall rate of new concussion was 22.2/100,000 AEs and recurrent concussion was 3.1/100,000 AEs. 13.2% of concussions were recurrent.</td>
<td>Demonstrated that recurrent concussion results in greater disability and greater potential for long-term impairment. Overall rates of new or recurrent concussion were higher among girls when compared with boys in sex-comparable sports.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lincoln et al, 201168</td>
<td>158,430 HS male and female athletes in 12 sports.</td>
<td>Overall 0.24 concussions per 1000 AEs.</td>
<td>Definition of concussion not specified by study. May not capture concussions not brought to ATC’s attention. Comparison of AEs may not be equivalent between sports or sexes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marar et al, 201269</td>
<td>US male and female athletes in 20 HS sports during the 2008-2010 academic years. Boy’s volleyball not reported because of zero concussions reported.</td>
<td>Overall injury rate of 2.5/10,000 AEs and overall rate of concussion were higher in competition than in practice. Concussions represented 13.2% of all reported injuries.</td>
<td>Latest study to include information on concussions in this broad collection of HS sports. Concludes girl’s concussion RR of 1.7 to boy’s 1.0 CI (1.4-2.0) and player-to-player-contact was the most frequent mechanism.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Confidence interval: 95% unless otherwise stated.

AE, athletic exposures; ATC, certified athletic trainer; CI, confidence interval, 95% unless otherwise stated; HS, high school; ISS, injury surveillance system; mTBI, mild traumatic brain injury; NA, not applicable; NCAA, National Collegiate Athletic Association; PPE, pre-participation physical; RIO, reporting information online, National High School Sports-Related Injury Surveillance Study; RR, rate ratio; SCAT2, Sport Concussion Assessment Tool 2; US, United States.
<table>
<thead>
<tr>
<th></th>
<th>Powell and Barber-Foss, 1999&lt;sup&gt;59&lt;/sup&gt;</th>
<th>Schulz, 2004&lt;sup&gt;60&lt;/sup&gt;</th>
<th>Gessel et al, 2007&lt;sup&gt;63&lt;/sup&gt;</th>
<th>Hootman et al, 2007&lt;sup&gt;64&lt;/sup&gt;</th>
<th>Lincoln et al, 2011&lt;sup&gt;68&lt;/sup&gt;</th>
<th>Castile et al, 2012&lt;sup&gt;67&lt;/sup&gt;</th>
<th>Marar et al, 2012&lt;sup&gt;69&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HS</td>
<td>HS</td>
<td>NCAA/HS</td>
<td>NCAA</td>
<td>HS</td>
<td>HS</td>
<td>HS</td>
</tr>
<tr>
<td>Male baseball</td>
<td>0.05 CI (0.02-0.07)</td>
<td>0.12 CI (0.03-0.21)</td>
<td>0.05/0.09</td>
<td>0.07 CI (0.06-0.08)</td>
<td>0.06</td>
<td>0.037</td>
<td>0.05</td>
</tr>
<tr>
<td>Male basketball</td>
<td>0.11 CI (0.08-0.15)</td>
<td>0.10 CI (0.04-0.16)</td>
<td>0.07/0.27</td>
<td>0.16 CI (0.14-0.17)</td>
<td>0.10</td>
<td>0.1</td>
<td>0.16</td>
</tr>
<tr>
<td>Female basketball</td>
<td>0.16 CI (0.12-0.21)</td>
<td>0.17 CI (0.01-0.34)</td>
<td>0.21/0.43</td>
<td>0.22 CI (0.20-0.24)</td>
<td>0.16</td>
<td>0.196</td>
<td>0.21</td>
</tr>
<tr>
<td>Female field hockey</td>
<td>0.09 CI (0.04-0.15)</td>
<td>NA</td>
<td>NA/NA</td>
<td>0.18 CI (0.15-0.21)</td>
<td>0.10</td>
<td>NA</td>
<td>0.22</td>
</tr>
<tr>
<td>Male football</td>
<td>0.59 CI (0.19-1.04)</td>
<td>0.33 CI (0.25-0.41)</td>
<td>0.47/0.61</td>
<td>0.37 CI (0.36-0.38)</td>
<td>0.60</td>
<td>0.539</td>
<td>0.64</td>
</tr>
<tr>
<td>Female gymnastics</td>
<td>NA</td>
<td>NA</td>
<td>NA/NA</td>
<td>0.16 CI (0.12-0.20)</td>
<td>NA</td>
<td>NA</td>
<td>0.07</td>
</tr>
<tr>
<td>Male ice hockey</td>
<td>NA</td>
<td>NA</td>
<td>NA/NA</td>
<td>0.41 CI (0.37-0.44)</td>
<td>NA</td>
<td>NA</td>
<td>0.54</td>
</tr>
<tr>
<td>Female ice hockey</td>
<td>NA</td>
<td>NA</td>
<td>NA/NA</td>
<td>0.91 CI (0.71-1.11)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Male lacrosse</td>
<td>NA</td>
<td>NA</td>
<td>NA/NA</td>
<td>0.26 CI (0.23-0.29)</td>
<td>0.30</td>
<td>NA</td>
<td>0.40</td>
</tr>
<tr>
<td>Female lacrosse</td>
<td>NA</td>
<td>NA</td>
<td>NA/NA</td>
<td>0.25 CI (0.22-0.28)</td>
<td>0.20</td>
<td>NA</td>
<td>0.35</td>
</tr>
<tr>
<td>Male soccer</td>
<td>0.18 CI (0.14-0.22)</td>
<td>0.23 CI (0.08-0.38)</td>
<td>0.22/0.49</td>
<td>0.28 CI (0.25-0.30)</td>
<td>0.17</td>
<td>0.197</td>
<td>0.19</td>
</tr>
<tr>
<td>Female soccer</td>
<td>0.23 CI (0.18-0.28)</td>
<td>0.13 CI (0.0-0.27)</td>
<td>0.36/0.63</td>
<td>0.41 CI (0.38-0.44)</td>
<td>0.35</td>
<td>0.298</td>
<td>0.34</td>
</tr>
<tr>
<td>Female softball</td>
<td>0.10 CI (0.06-0.14)</td>
<td>0.10 CI (0.01-0.19)</td>
<td>0.07/0.19</td>
<td>0.14 CI (0.12-0.16)</td>
<td>0.11</td>
<td>0.099</td>
<td>0.16</td>
</tr>
<tr>
<td>Female volleyball</td>
<td>0.02 CI (0-0.3)</td>
<td>No result</td>
<td>0.05/0.18</td>
<td>0.09 CI (0.07-0.10)</td>
<td>NA</td>
<td>0.068</td>
<td>0.06</td>
</tr>
<tr>
<td>Male wrestling</td>
<td>0.25 CI (0.24-0.29)</td>
<td>0.09 CI (0.0-0.19)</td>
<td>0.18/0.42</td>
<td>0.25 CI (0.22-0.27)</td>
<td>0.17</td>
<td>0.181</td>
<td>0.22</td>
</tr>
<tr>
<td>Male spring football</td>
<td>NA</td>
<td>NA</td>
<td>NA/NA</td>
<td>0.54 CI (0.50-0.58)</td>
<td>NA</td>
<td>0.06</td>
<td>NA</td>
</tr>
<tr>
<td>Cheerleading</td>
<td>NA</td>
<td>0.09 CI (0.02-0.17)</td>
<td>NA/NA</td>
<td>NA</td>
<td>NA</td>
<td>0.06</td>
<td>NA</td>
</tr>
<tr>
<td>Male track</td>
<td>NA</td>
<td>0.10 CI (0.0-0.25)</td>
<td>NA/NA</td>
<td>NA</td>
<td>NA</td>
<td>0.06</td>
<td>NA</td>
</tr>
<tr>
<td>Female track</td>
<td>NA</td>
<td>0.14 CI (0.0-0.43)</td>
<td>NA/NA</td>
<td>NA</td>
<td>NA</td>
<td>0.06</td>
<td>NA</td>
</tr>
<tr>
<td>Male swim/dive</td>
<td>NA</td>
<td>NA</td>
<td>NA/NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0.01</td>
</tr>
<tr>
<td>Female swim/dive</td>
<td>NA</td>
<td>NA</td>
<td>NA/NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0.02</td>
</tr>
<tr>
<td>Total concussions</td>
<td>NA</td>
<td>NA</td>
<td>NA/NA</td>
<td>NA</td>
<td>0.17 CI (0.13-0.21)</td>
<td>0.23/0.43</td>
<td>0.28 CI (0.27-0.28)</td>
</tr>
</tbody>
</table>

Athletic exposures have all been converted to per 1000 for consistency and ease of comparison. CI, confidence interval, (95% unless otherwise stated); HS, high school; NA, not applicable; NCAA, National Collegiate Athletic Association.
Vulnerabilities

Overall, the linebacker is the position most associated with frequent concussions, but variation in the literature does exist and may be explained by changes in style of play over the 10 years covered by the studies. The most frequently concussed in the NFL are quarterbacks. Delaney et al found goalies at greatest concussion risk in soccer. Most concussions occur during player-to-player contact. High-speed player-to-player impact appears to be the most likely reason for concussion in football. Most frequent impacts occur at linebacker and linemen positions.

Athletes experience 68.5% of concussions during competition and increased game risk is from 3 to 14 times higher than practice across a variety of sports and both sexes.

Football concussion was 4 times higher in contact compared with noncontact practices. Head impact examined with accelerometer telemetry demonstrated nearly 3 times more impacts in games than in practice.

Younger athletes

Despite less exposure and fewer cumulative concussions, which are established risk factors, younger athletes report higher incidence. Injury capture of HS athletes should be lower because of less medical staff coverage in HS than in college, so the data are somewhat counterintuitive.

High school athletes’ prolonged memory dysfunction recovery due to immature neuroanatomy may explain the greater frequency. Shankar et al postulate that HS players may be at greater risk because teams run more and pass less than in college and players are less skilled in tackling and blocking techniques. Immature neurological, vascular, and musculoskeletal physiology combined with less experience, training, and tackling...
Table 9  Example of reporting mechanisms of sport concussion


<table>
<thead>
<tr>
<th>Sport a</th>
<th>Activity</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football (n = 55,007) b</td>
<td>Blocking drill 2225 4.1%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>General play 1866 3.4%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kickoff coverage/return 3238 5.9%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passing play (offense/defense) 8928 16.3%</td>
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</tr>
<tr>
<td></td>
<td>Punt coverage/return 1497 2.7%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Running play (offense/defense) 30,418 55.4%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tackling drill 2833 5.2%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other 3895 7.1%</td>
<td></td>
</tr>
<tr>
<td>Wrestling (n = 5935)</td>
<td>Conditioning 608 10.2%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Escape 377 6.4%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fall 200 3.4%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Riding 153 2.6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sparring 1297 21.9%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Takedown 2526 42.6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other 774 13.0%</td>
<td></td>
</tr>
<tr>
<td>Soccer  Boys (n = 20,929) b</td>
<td>Attempting a slide tackle 959 4.6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ball handling/dribbling 0 0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blocking shot 673 3.2%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chasing loose ball 286 1.4%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Defending 780 3.7%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>General play/other 2203 10.6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Goaltending 4268 20.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heading ball 8433 40.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Receiving a slide tackle 0 0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Receiving pass 2180 10.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other 1045 5.0%</td>
<td></td>
</tr>
<tr>
<td>Soccer  Girls (n = 29,167)</td>
<td>Boys (n = 20,929) b</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>General play/other 2203 10.6%</td>
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<td>Goaltending 4268 20.5%</td>
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<td>Other 1045 5.0%</td>
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<td>Basketball Boys (n = 3823)</td>
<td>Ball handling/dribbling 399 10.4%</td>
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<td>Other 0 0%</td>
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<td>Baseball and softball Boys (n = 1991)</td>
<td>Batting 1008 50.6%</td>
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<td>Catching 171 8.6%</td>
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<td>General play 171 8.6%</td>
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<td>Other 441 22.1%</td>
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Reprint is courtesy of the *Journal of Athletic Training.*

a Because of the small sample size of concussions suffered by volleyball players, volleyball was excluded from analyses of activity involving nationally weighted data.

b Excludes injuries in which activity associated with concussion was not reported.
skill may result in more absolute force to the brain per hit and result in higher incidence.70

Alternatively, older athletes may become resistant to report injury because of scholarships, scouting, or progression to professional status. Independent and objective data capture methods at older ages may eliminate these concerns.

Return to play and concussion recurrence

The Third Zurich recommends that athletes diagnosed with concussion not return to play until free of symptoms. Specifically, adolescent athletes should have “cognitive rest” and limit exertion until asymptomatic and return to play only when completely free of symptoms.9 Recurrent concussions demonstrate longer symptom resolution time, increased time out of play, and higher likelihood of loss of consciousness than the first concussed.67

Although guidelines are in place, there is concern that missed diagnoses result in premature return to play.29,44,49,66 This may explain the higher incidence of repeat concussion in individuals with a history of a prior concussion.28,30,31,35,51,65,70

Male vs female concussions

In sex-comparable sports, female incidence is consistently higher than male,59,60,63,64,67-69 excepting lacrosse, where concussions were more frequent in males than females.54,56,64,68,69 Player contact was the cause of concussions for 72% of men but 41% of women.43 Frommer et al71 reported little difference between sexes in severity or outcome of concussions.

Female hockey players sustain fewer impacts and lower head acceleration than males.46 This suggests that frequency of impact may not be the source of greater incidence in female hockey players.

Daneshvar et al70 suggested that patterns in reporting by athletes may explain the greater incidence.

Studies have speculated that females have more concussions because of intrinsic differences between the sexes, such as height, weight, head and neck size, or strength.70,72

Protective gear

Changes to protective equipment are of uncertain benefit according to the literature. Collins et al35 reported that 5.3% of athletes wearing new helmets vs 7.6% wearing standard helmets were concussed per season, but a coauthor may have had a conflict.

Padded headgear did not reduce concussions in rugby union players.49 Universal use of headgear may cause players to develop a false sense of security, tackle harder, or cause more aggressive heading and head challenges, leading to increased risk of injury.72 In NCAA men’s and women’s lacrosse studies, concussions rose after the introduction of a new helmet in 1996-1997.41,54

Summary of findings

Surveillance research methods that allow an open cohort, a wider definition of concussion, and exposure data that are not time based may cloud accuracy and make some comparisons difficult. There appears to be a place in future research for smaller, tightly controlled studies. Growing concern about the long-term consequences of brain injury makes understanding the “true” incidence within sport subpopulations even more important. The current trend of increased attention on concussion is likely to result in higher reported incidence.

Concussion risk includes modifiable risk factors such as use of protective gear, prevention through strength training, improved education, rules modification, and changes to player position techniques. Non-modifiable risk factors include sex (female/male), age, and history of prior concussion. Concussion research to date has identified higher-risk groups such as football quarterbacks and linebackers, but management of concussion and return to play guidelines need to be universally adopted to improve concussion research and consistently train all personnel involved in sports.
Guidelines may improve by using time-based AEs coupled to real-time accelerometer helmet data. An intensity scale based upon measured impact force could be correlated to concussion and used to guide practice or drill intensity. Studies that objectively delineate the mechanisms of injury should guide rule or equipment changes for at-risk player positions, player-to-player contact sports, sex-specific conditioning, and youth. Following these modifications to sports, concussion incidence should be reassessed with the same method used before the changes.

Study of the incidence of concussion has identified this injury as a risk to athletes and resulted in changes in attitudes of players, coaches, medical support personnel, and researchers. Based upon current findings, alterations to equipment, rules, and policies are making the field of play safer for athletes; but advancements in research are sure to result in additional improvement.

Increased research representation of at-risk groups such as females and youth is needed. Continued emphasis on contact sports appears reasonable; but factors that increase risk, such as player positions, should be specifically targeted. Evaluating research methods and data reporting objectivity will likely improve incidence accuracy.

Study limitations

Motor sports and “extreme” sports such as skateboarding are likely to result in concussion, but were not represented in this study because of a lack of literature examining these groups as sport subpopulations. Search by name of all individual sports would have likely resulted in additional capture. We used only PubMed as our search engine, so it is possible that other relevant studies were not included. We frequently did not have access to raw data sets in which to verify all calculations, and rounding error may have occurred when adjusting data to conform to a standard measure of concussions (per 1000 AEs). We did not use a statistician to verify the appropriateness of reported data.

Conclusion

The studies examined in this article show that there is risk of concussion in nearly every sport. Some sports have higher concussion frequency than others, which may depend upon the forces and roles of the positions played in these sports. Younger athletes have a higher incidence of concussion, and female incidence is greater than male in many comparable sports. Headgear may reduce concussion in some sports but may also give athletes a false sense of protection.

Funding sources and conflicts of interest

No funding sources or conflicts of interest were reported for this study.

References

Epidemiology of concussion in sport


40. Benson BW, Mohtadi NG, Rose MS, Meeuwisse WH. Head and neck injuries among ice hockey players wearing full face shields vs half face shields. JAMA 1999;282(24):2328–32.


Appendix A. Search terms


SUBMITTING MANUSCRIPTS TO BIOMEDICAL JOURNALS: COMMON ERRORS AND HELPFUL SOLUTIONS

Claire Johnson, DC, MSEd,a and Bart Green, DC, MSEd,b,c,d

ABSTRACT

This article reviews common, but avoidable, errors that authors may make when submitting to a health care–focused, biomedical journal (eg, chiropractic, medicine, nursing, and physical therapy). As editors, we offer suggestions for improving the quality of manuscripts submitted to biomedical journals, provide suggestions for how to avoid making errors, and recommend effective writing and submission strategies. Common errors in the following sections are discussed: title, abstract, key words, introduction, methods, results, discussion, conclusion, acknowledgments, references, tables, figures, cover letter, format and writing, submission processes, communication with the editor, revision processes, and proof processes. This article includes a checklist that authors may use before submission and that peer reviewers may use for general critique of a manuscript. The goal of this article is to assist authors with successful manuscript submission and eventual publication. (J Manipulative Physiol Ther 2009;32:1-12)

Key Indexing Terms: Biomedical Research; Peer Review, Research; Periodicals As Topic; Writing; Publishing; Chiropractic; Manuscripts As Topic; Complementary Therapies

The dissemination of research findings is crucial to the continued growth of science. Although the submission requirements and peer review processes of indexed journals may seem to be barriers to information dissemination, authors can reduce the likelihood of delays not only by submitting high-quality papers and by following journal instructions but by avoiding common errors. A manuscript submitted to a biomedical journal that is in compliance with the journal’s instructions for authors is more likely to move smoothly through the submissions process than one that is rife with errors.

In our roles as journal editors, we have observed mistakes made by authors that heighten the barriers to acceptance. Avoiding common errors could make the submission process easier for authors, regardless of the journal to which they submit their manuscript. Our hope in writing this article is to assist you as an author in a successful submission process. This article identifies the errors that we commonly see as editors and offers solutions to both novice and seasoned authors for how to avoid them.

DISCUSSION

With proper planning and forethought, common errors in manuscripts and submission processes can be avoided. Each set of common errors listed below is followed by solutions and suggestions for preventing these problems. In this discussion, we make the assumption that the study has been completed in an ethical manner, that all scientific procedures have been performed appropriately, and that there are no fatal flaws in the research or study design.
Title

Common errors:
1. Is too long or too short
2. Does not match the article or study design
3. Includes abbreviations, jargon, or attempts to be witty at the expense of clarity
4. Inadequately describes the study

Solutions:
Article titles should provide an accurate and succinct description of the contents of the article so that the reader knows exactly what the article contains.\textsuperscript{1,2} The study design and aim should be understood from simply reading the title. Typically, the title includes key words to assist readers with finding the article. Clever or artistic titles are generally discouraged, as they are often difficult to read, are confusing, and cloud the meaning and focus of the paper.\textsuperscript{3,4}

Abstract

Common errors:
1. Exceeds the maximum number of words allowed by the journal
2. Incorrect format for the journal (eg, unstructured instead of structured)
3. Lacks enough detail to accurately summarize the article
4. Omits primary findings or highlights inconsequential findings
5. Inaccurately reflects the contents of the manuscript or findings of the study

Solutions:
Abstracts should provide the core details of the study so that the reader will know what is contained in the full paper. Although it may be challenging to present succinctly the importance and depth of your research in the word count allowed by a journal, it is largely possible to provide an appropriate summary by following the instructions for authors. These instructions usually describe the format desired, word length, and other pertinent information.\textsuperscript{5} Inasmuch as we have brought up the topic of instructions for authors, we should mention that following the journal’s instructions for authors can help you avoid errors in all parts of the manuscript. Following the instructions is recommended by many experienced authors and journal editors as essential to successful publication.\textsuperscript{4,6-8}

Abstracts help readers find your article. The information in the abstract and the title are entered into computer databases and indexing systems; and therefore, the abstract contents are essential for those conducting literature searches and performing further research.\textsuperscript{9} Therefore, you should be sure that your abstract accurately represents the contents of your manuscript. It is recommended that each section of your article is represented in the abstract and that primary reporting guidelines are followed in both the abstract and manuscript (eg, CONSORT, MOOSE, QUOROM, STARD, TREND), delineated in Table 1.

Key Words

Common errors:
1. Key words are not Medical Subject Headings (MeSH)
2. Wrong MeSH are used; terms do not match content of the paper

Solutions:
MeSH are the cataloging terms used by PubMed that help readers and researchers more easily find your article. Therefore, using the correct key words is vital.\textsuperscript{2} To identify which terms are appropriate MeSH, visit the Web site http://www.ncbi.nlm.nih.gov/sites/entrez?db=mesh and search for the MeSH that best match your study. It is important for authors to select the correct terms to identify their paper because commonly used words may have different meanings for a particular search engine. For example, searching PubMed with the term \textit{CAM} may result in articles that are about “CAM 5.2 antigen,” as opposed to “complementary and alternative medicine” or “complementary therapies.” In addition, MeSH such as \textit{Physical Therapy, Specialty and Physical Therapy Modalities} are distinctly different; so one term should not be used arbitrarily in place of the other. Selecting the appropriate key words will help more readers and researchers access your article.

Introduction

Common errors:
1. Contains material that is irrelevant to the purpose of the study
2. Does not include background information and foundational research
3. Omits or vaguely describes the purpose/hypothesis
4. Contains materials that belong in other areas (eg, methods, results, discussion of results)
5. Is unnecessarily long
6. Contains unsubstantiated statements

Solutions:
The introduction should provide the reader with a brief overview of the topic, a well-referenced and grounded rationale for the study, and the purpose (or hypothesis) for the paper.\textsuperscript{10} You should avoid interjecting personal opinions and unsubstantiated claims into this section. The introduction should include the theoretical underpinnings or models for the study, as appropriate for the research purpose or design.\textsuperscript{6} It is important to provide enough background information to provide context for the study and establish its necessity; however, you should not provide excessive background that would detract from the study or include commentary.\textsuperscript{11} Although a comprehensive review of the
literature is performed to prepare the manuscript, it is important to limit the amount of information in the introduction to what is adequate to familiarize readers with the topic. Editors recommend that introductions be short (eg, approximately 3-4 paragraphs in length). Summarily, the introductory points should be covered in a few paragraphs, including the purpose/hypothesis, which should lead the reader comfortably to the methods section of your study.

Methods Section

Common errors:

1. Does not follow current reporting or quality guidelines for study designs (eg, CONSORT, MOOSE, QUOROM, STAR, TREND)
2. Does not provide adequate information; the reader would not be able to duplicate the study

Solutions:

Methods should be written clearly. Methods should follow published study guidelines and the instructions for authors for the journal. Some journals have particular

<table>
<thead>
<tr>
<th>Guidelines acronym</th>
<th>Guideline name</th>
<th>Description</th>
<th>Web site</th>
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<tbody>
<tr>
<td>ASSERT</td>
<td>A Standard for the Scientific and Ethical Review of Trials</td>
<td>Checklist for research ethics committees to review proposals for randomized controlled clinical trials</td>
<td><a href="http://www.assert-statement.org">http://www.assert-statement.org</a></td>
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<tr>
<td>CONSORT</td>
<td>Consolidated Standards of Reporting Trials</td>
<td>A checklist for randomized controlled trials</td>
<td><a href="http://www.consort-statement.org">http://www.consort-statement.org</a></td>
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<td>PEDro Scale</td>
<td>Physiotherapy Evidence Database</td>
<td>A criteria list for quality assessment of randomized clinical trials for conducting systematic reviews</td>
<td><a href="http://www.pedro.fhs.usyd.edu.au/scale_item.html">http://www.pedro.fhs.usyd.edu.au/scale_item.html</a></td>
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<td>STARD</td>
<td>Standards for Reporting of Diagnostic Accuracy</td>
<td>Checklist for accuracy and completeness of reporting of studies of diagnostic accuracy</td>
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<tr>
<td>STARLITE</td>
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<td>Guideline for reporting of literature searches</td>
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<tr>
<td>STROBE</td>
<td>STrengthening the Reporting of Observational studies in Epidemiology</td>
<td>Checklist for observational studies (eg, cohort, case-control, and cross-sectional studies)</td>
<td><a href="http://www.strobe-statement.org">http://www.strobe-statement.org</a></td>
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<td>TREND</td>
<td>Transparent Reporting of Evaluations with Nonrandomized Designs</td>
<td>A checklist for nonrandomized trials</td>
<td><a href="http://www.ajph.org/cgi/reprint/94/3/361?ijkey=b1509dd44d955fdff94a289bd01e9cfe874878">http://www.ajph.org/cgi/reprint/94/3/361?ijkey=b1509dd44d955fdff94a289bd01e9cfe874878</a></td>
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3. Uses inappropriate statistical methods or poorly reports appropriate statistical methods
4. Lacks details of ethical approval or consent (when required)
5. Adequate details not provided (eg, manufacturer of apparatus used in the research is not reported, nor are the city and state/country of the manufacturer)
6. Fails to declare clinical trial registry in one of the many clinical trial registries available
7. Fails to report that human subjects research was reviewed by an appropriate ethics board before the initiation of the study that approval was given to publish a case report
requirements for formatting this section; most journals expect you to use the appropriate reporting format for specific studies, such as clinical trials or systematic reviews. For examples of checklists and guidelines for specific study designs, see Table 1. It is crucial that the methods provide enough detail that another team of researchers could replicate the study.

When a study involves human subjects, you must include a statement that demonstrates the research was performed in compliance with commonly required ethical principles and was approved or deemed exempt by an ethics committee/institutional review board. It is important to remember that an ethics committee determines if a study involving human subjects data is deemed exempt, not you. For case reports, a signed consent form from the patient or guardian to publish the study is required. For studies involving animals, you should state which committee on the use and care of animals approved the experimental protocol before commencement of the study. For clinical trials (recruiting patients on or after July 1, 2005), you should identify that the trial is included in a clinical trial registry.

Data safety monitoring should be reported, when applicable. Statistical analyses used to produce the results should be presented clearly. It is sound advice to consult a statistician before commencing with the research project to ensure that the appropriate analyses are used. Some suggest that a statistician should review the entire manuscript for clarity of statistical information. In addition, you should refer to the style guide on which the journal is based. For example, the AMA Manual of Style requires that you include the manufacturer information for devices and software used. Therefore, you should include this information in the methods section.

Results

Common errors:
1. Inappropriate or incomplete reporting of data or statistics
2. Redundant reporting of findings in the text, tables, and figures
3. Commentary, methods, or discussion is included in the results section
4. Contains technical jargon that focuses on the statistical function, rather than the results

Solutions:
Results should be clearly reported and stand on their own, without the need for the injection of interpretations or arguments by the author. As has been suggested by Alexandrov, "Make data presentation so clear and simple that a tired person riding late on an airplane can take your manuscript and get the message at first reading."

Findings should be reported in this location of the paper; further results should not meander into the discussion section. You should be thoughtful in selecting the best format to present your data. If data are better presented in a table or figure, this should be done; but do not redundantly report the same information in multiple places, such as text, tables, and figures. Common statistical reporting standards should be used, such as reporting confidence intervals when appropriate. The best authors are able to present data in a fashion that focuses on the meaning of the results and clearly present the results of statistical functions. A useful resource to refer to when writing the results section is How to Report Statistics in Medicine: Annotated Guidelines for Authors, Editors, and Reviewers.

Discussion

Common errors:
1. Includes material that is unrelated to the study and/or interjects irrelevant opinions
2. Contains material that is redundant to the introduction or results
3. Does not explain how the findings contribute to the larger body of evidence
4. Overinterprets findings, making them appear more or less meaningful than they actually are
5. Ignores the current body of knowledge in the area of the study
6. Does not include a section describing the limitations to the study or uses the limitations section to argue or downplay the limitations that were present

Solutions:
The discussion section helps the reader interpret the study findings and better understand how the new information supports or alters previous knowledge. Important points that emerge from the research should be elaborated upon; however, you should not digress and include irrelevant or tangential topics that do not relate to the study’s findings or purpose. In this section, you have the opportunity to point out the novelty of the study as it relates to previous research. The discussion should cogently relate the current findings with other highly relevant publications.

Usually, research endeavors unearth or inspire ideas for future studies and you should include these in the discussion. Whether included in the discussion or the conclusion, the statement “more research is necessary” is overused, virtually meaningless, and provides no thoughtful direction as to what research activities should be engaged. If more research is truly needed, the discussion section should provide insightful comments about lessons learned from the current study and what type of future research should be done.
Because no research project is perfect and all studies have limitations, this section should contain a paragraph or two that addresses the shortcomings of the study. This portion should honestly address the limitations and not contain arguments against limitations or excuses for why the results did not match the authors’ expectations.

Conclusion

Common errors:
1. Repeats content from other portions of the manuscript
2. Includes statements that are not supported by the study’s findings
3. Includes extraneous information
4. Does not succinctly communicate the primary findings of the research as it relates to the purpose of the study

Solutions:
The conclusion of a paper, whether it is a separate section or the ending paragraphs of the discussion section, should provide insightful statements about the importance and relevance of the study without generalizing beyond the study’s findings. It is not meant to replicate the abstract or other areas already mentioned in the paper. The conclusion should not interject author opinions, make unsupported claims, or give statements that go beyond the limits of the study findings. This section should be brief, perhaps 1 or 2 paragraphs, and provide clear answers and summarize how the research thesis or hypothesis presented in the introduction was addressed.

Acknowledgment

Common errors:
1. Thanking general groups of nameless people
2. Thanking people without being specific as to how they contributed to the article
3. Not obtaining signed permission to publish the name of the person or entity being listed

Solutions:
The acknowledgment section recognizes those who contributed to the article but who did not fully meet the necessary requirements to be authors. People who did not contribute directly and substantially to the manuscript should not be included in the acknowledgment section. For example, statements thanking the “clinicians who worked on this study” or “my family for being patient with me as I wrote this manuscript” are not appropriate. The acknowledgments should include a brief statement of gratitude and explanation of how the person or entity contributed. All persons or entities that are acknowledged are usually required to send a release form to the journal office that indicates they are consenting to their names being published in the acknowledgment section of your paper. Funding sources typically should not be included in the acknowledgment section but in a separate area dedicated to funding, which is usually located near the author affiliations or on the title page.

References

Common errors:
1. Improper citation style or reference format
2. Incomplete reference information
3. Using a reference inappropriately (eg, including a reference that does not accurately support the statement being made)
4. Using outdated references and/or ignoring landmark studies
5. Using too many or too few references
6. Using inappropriate references for biomedical journals (eg, Wikipedia, magazines, etc)

Solutions:
Because there are different technical styles (ie, Vancouver, American Psychological Association, etc), references should be formatted and organized as indicated in the journal instructions for authors. The most common format in biomedical and health care journals is Vancouver, although a number of public health journals use the social sciences format of the American Psychological Association.

Typically, references should be numbered in the order that they appear, including the tables. Each reference should only receive 1 number; thus, if it is used again, the original number should be reused. We highly recommend that you use a reference manager software program so that the order and numbering of manuscripts are updated automatically, per the format you prescribe, as you revise your manuscript. This is very helpful, as it negates the need to manually reorganize the references when the manuscript is undergoing revision.

References should be current, be accurate, and allow the readers to find the information if they wish to retrieve the original reference. This means that you need to provide information for a complete reference, including pages, journal name, or, if it is a text, publisher and editor information. References should come from high-quality, peer-reviewed sources, such as peer-reviewed journals.

People often ask, “How many references should I have?” Our answer is that the correct number of references is the number required to appropriately document your statements. Some journals impose limits on the number of references allowed for specific research designs, such as case reports; however, other journals do not impose a limit. A single authoritative reference for a factual statement may be adequate to support a statement; a lengthy list of references published for the sake of documenting laborious scholarship may suggest a lack of understanding of the publication process and indiscrimination. It is your responsibility as the author to accurately represent the information in the referenced article. Be sure that you have read the full article,
not just the abstract, and understand its contents before using it as a reference.

Tables
Common errors:
1. Location is not identified in the text where the table should be placed
2. Include abbreviations without a legend
3. Do not present data (e.g., are lists of items)
4. Authors do not submit appropriate permissions to republish a table that has been published previously

Solutions:
Sets of information in columns and rows that aid in visually presenting information in an appealing manner (rather than listing information as text in a paragraph) are tables. Tables should not be used for small amounts of data that could be conveyed clearly in a sentence. You should not reiterate in the text the same data that are also shown in a table because the point of creating a table is to eliminate that type of information from the text.23

Tables have a minimum of 2 rows and 2 columns and should be arranged so that horizontal rows and vertical columns of information are related to one another.24 For example, a list of differential diagnoses for a given condition or a list of exclusion criteria is a figure and not a table. Tables should be simple and self-contained, needing no further explanation. All abbreviations used in a table should be explained in a legend underneath each table.

If you wish to use previously published tables, the copyright owner of the original material must grant permission to do so; it is your responsibility to receive this permission before submitting the manuscript to a journal. The placement of each table should be clearly listed in the manuscript so that the editorial staff does not have to guess where they should be placed. To do this, type in “see Table 1” at the end of the appropriate sentence or “see Table 1” in the text; and that will help place the table in your paper.

Figures
Common errors:
1. Locations are not identified in the text where the figures should be placed
2. Figures are embedded in the manuscript file
3. Legends and picture captions are missing at the end of the text
4. Legends are built into the image as part of a software package
5. Figures are of poor quality or low dots per inch
6. Graphs have multiple colors that, once converted to gray scale for printing, look similar; and the reader cannot decipher which bar represents the corresponding data
7. Not formatted as per the journal instructions for authors
8. Contain personal protected information
9. Lack appropriate permissions for use of previously published images or model release forms

Solutions:
Figures need to be clear images submitted in an electronic format. When creating figures, identify in the text where the figure should be placed when it is time for the paper to go to layout. Number figures in the order that they appear. Each image should have a corresponding figure caption placed at the end of the manuscript. At the end of the manuscript, create a separate section identified as “figure legends”; and write a caption for each figure so that the reader will understand what you are trying to convey.

Figures should not be embedded in the manuscript file. The image should be created and saved as a separate image file (e.g., TIFF, JPEG, or the format preferred by the journal) so that the publishing company may print the best possible image for your paper. The journal’s instructions for authors will usually provide all necessary information for the size, resolution, type of image required (i.e., JPEG, TIFF, etc), and methods of transmitting the image. Because journals change their requirements for figures with advances in technology, we recommend that the most current author instructions be reviewed to avoid submitting images in an outdated format.

Because most journals and readers print in black and white, you should remember that graphs should be constructed so that, when printed in black and white, the data will be interpretable. For example, a bar graph with bars in similar tones of green, blue, and red will all appear the same shade of gray when printed in black and white. Use different tones, symbols, or patterns to distinguish one set of graph data from another. If you are not sure how an image will look, print the photograph or graph using a black and white copier/printer and then adjust your image colors so that it will be interpretable.

If authors wish to use previously published photographs or illustrations, permission must be obtained from the copyright holder of the material; it is your responsibility to receive this permission before submitting a manuscript to a journal. If models or identifiable people appear in figures, you need to submit a signed release form for each person photographed, demonstrating that each person has given permission for his or her likeness to be published in the journal. Even if a bar is placed across their eyes in the photograph, if their mother or spouse would be able to recognize them, a signed permission note needs to be submitted.

Cover Letter
Common errors:
1. Not disclosing all conflicts of interest for all authors
2. Not disclosing potential issues of concern (e.g., if some of the information has been published previously in
print or electronically, or if a portion of the material has been presented elsewhere
3. Not providing required items as stated in the instructions for authors
4. Is addressed to the wrong journal and/or editor
Solutions:
The cover letter is typically the initial communication that you have with the editor about your manuscript, and it should be written in a way that makes a good presentation of you and your research. The cover letter should briefly and accurately communicate the importance of your manuscript, how the manuscript meets the mission of the journal, any issues of potential concern, and all necessary disclosures. Relevant conflict of interests should be included in the cover letter. For example, if you are the president of the company that makes the gadget or product that you are testing, or if you or your spouse owns stock in this company or receives benefits from the company, this information should be declared to the editor and be included on the title page.

If for some reason your paper was submitted to another journal and you change your mind and wish to submit elsewhere, be sure that your paper is no longer being considered by the first journal and your copyright has been returned to you because you are not allowed to submit to 2 journals at the same time.22,25 If your paper was rejected and you are now submitting to another journal, it is important to update your cover letter in addition to the format of the manuscript. Although it may sound obvious, you should check to make sure that the date, the name of the new journal, and the name of the editor of the new journal are correct.13

Format and Writing
Common errors:
1. Authors are not familiar with the journal content or format
2. Making statements of fact without support from proper references
3. Grammar or spelling errors are not corrected before submission
4. Jargon, new words, or new acronyms are created instead of using standard accepted terminology
5. All required materials are not submitted: the submission is missing figures, tables, funding information, conflict of interest statements, copyright forms, cover letter, permission forms, etc
6. Materials are not in order or correct format (eg, the format does not follow instructions for authors)
7. Author information is incomplete (eg, contact information, degrees, institutional affiliations, etc)
8. Authorship issues are not appropriately managed
9. Electronic files are not in required format (eg, dots per inch too low for figures, use of uncommon software program)
10. Duplicating, plagiarizing, or self-plagiarizing content that has been published in another document (eg, article, book, Web site)
11. The manuscript is not proofread by someone fluent in the English language
12. The paper is submitted with multiple format errors, fonts, columns, page breaks, etc

Solutions:
Although most general errors may be avoided by following the instructions for authors, a few of these items deserve elaboration. We are surprised when we receive a paper, or are peer-reviewing a paper for another journal, where it is obvious that the author has never consciously read an article published in that particular journal. In these cases, the topic, style, and content do not seem to meet the mission of the journal. Please avoid this mistake, as it reflects badly upon you as an author. Reviewing several recent issues of the journal, in addition to reading the mission and instructions for authors, will assist you with becoming more familiar with the journal. The submission should be able to meet the mission of the journal; your paper should be similar in aim and context to other articles in the journal and be formatted as such.

That being said, please do not take this advice too far and format your paper as if you were the publisher. We have received manuscripts formatted by authors as if the paper was already published and printed, complete with fonts, section breaks, column settings, figure placement, etc, that exactly match the printed version of the journal. Unfortunately, we must send those manuscripts back to authors so that they may be formatted in plain, old, and boring standard double line–spaced manuscript format, just as it clearly states in the instructions for authors.

Regarding authorship, each person who is listed as an author must meet the criteria necessary to be designated as an author as defined by the International Committee of Medical Journal Editors.22 This includes that each author has22: “(1) provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; (2) drafting the article or revising it critically for important intellectual content; and (3) final approval of the version to be published.” As well, all authors who qualify and should be listed as authors should be included as authors.26 Authors typically may not be added or removed, and their order may not be changed, once the paper has been submitted to a journal without consent from each person involved. All authorship issues should be managed appropriately before submission.

English is the language for scholarly journals.27,28 If you do not write often or are not fluent in writing in English, it may be worth the time and money to have your manuscript edited by a proficient English proofreader. Even experienced authors benefit from having a fresh pair of eyes look over their manuscripts, and many experienced authors will enlist the specialized skill of a medical writer/
Submission Process

Common errors:
1. Not following the journal’s submissions instructions
2. Submitting a revision as if it were a new paper
3. Not submitting all required materials

Solutions:
Each journal has its own submissions process, so it is in your best interest to familiarize yourself with this process before submission. Usually, the instructions for authors and the journal’s Web site provide this information. Many journals have online tutorials for their electronic submissions processes; so you may wish to take a few minutes and run through the tutorial, which should help speed up the submissions process for you. Even if you have submitted to a particular journal in the past, you may not have the most updated materials because electronic processes are updated regularly. Therefore, it behooves you to review the procedures just before submitting to make sure that you have the most current versions. Some authors may not be aware that, for some journals, each new submission is logged with a new code number that carries with it an accompanying cost to the journal. Therefore, if an author submits a revision as if it were a new submission, it wastes journal resources and does not reflect well on the author.

Please be sure to submit all required materials at the time of initial submission. Some journals require that the copyright form, disclosure forms, and other materials are submitted at the time of the initial manuscript submission. It wastes time for the editor and editorial staff to identify and track down missing items. This slows down the processing of your manuscript. Be sure to use the most current forms and format for submission (eg, do not use an older version that you have stored on your computer), as the journal will most likely require the updated version. It may only take a few minutes to check and make sure that you have all the updated forms and are meeting the updated version of the journal’s instructions for authors. This is time well spent because, when your submission is not in compliance with the journal policies, it will delay your paper from moving forward in the review process.

Communications With the Editor

Common errors:
1. Nonauthors communicate with the editor about a submission
2. Not including manuscript title and identifier when querying editorial staff
3. Having a demanding, arrogant, or rude manner in your communications

Solutions:
Carefully select the corresponding author. This person must qualify as an author and should be responsible for all follow-up and other communications with the editor and editorial staff. Editors do not typically communicate with nonauthors because of blinding and other confidentiality issues surrounding submission content. Therefore, authors should not ask their nonauthor staff to query the editor; only authors should communicate directly with the editor. When communicating about a manuscript, be sure to include identifying information, such as the manuscript, number, and title. Most journals have hundreds to thousands of articles in process at any given point, and some authors have more than one manuscript in process at the same journal. Therefore, it is helpful for the editor to know which manuscript you may be asking about. Editors and their staff are usually eager to help you; so if you are polite when communicating with them, you are likely to find that they will be polite back to you.

Revision Process

Common errors:
1. Ignoring or not adequately addressing all of the reviewer comments and editor requests
2. Arguing with the reviewer comments instead of making improvements to the manuscript
3. Not returning a revision by the requested due date
4. Ignoring editor requests for materials or changes
5. Sending multiple e-mails and/or making multiple calls to the editor demanding a decision on your manuscript

Solutions:
Revisions should be addressed and returned to the journal in a timely manner (eg, typically 30 days after revision request). Often, we hear authors complain they would like the manuscript processing time to be faster; however, these are often the very same authors who are extremely tardy in returning their revisions, often delaying the forward movement of their manuscript for many months because they do not return their revisions on time.
or follow the instructions for authors. If you have questions about what is being requested for your revision, such as if there are conflicting comments between peer reviewers, you should contact the editor for further guidance and clarification. Editors generally appreciate nonjudgmental process-driven queries.

All reviewers’ comments should be addressed, either as a modification in the manuscript or as a polite and thoughtful response that explains the rationale for why the requested change was not made. On the other hand, it is quite irritating for an editor to receive a revision letter from an author that states, “We revised our paper and made all the requested changes.” Without the appropriate list of details that were requested in the revision letter, it is sometimes uncertain if this is, indeed, a true statement. It is your responsibility to clearly show how the revision changes were made and that each of the reviewer and editor comments has been responded to and/ or addressed.

There is an art to addressing reviewers’ concerns, and we suggest that you write your revisions in a polite point-by-point format so that the reviewers can readily identify that you did your job well. This will help speed up the processing time for the review of your revised manuscript. Authors can copy and paste reviewers’ comments into a word processing document and then address each one of the comments in their revision reply to the reviewers. Here is a suggested format:

Reviewer 1 comment: “The paper starts out well, however the specific hypothesis being tested is never clearly revealed to the reader.”

Response (from author): We thank the reviewer for pointing this out and have added a specific hypothesis statement to the end of the introduction section. It now reads: “The purpose of this study is to evaluate the effects of manipulation of the spine on older adult patients’ attitudes and pain response.” Please see yellow highlights in manuscript for additional clarifications to the hypothesis in the introduction section.

If you think that a reviewer has made a mistake, politely offer a correction and substantiate your reply. If you think that a reviewer has misread or misunderstood a portion of your paper, it is possible that your paper is not written as clearly as it could be. The revision process is an excellent opportunity to clarify your paper (instead of arguing with the reviewer) because the clarification will ultimately make your final paper better once it is published. It is unproductive to reply to reviewers in a sarcastic, rude, or argumentative manner, as this accomplishes nothing more than angering the reviewers and places the editor in the uncomfortable position of asking you to either correct such commentary or face unnecessary criticism from reviewers when your commentary is forwarded on to them. After all, it is the editor and reviewers who wish to see the best possible articles published in the journal; and they will determine if your paper will be accepted for publication. Keep your communications thorough and polite, and it will enhance your chances for acceptance.

Proof Review Process

Common errors:
1. Ignoring or not addressing queries from the editor or publisher
2. Not returning proof responses and corrections on time
3. Changing corrections into errors or inserting new errors
4. Making substantial changes, revisions, or additions
5. Missing errors and expecting corrections to be made once the paper has already gone to press

Solutions:
Proofs are the publisher’s nearly final draft of your manuscript. As well, the proof stage is the prelude to celebration; this is the last step before your paper is published in its final form. Reviewing the proofs is your opportunity to correct any final minor errors that either were present in the accepted manuscript (your mistake) or were inadvertently introduced during copy editing (the mistake of the editors or publishing team as they were preparing your manuscript for press). Unfortunately, sometimes during the copy editing process, corrections are made, despite all good intentions, that may alter the meaning of your original intention. It is important that you understand that edits are made in an attempt to assist with the clarity and accuracy of the final paper and to conform to journal style and publication standards, and are not meant to harm the paper or you in any way. We are a team; please be polite in requesting corrections. Everyone wants to see an excellent end product. Please treat the editorial staff with the respect that they deserve as you request corrections to the proof.

You should be familiar with the basic standards and style of the journal and should not introduce errors into the manuscript during the proof stage. For example, if the journal abides by the AMA Manual of Style, it would be inappropriate to request changes outside of this style. Another error that we commonly see is that some authors think that the proof stage is an opportunity to make major revisions or additions. This is not the case: only minor changes, such as spelling, punctuation, checking the order of tables and figures, and ensuring that figures are set appropriately (eg, not upside down), may be made at this time. Unacceptable changes include adding new figures, tables, content, or paragraphs; adding or deleting an author; adding new information that would require additional permissions (eg, new photos, acknowledgments, tables); or anything that would make a major change in the layout or content of the paper. Major changes made by the author at the proof stage are not allowed, unless it is at the request of the editor or done with the approval of the editor in advance. You should know that requesting a major change is not something that most editors are fond of or condone. Because of author requests for major changes, we have seen several papers that had to be resubmitted and go through peer review again because of extensive author modification requests at the proof stage. Although we
understand that sometimes substantial changes may be necessary at this late stage, often these can be avoided if the initial manuscript was developed properly.

All sections of the article proof must be reviewed by the authors. It is your responsibility to review the proof to make sure that all items are correct and to answer any queries that the layout staff has included with the proof. If you miss an error and the paper goes to final press, there is no way that a correction can be made to the final published copy because it has already been published. Therefore, it is your full responsibility to review the entire content and not just answer the queries. Because of journal publication schedules, it is important for you to return proof queries and corrections quickly, often within 48 hours of receipt of the proofs. If you will be out of town at this time, it is important to have a coauthor prepared to review the proof for corrections and reply to all queries.

**Conclusion**

We hope that this article will help you as an author with improving and streamlining your manuscript submission processes. Appendix A provides a checklist of the above items, which may be helpful to you as an author preparing a manuscript for submission to a biomedical journal or if you happen to be peer reviewing an article for a journal.

We admit that this is not an all-inclusive list and that some journals have different requirements and expectations. However, many editors with whom we have communicated have shared similar requests. If we must put one item at the top of our wish list when it comes to publications, it is a request for you to please read the most current instructions for authors. The instructions for authors will typically answer most, if not all, of your questions that relate to the submissions process. The second item on our wish list is that, if you still have a question after reading the most current version of the instructions for authors, please contact us so that we may assist you.

As an author, you wish to publish your material to disseminate your research findings. As editors, we act as keepers of the quality of the material published in our journals; but we are also here to help you publish your paper in its best form and in the fastest manner possible. We are pleased, and sometimes become a little giddy, when we receive a well-delivered, properly formatted manuscript. We hope that this article will assist you with the successful publication of your future papers.

**References**

5. Pierson DJ. The top 10 reasons why manuscripts are not accepted for publication. Respir Care 2004;49:1246-52.
28. Thompason A. How to write an English medical manuscript that will be published and have impact. Surg Today 2006;56:407-9.
**APPENDIX A. PRESUBMISSION CHECKLIST.** THE MORE “YES” BOXES THAT YOU HAVE CHECKED MEANS THAT YOU HAVE AVOIDED MAKING COMMON ERRORS AND YOUR SUBMISSIONS PROCESS WILL TEND TO BE MORE SUCCESSFUL.

<table>
<thead>
<tr>
<th>Section</th>
<th>Criteria</th>
<th>Yes</th>
<th>No</th>
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<tr>
<td>Title</td>
<td>Is the title the appropriate length?</td>
<td>☐</td>
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<tr>
<td></td>
<td>Does the title match the article and study design?</td>
<td>☐</td>
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<tr>
<td></td>
<td>Does the title avoid abbreviations, jargon, or “witty” comments?</td>
<td>☐</td>
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<td></td>
<td>Does the title adequately describe the study? Can it “stand alone”?</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>Abstract</td>
<td>Does the abstract meet the word length required by the journal?</td>
<td>☐</td>
<td>☐</td>
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<td></td>
<td>Is the abstract format correct for the journal (eg, structured)?</td>
<td>☐</td>
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<td></td>
<td>Does the abstract provide enough detail to accurately summarize the article?</td>
<td>☐</td>
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<td></td>
<td>Does the abstract contain primary findings of the paper?</td>
<td>☐</td>
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<td></td>
<td>Does the abstract adequately reflect the contents of the manuscript?</td>
<td>☐</td>
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<tr>
<td>Key words</td>
<td>Can all key words be found in the MeSH list?</td>
<td>☐</td>
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<td></td>
<td>Are key words correct for the contents of the paper?</td>
<td>☐</td>
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<tr>
<td>Introduction</td>
<td>Does the introduction only contain material that is relevant to the purpose of the study?</td>
<td>☐</td>
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<td></td>
<td>Does the introduction include background information and references to foundational research?</td>
<td>☐</td>
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<td>Does the introduction include a clear purpose/hypothesis?</td>
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<td>Does the introduction avoid materials that belong in other areas (eg, methods, results)?</td>
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<td>Is the introduction brief and to the point?</td>
<td>☐</td>
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<td>Does the introduction contain referenced statements of fact?</td>
<td>☐</td>
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<tr>
<td>Methods section</td>
<td>Does the methods section follow established guidelines for study designs?</td>
<td>☐</td>
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<td></td>
<td>Does the methods section provide adequate information so one would be able to duplicate the study?</td>
<td>☐</td>
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<td>Does the methods section use appropriate statistical methods?</td>
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<td>Does the methods section provide details of ethical approval and/or consent?</td>
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<td>Does the methods section provide adequate details (eg, apparatus and manufacturer information)?</td>
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<td>Does the methods section report clinical trial registry (for clinical trials)?</td>
<td>☐</td>
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<td>Does the methods section state the appropriate ethics board or case consent information?</td>
<td>☐</td>
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<tr>
<td>Results</td>
<td>Do the results report appropriate and complete data or statistics?</td>
<td>☐</td>
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<td></td>
<td>Do the results avoid redundant reporting of findings in the text, tables, and figures?</td>
<td>☐</td>
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<td></td>
<td>Do the results only contain the results and avoid commentary or discussion?</td>
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<td>Do the results focus on the results and avoid technical jargon or descriptions of statistical tests?</td>
<td>☐</td>
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<tr>
<td>Discussion</td>
<td>Does the discussion focus on material that is relevant to the study and avoid irrelevant opinions?</td>
<td>☐</td>
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<td></td>
<td>Does the discussion avoid material that is already contained in the introduction, methods, or results?</td>
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<td>Does the discussion explain how the findings contribute to the larger body of evidence?</td>
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<td>Does the discussion appropriately interpret findings, not making them more or less meaningful?</td>
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<td>Does the discussion address the current body of knowledge in the area of the study?</td>
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<td>Does the discussion include a section describing the limitations to the study?</td>
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<tr>
<td>Conclusion</td>
<td>Does the conclusion avoid repeating content from other portions of the manuscript?</td>
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<td>Does the conclusion include statements that are only supported by the study’s findings?</td>
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<td>Does the conclusion only include pertinent information?</td>
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<td>Does the conclusion succinctly summarize the primary findings?</td>
<td>☐</td>
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<tr>
<td>Acknowledgment</td>
<td>Do the acknowledgments clearly thank specific people?</td>
<td>☐</td>
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<td></td>
<td>Do the acknowledgments specifically state how those people contributed to the article?</td>
<td>☐</td>
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<tr>
<td></td>
<td>Did the author obtain signed permissions to publish the name of the person or entity being thanked?</td>
<td>☐</td>
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<tr>
<td>References</td>
<td>Are all references in the proper citation style or reference format?</td>
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<td>Are all references complete?</td>
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<td>Are all references accurately used?</td>
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<td>Are references current and landmark studies included?</td>
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<td>Is the correct number of references used (not too many or too few)?</td>
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<td></td>
<td>Are all references appropriate for biomedical journals (eg, avoid using Wikipedia, magazines, etc)?</td>
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## Appendix A. (continued)

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<td>Are all abbreviations used in the table included in a legend?</td>
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<td>Does the table provide appropriate contents and data?</td>
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<td>If from a copyrighted source, did you obtain the appropriate permissions to republish it?</td>
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<td>Are figures submitted as separate image files and not embedded in the text?</td>
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<td>Are legends and picture captions included at the end of the text?</td>
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<td>Are legends listed separately and not built in to the image?</td>
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<td>Are images high quality and have the resolution that is required by the journal?</td>
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<td>Do graph bars have appropriate tones so that they are discernible when printed in black and white?</td>
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MANIPULATIVE THERAPY AND REHABILITATION FOR RECURRENT ANKLE SPRAIN WITH FUNCTIONAL INSTABILITY: A SHORT-TERM, ASSESSOR-BLIND, PARALLEL-GROUP RANDOMIZED TRIAL

Danella Lubbe, MTech(Chiro), Ekta Lakhani, MTech(Chiro), James W. Brantingham, DC, PhD, Gregory F. Parkin-Smith, MTech(Chiro), MBBS, MSc, DrHC, Tammy K. Cassa, DC, Gary A. Globe, PhD, MBA, and Charmaine Korporaal, MTech(Chiro)

ABSTRACT

Objective: The purpose of this study was to compare manipulative therapy (MT) plus rehabilitation to rehabilitation alone for recurrent ankle sprain with functional instability (RASFI) to determine short-term outcomes.

Methods: This was an assessor-blind, parallel-group randomized comparative trial. Thirty-three eligible participants with RASFI were randomly allocated to receive rehabilitation alone or chiropractic MT plus rehabilitation. All participants undertook a daily rehabilitation program over the course of the 4-week treatment period. The participants receiving MT had 6 treatments over the same treatment period. The primary outcome measures were the Foot and Ankle Disability Index and the visual analogue pain scale, with the secondary outcome measure being joint motion palpation. Data were collected at baseline and during week 5. Missing scores were replaced using a multiple imputation method. Statistical analysis of the data composed of repeated-measures analysis of variance.

Results: Between-group analysis demonstrated a difference in scores at the final consultation for the visual analogue scale and frequency of joint motion restrictions (P ≤ .006) but not for the Foot and Ankle Disability Index (P = .26).

Conclusions: This study showed that the patients with RASFI who received chiropractic MT plus rehabilitation showed significant short-term reduction in pain and the number of joint restrictions in the short-term but not disability when compared with rehabilitation alone. (J Manipulative Physiol Ther 2015;38:22-34)

Key Indexing Terms: Ankle Injuries; Musculoskeletal Manipulations; Rehabilitation

Recurrent ankle sprain with functional instability (RASFI) is a common ankle disorder, with more than 40% of inversion sprain injuries progressing beyond RASFI to chronic ankle instability (CAI). Because approximately 85% of all ankle injuries are from forced inversion and plantarflexion, RASFI would therefore account for a significant portion of all ankle injuries.
States, it is estimated that, for up to 23,000 individuals and athletes per day, it is the most common site of injury in 24 of 70 sports that have been examined. Inversion ankle sprain is one of the most common injuries in sport, making up for 10% to 30% of all sports injuries and is high in court games such as volleyball, handball, and basketball and/or in contact team sports, such as rugby, American football, and soccer. Inversion sprain is a cause of a significant absence from sport, with a high rate of recurrent sprain or persistent symptoms in athletes on their return. Such injury is estimated to account for 15% of all athletic injuries, and in an incidence rate estimated to be 2.15 per 1000 person years, up to 72% of all athletes will sustain chronic or long-term ankle signs and symptoms (lasting up to and >18 months).

Commonly injury occurs first to the anterior talofibular, then calcaneofibular, and, finally, the posterior talofibular ligaments with an associated increase in severity, chronic pain, altered gait, and significant loss of dorsiflexion. These features of RASFI, including restricted ankle dorsiflexion range of motion due reputedly to loss of anterior-to-posterior talar glide with, associated intermittent pain and prevent locking of the mortise joint into full dorsiflexion leaving the ankle slightly plantarflexed and inherently less stable with a predisposition to further periodic “giving way” and recurrent sprain.

The mechanical injury thought responsible for RASFI is a tear predominantly in the anterior talofibular or more severely the full, lateral collateral ligament, which often manifests as “functional” instability (ie, instability brought out only in significantly stressful activities of the ankle in sports or other activities) and not easily detectable mechanical instability (ie, by simple testing with the anterior drawer test). Loss of ankle dorsiflexion and posterior glide of the talus with a concomitant slight plantarflexion appears to lead to an associated loss of neuromuscular control (proprioceptive and muscular) and is associated with even lesser grades of ligamentous injury (grades I-II), even if no mechanically detectable instability is apparent. The definition of RASFI used in this article is drawn from work that describes this disorder as the same ankle, sprained on at least 2 occasions, with associated feelings of instability, or reports of it “giving way” with continued pain and impaired proprioception, neuromuscular balance, and control—and becoming a recurrent and chronic problem.

In participants with RASFI, preventing chronic pain, avoiding the development of mechanical instability, and reducing the chance of repeated injury is a goal, particularly in athletes where a return to sport or optimal performance is a priority. A combination of early proprioceptive and strength training is advocated after inversion sprain to reduce the symptoms of RASFI and avoid progression to CAI. For example, local muscle strengthening is considered essential in regaining full functionality and to reduce the risk of resprain. Consequently, trials have demonstrated significant improvement in functional stability and ankle range of motion scores after primarily proprioceptive and secondarily traditional ankle strength training. Joint mobilization and manipulation of the foot/ankle joints are emerging as promising treatments for ankle sprain and often form part of a package of care in clinical practice, as an adjunct to rehabilitation. However, it is unclear if the addition of manipulative therapy (MT) to rehabilitation will show a benefit over rehabilitation alone in terms of pain and disability. Therefore, the purpose of this trial was to compare rehabilitation alone vs an MT plus a rehabilitation protocol in the treatment of RASFI.

METHODS

Background of Study Design and Changes to the Methods

This study was initially set out to test MT for CAI, designed as a single-center, assessor-blind, parallel-group clinical trial with balanced randomization and 1- and 3-month follow-up. However, as the project evolved, it emerged that the full criteria for CAI were not being achieved based on an apparent growing consensus in published definitions. In particular, the mechanical instability encountered; and the just then growing consensus on “chronicity” to reflect 6 months, within the diagnosis of CAI, was not being reflected in this trial’s sample. There was not a clear and detectable positive test for tear of the anterior talofibular ligament greater than 4° on anterior draw test nor a clear and detectable positive inversion talar tilt test with all participants included as some suggest must be included in CAI due to mechanical instability, instead functional ankle instability was confirmed in all subjects. Thus, the narrative diagnosis for included participants was adjusted to represent RASFI rather than CAI including definitions of “chronicity” at the time of protocol development and later and current consensus and definitions of “chronicity.” However, at the time this protocol was developed significant disagreements as to what constituted mechanical or functional CAI, chronicity and to other ankle diagnoses were extant as clearly explicated in the work of a number of authors. Chronic ankle instability due to functional instability may include subjective complaint of ankle weakness, pain and/or swelling, and a perception of less functionality and range of motion than the opposite normal ankle but not necessarily exceeding normal physiologic limits yet experienced as beyond voluntary control with perceived or actual giving way of the ankle or both. This study was also intended as a fully powered trial with medium-term follow-up; but due to internal financial restrictions and resources, which developed during the course of the project,
Fig 1. Patient interview and examination occurred at the first consultation.

the researchers had to settle for short-term outcomes with the minimum required sample size.

Setting and Participants
This study was implemented at the Durban University outpatient teaching clinic. Participants were recruited to the study by advertisements on campus, local radio, and in the local newspapers. Potential study candidates with ankle pain who were seeking care contacted the primary researcher. The primary researcher screened each potential participant by telephone or in person for eligibility, the screening criteria being (a) history of inversion sprains, (b) mortise joint tenderness/pain, and (c) had not injured or sprained their affected ankle in the last 6 weeks. Potentially eligible participants meeting the screening criteria then made an appointment with the primary researcher and underwent a thorough assessment and examination (Fig 1), with those participants meeting the study’s inclusion criteria being given an information sheet and invited to participate. Eligible participants who volunteered were then consented, in writing, and randomly allocated (1:1) to one of the treatment groups.

Over the 3-month recruitment period, from August to November 2010, 52 potential participants were screened and assessed after responding to the project’s advertisements; 33 were eligible for the study and consented to participate. Eighteen participants were randomized to group 1 (rehabilitation alone), and 15 participants were randomized to group 2 (MT plus rehabilitation).

Selection Criteria
Participant inclusion criteria were a diagnosis of RASFI; subjects between ages of 18 and 45 years with the upper limit of 45 years so to exclude participants with possible degenerative change in the ankle/foot; baseline scores within specific ranges; visual analogue scale (VAS) pain score of between 20 and 70 mm; and Foot and Ankle Disability Index (FADI) scores of between 50 and 90 points; restricted joint motion on palpation of the affected foot/ankle; and if an eligible patient was taking analgesic, antiinflammatory, or muscle relaxant medication, they were required to undergo a wash-out period of 3 days. 18

The definition of RASFI is drawn from those proposed by a number of authors, with a view to generate a set of explicit inclusion criteria (that excluded mechanical ankle instability as found with CAI). 11,19-29 Thus, the definition of RASFI for this trial was where the same ankle is sprained on at least 2 occasions, is associated with a feeling of instability of the ankle, the experience of “giving way” of the ankle, and a problem that is chronic and months in duration. 20-29 This definition corresponds with the classification of RASFI characterized by (a) a history of ankle sprain with pain and/or limping for more than 1 day; (b) chronic subjective weakness, pain, and/or a feeling of instability attributed to the initial injury; and (c) “giving way” in the last 6 months. 30,31 Inclusion and exclusion criteria are listed in Figure 2.

Interventions

Group 1: Rehabilitation Alone. The rehabilitation in this trial was based on the recommendations from a number of recently published studies. 31-33 Various rehabilitation regimes for ankle sprains exist, with trials showing success with balance boards, coordination training exercises, and strength training. 31,34 Exercise has been emphasized in published trials focusing on peroneal muscle conditioning because insufficient strength in this muscle group has been associated with progression of RASFI to CAI and recurrent injury. 35 Strengthening should start with isometric exercises, progressing to dynamic resistive exercise using surgical tubing or resistance bands. 32 Once the patient achieves pain free weight bearing, which may indeed be at the onset of rehabilitation, proprioceptive training is initiated for the recovery of balance and control. 36 The simplest device that has been tested in trials for proprioceptive training is the wobble board or similar device. 37 The rehabilitation protocol consisted of both peroneal muscle strengthening and proprioceptive training. Peroneal muscle strengthening was performed using a wide elastic band of known resistance, typically used for strengthening after injury. 23 The participant would wrap one end of the elastic band around the inside of the affected foot and the
The inclusion criteria for RASFI were:

a. With/out mild to moderate (grades I or II) localized bruising (contusion) over the area of inversion sprain;
b. With/out mild to moderate localized swelling over the area of injury;
c. Tenderness or pain of the area of injury;
d. Recurrent subjective feeling of giving way of the ankle;
e. A history of recurrent sprains;
f. No or minimal varus laxity of the mortise joint (determined by the assessing clinician on examination with a theoretical guide of talar tilt less than –5 degrees beyond the opposite normal);21,33,34 and
g. No or minimal anterior drawer sign (determined by the assessing clinician on examination with a theoretical guide of less than –5mm).21,33-35

The exclusion criteria were:

a. Full, pain-free range of motion of the ankle without joint restriction(s); or
b. Significant, gross ligamentous laxity (varus and anterior drawer) of the affected ankle (determined by the assessing clinician on examination with a theoretical guide of ≥5mm anterior drawer and/or ≥5mm degrees talar tilt beyond the opposite normal); or
c. Acute injury or acute re-injury of the affected ankle 6 weeks prior to or during the study (as acute injury superimposed on RASFI would likely alter the outcome).21,33,34

d. General exclusion criteria included significant balance disorders or neurological disease unrelated to the affected ankle joint and contraindications to manipulative or rehabilitation therapy (such as connective tissue disorders or peripheral vascular disease).

Fig 2. Inclusion and exclusion criteria.

other end to a sturdy object, like a table, perpendicular to the leg. Holding the affected leg straight and with the heel on the floor, the participant would then evert the foot, that is, rotate the foot up and outward against the elastic band on the floor, the participant would then evert the foot, that is, rotate the foot up and outward against the elastic band (determined by the assessing clinician on examination with a theoretical guide of less than –5mm).21,33-35

d. General exclusion criteria included significant balance disorders or neurological disease unrelated to the affected ankle joint and contraindications to manipulative or rehabilitation therapy (such as connective tissue disorders or peripheral vascular disease).

The treating chiropractic clinician could then freely choose an MT technique to address the identified joint restrictions. This usually included high-velocity low-amplitude grade V manipulation, occasionally with a grade IV mobilization 2 to 5 times before delivery of a grade V manipulation. If there was a concern regarding the amplitude of the manipulation (pain or intolerance) then, 2 to 5 grade III mobilizations were applied before a grade IV mobilization with gentle thrust (instead of a full grade V manipulation). Manipulation techniques used the high-velocity low-amplitude grade V–type manipulation that
Outcome Measures

The FADI and the VAS for pain were the primary outcome measures, whereas joint motion palpation was the secondary outcome measure.

The FADI is a region-specific participant self-report of function related to daily living, with a 26-item questionnaire that contains 4 pain-related items, 22 activity-related items, and (www.orthopaedicscores.com). Each question is scored on a 5-point Likert scale (0-4), with a total possible best score of 104 points. The total score is then transformed into percentage to give an indication of the degree of disability—the higher the score, the better the ankle function. Of the many foot/ankle measurement instruments, the FADI has been used extensively in clinical trials and has demonstrated satisfactory sensitivity and reliability for ankle sprain injuries. Specifically, it has been demonstrated as reliable over 1-week and 6-weeks for CAI, whereas in a systematic review, the FADI score was identified as 1 of 2 appropriate outcome measurers for chronic ankle instability. The FADI has been used in many clinical trials and often encountered as an outcome measure for ankle injury with a generally reported approximated minimally clinically important difference of 8 points.

The VAS is a 100-mm scale, where 0 represents no pain, and 100 represents the worst imaginable pain. Visual analogue scale has been used in many clinical trials and often encountered as an outcome measure for ankle injury with a generally reported approximated minimally clinically important difference of 20 to 30mm.

Joint motion palpation was used to determine the presence of joint restriction. The function of joint motion palpation was to examine the range of motion within a specific joint along all axes of motion, be it before or after treatment, with a view to detect joint motion restrictions. Although the validity and reliability of joint motion palpation are debated, it is commonly encountered in clinical practice and would provide supplementary data that may have clinical relevance as a secondary outcome. A blind assessor (an experienced chiropractic clinician) palpated each participant foot/ankle and recorded the findings. The findings were then used to inform the selection of manipulative treatment/techniques used by the treating clinician.

Sample Size Estimation

One author has indicated that a clinically meaningful FADI effect size index in ankle injury studies is 0.5 and another on CAI. The authors decided on a more conservative effect size of 0.3 to offer a power of more than 80%. Using G*Power software (www.psych.uniduesseldorf.de; Heinrich-Heine-Universität, Düsseldorf, Germany) for repeated-measures analysis of variance (F test, 2 tailed, \( \alpha = .05 \) and \( 1-\beta = 0.80 \)) for within-between interaction effects, the total sample size calculated was 34, with a needed sample of 40 when accounting for 20% dropout. However, a minimum sample size of 30 to 34 would be satisfactory (15 per group) to achieve the primary end points. This sample size estimation used a generic process with a view to offer a sample size large enough from which to draw insight regarding the short-term outcomes only because this trial was hampered by practical and financial constraints.

Randomization and Data Management

Computer-generated random numbers, randomization, and tabulation of participant allocation were done before commencement of the study by the independent statistician. The randomization sequence was generated by IBM SPSS 20.0 statistical software (SPSS Inc, Chicago, IL) with a 1:1 allocation. The tabulated allocation of participants that were kept in a folder was kept by an independent clinic manager, concealed from clinicians or assessors, who identified the group to which participants were allocated, after each eligible participant was consented. Whereas participants and clinicians allocated to the treatment groups were aware of the allocation, the outcome assessors (data collection) and the researcher responsible for data analysis were blinded to the allocation.

This study used 2 clinical assistants who were blind to the treatment received by participants—1 assistant palpated the participants’ foot/ankle joints to determine the joints to be manipulated, and the second assistant collected the data using the stated outcome measures. The reason for having blind assessors was (a) that an experienced clinician would potentially have greater ability in detecting and defining joint restrictions through motion palpation, and (b) blinding would reduce the potential for assessment and treatment bias.

The primary researcher performed the initial patient assessment/examination and administered the treatment but
was masked from data collection. The role of the primary researchers was to screen potential patients, assess potential patients for eligibility, deliver treatment to study patients, and to write up the initial draft of the study article. The assistants and the primary researcher were instructed not to discuss the study participants or to share data. The blinding process only allowed the clinic manager access to patient allocation, thus facilitating blinding of those who collected data.

Data Analysis

Intention-to-treat analysis was performed using a software package by replacing missing data using a multiple imputations method (WinMICE prototype version 0.1; TNO Quality of Life, Leiden, The Netherlands). The calculations were performed using a multilevel regression model that created 5 multilevel imputations. The mean of the 5 imputed values were then used to replace missing scores, and the data were then analyzed using standard statistical tests.

This study represents a within-subject design amendable to repeated-measures analysis of variance. The data were tested for within-subject effects, between-subject effects, and interaction effects, using 2-tailed tests at 95% confidence level ($\alpha = .05$) using Medcalc software (MedCalc Software bvba, Ostend, Belgium). The within-subject factor was time with 2 levels, and the between-subject factor was treatment group (rehabilitation plus MT and rehabilitation alone, respectively). The 2 levels were the measurement (data collection) time-points of baseline and final consultation (after 6 treatments and/or approximately equal to 35 rehabilitation sessions, during week 6). (www.medcalc.org).

RESULTS

Patient Characteristics and Baseline Data

Participant recruitment and flow are represented in Figure 3. Three participants dropped out of the study due to nonclinical reasons. In total, 9% of the data was missing (36/396 scores) across all data sets (28/216 scores in group 1 and 8/180 scores in the group 2), which were replaced using the multiple imputation method described previously. Examination of the descriptive and patient characteristics

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**Fig 3.** Flow diagram of participant recruitment and retention (consolidated standards in reporting trials [CONSORT] diagram).
suggests that the 2 groups were similar at baseline and that the average participant was a young adult of healthy weight who had experienced chronic symptoms and had repeatedly injured his/her ankle (Table 1).

**Table 1. Sample Characteristics—Descriptive Statistics and Group Comparison**

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<th>Variable</th>
<th>Experimental Group (MT + Rehabilitation)</th>
<th>Comparison Group (Standard Rehabilitation Only)</th>
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<td>n</td>
<td>15</td>
<td>18</td>
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<tr>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
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<tr>
<td>95% CI</td>
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<tr>
<td>Age (y)</td>
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<td>23-29</td>
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<td>Sex (frequency)</td>
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<tr>
<td></td>
<td>Female 7</td>
<td>Female 7</td>
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<tr>
<td>BMI</td>
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<td></td>
<td>23-27</td>
<td>22-27</td>
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<tr>
<td>Duration of symptoms (d)</td>
<td>260 (218)</td>
<td>310 (314)</td>
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<td></td>
<td>139-381</td>
<td>136-484</td>
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<tr>
<td>No. of sprains of same ankle</td>
<td>4 (1.1)</td>
<td>6 (2.5)</td>
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<td></td>
<td>4-5</td>
<td>6-7</td>
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<tr>
<td>No. of rehabilitation sessions performed (of 35 possible sessions)</td>
<td>31 (3.2)</td>
<td>29 (3.2)</td>
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<td>30-33</td>
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**Table 2. Comparison of FADI Data of the 2 Treatment Groups**

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<td>Cubic (P value &lt; .0001)</td>
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| Within-Subject Effects          | A × B P value = .46 |

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<tr>
<th>Summary Statistics</th>
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<tr>
<td>SD (SEM)</td>
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<td>74.6-86.2</td>
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<td>Exp final</td>
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<tr>
<td>SD (SEM)</td>
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<tr>
<td>95% CI</td>
<td>94.4-103.5</td>
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<tr>
<td>Comp baseline 75.9 (12.4)</td>
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<tr>
<td>SD (SEM)</td>
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<td>95% CI</td>
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<td>Comp final 91.3 (9.4)</td>
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<tr>
<td>SD (SEM)</td>
<td>9.4 (2.4)</td>
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<td>95% CI</td>
<td>86.1-96.5</td>
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**Discussion**

Based on the between-group analysis, it appears that the addition of MT to rehabilitation is beneficial over rehabilitation alone in the short-term (over 4 weeks) for RASFI in terms of pain reduction and a reduced number of joint restrictions but not for disability. Pain is only 1 dimension of the FADI, which also measures other dimensions of function and ability. It may well be that the addition of MT does not change the score for disability/function but does for pain, thereby delivering the significant differences for VAS but not for FADI.

The results of this trial are in accordance with the positive outcomes seen with MT for ankle injury (ie, inversion sprain) as reported by other authors using similar techniques. Other studies of MT or MT plus rehabilitation and/or exercise for ankle sprain have also demonstrated a significant decrease in pain by similar outcome measures such as the numerical rating scale or other scales such as the short-form McGill pain questionnaire (correlated to the VAS) and compared with placebo and/or standard care and/or decreased pain per algometry.

Overall, it seems that both treatment approaches were statistically significant and useful (see “within-group” changes Tables 2, 3, and 4); but the addition of MT offered a greater improvement in pain and, potentially, joint motion. In participants where pain is a prominent symptom, the early addition of MT may be clinically useful, allowing improved rehabilitation and use and diminish the further likelihood of developing disability.

Furthermore, no adverse events or complications (defined as persistent severe stiffness, pain, or disability) were reported, and no participants were known to have left the trial due to adverse effects or significant side effects.
of using motion palpation is that all the previous components used in this procedure in the past were considered unreliable, so its usefulness as an outcome measure is questionable; however, most components used in this trial (Pain, Asymmetry, Range of Motion, Tone, Texture or Temperature soft tissue abnormalities and Special tests, or PARTS) appear to be able to direct a chiropractor to the appropriate joint to apply MT, too; and this study looked at a newly forming concept (larger decrease in numbers of hypomobile joints—which may or may not eventually be determined as a useful measure).18,58,66,67

The implication of the outcomes of this trial is that MT may be considered a viable addition to rehabilitation as part of a treatment package, principally ankle injuries as a result of sprain. With cost containment in mind, a logical approach may be to begin care with a 1-month rehabilitation program, followed by the addition of MT if satisfactory results are not achieved; “satisfactory” is a matter of opinion, but the authors suggest more than 30% reduction in pain or measurement.18,50,59 If the short-term goal of treatment is to address pain and restricted joint motion specifically, particularly in athletes, where return to sport is a priority, then the early addition of MT may be of benefit.

Limitations

One limitation of this trial is that, although there is a comparative treatment already demonstrated superior to placebo for the treatment of ankle sprain, there is no supplemental “control” group featuring either no treatment or a placebo treatment. So therefore it does not permit fully definitive conclusions regarding the effectiveness of the individual treatments tested.34 Another limitation of this study is the definition of “chronicity” used, as this was defined as more than 7 weeks; but CAI is often defined beyond this period.34,68 “Chronicity” in CAI has presently coalesced, about current inclusion criteria for this disorder more recently around 6 months; however, as some authors make clear—agreement still does not yet exist with a period more than 1 year as recently suggested.2,34 Thus, this study, having a mean chronicity for both groups of more than 6 months but participants with a range above and below that cut-off may be respectfully seen as a possible look at an earlier developing stage of functional CAI.34 However, the natural history of RASFI, which is often characterized by fluctuating signs and symptoms, alongside the potential effect of the Hawthorne phenomenon, may account for some of the improvement seen in each treatment group. The small sample size used in this study, as a result of practical financial constraints, is unlikely to be fully generalized to the general population; but the results are able to offer useful insights related to short-term outcomes and, of course, inform future trails.

Because this study included only participants with RASFI, the outcomes of this trial do not relate to other ankle disorders, such as truly demonstrated CAI, where the

### Table 3. Comparison of VAS Data of the 2 Treatment Groups

<table>
<thead>
<tr>
<th></th>
<th>A × B</th>
<th>P value = .0014</th>
<th>95% CI</th>
<th>95% CI</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A × B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within-Subject Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary Statistics</td>
<td>Mean</td>
<td>SD (SEM)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exp baseline</td>
<td>47.3</td>
<td>15.2 (3.9)</td>
<td>38.9-55.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exp final</td>
<td>6.2</td>
<td>9.4 (2.4)</td>
<td>1.0-11.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp baseline</td>
<td>40.0</td>
<td>17.3 (4.5)</td>
<td>30.4-49.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp final</td>
<td>22.1</td>
<td>15.6 (4.0)</td>
<td>13.5-30.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within-Group Comparison</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Difference</td>
<td>41.1</td>
<td>4.4</td>
<td>&lt;0.0001</td>
<td>27.5 to 54.7</td>
<td></td>
</tr>
<tr>
<td>SEM</td>
<td>3.7</td>
<td>0.0016</td>
<td>6.6 to 29.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95% CI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp baseline</td>
<td>17.9</td>
<td>3.7</td>
<td>0.0016</td>
<td>6.6 to 29.1</td>
<td></td>
</tr>
<tr>
<td>Comp final</td>
<td>−15.9</td>
<td>5.2</td>
<td>0.0059</td>
<td>−32.0 to 0.1</td>
<td></td>
</tr>
</tbody>
</table>

CI, confidence interval; SD, standard deviation; SEM, standard error of the mean.

a Experimental group.
b Comparison group.
c SD.
d SEM.
e Confidence Interval.
f Minimally clinically important difference (20-30 mm approximate reported values—see above).

Although there were isolated cases of transient, benign symptoms of stiffness or pain reported in both intervention groups, these benign side effects subsequently resolved in all cases and were not reported as adverse effects including in subjects involved in sports or sporting activity.

Another result from this study was the significant decrease in the frequency of joint restriction (sometimes referred to as “fixations,” ankle or foot restricted joint play or glide) in group 2 (MT plus rehabilitation). Similar changes in restricted ankle or foot joint play or glide have been documented in studies by a variety of authors.17,42,58,65 The reduction in joint restrictions due to the addition of MT to rehabilitation supports the hypothetical relationship between MT and joint motion, although this concept requires further testing. Overall, the limitation
affected ankle would exhibit mechanical instability (> 4 mm anterior drawer laxity). In addition, intraexaminer reliability of a manually performed anterior drawer test is low, and talar tilt is unreliable; significantly improved anterior drawer test accuracy may be accomplished by the use of arthrotomy, and it is suggested that this be used in future research.

When comparing the number of rehabilitation sessions performed by participants in each group, a marginal but significant difference was discovered ($P = .043$), with a 2-session difference between the groups (Table 1), with more sessions having been performed in group 1 (MT plus rehabilitation). The authors believe that this difference is unlikely to have influenced the outcome in this trial but admit it is a matter of opinion. Duration of symptoms appears to be actually similar, with no statistically significant difference between the groups (but not reported). Accounting for this difference in statistical analyses (although not reported) did not change the outcomes (using analysis of covariance [ANCOVA]). Nevertheless, this perceived difference in symptom duration should be addressed by a larger sample size of future trials.

In this study, the same clinician did not perform the joint palpation and then apply the manual/manipulative treatment. This was a strategy to improve on the detection and description of joint motion restrictions, as the blind assessor was an experienced clinician and to reduce possible examination bias. In hindsight, this approach does not mimic real-life clinical practice; and having the treating clinician blind to the palpation/joint assessment is unlikely to improve on reducing potential biases because the treating clinician is informed of the palpatory findings anyhow, as this is necessary for treatment. Therefore, the authors recommend dual assessment and agreement on the joint restriction(s) and the joints to be manipulated, with the treating clinician as one of the assessors, thereby reflecting clinical practice and the approach used in similar published trials.

<table>
<thead>
<tr>
<th>Table 4. Comparison of the Frequency of Joint Restrictions Identified by Joint Motion Palpation of the 2 Treatment Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sphericity</strong></td>
</tr>
<tr>
<td>Greenhouse-Geisser</td>
</tr>
<tr>
<td>Sphericity assumed</td>
</tr>
<tr>
<td>Trend</td>
</tr>
<tr>
<td><strong>Within-Subject Effects</strong></td>
</tr>
<tr>
<td>$A^aB$</td>
</tr>
<tr>
<td>$P$ value &lt; .001</td>
</tr>
<tr>
<td><strong>Summary Statistics</strong></td>
</tr>
<tr>
<td>Minimum required difference of mean rank = 0.385 (Friedman)</td>
</tr>
<tr>
<td><strong>Median</strong></td>
</tr>
<tr>
<td>Exp $^a$ baseline</td>
</tr>
<tr>
<td>Exp final</td>
</tr>
<tr>
<td>Comp $^b$ baseline</td>
</tr>
<tr>
<td>Comp final</td>
</tr>
<tr>
<td><strong>Within-Group Comparison</strong></td>
</tr>
<tr>
<td><strong>Mean Difference</strong></td>
</tr>
<tr>
<td>Exp baseline − exp final</td>
</tr>
<tr>
<td>Comp baseline − comp final</td>
</tr>
<tr>
<td><strong>Between-Group Comparison</strong></td>
</tr>
<tr>
<td><strong>Mean difference</strong></td>
</tr>
<tr>
<td>Comp − exp at baseline</td>
</tr>
<tr>
<td>Comp − exp at final</td>
</tr>
</tbody>
</table>

CI, confidence interval; SD, standard deviation; SEM, standard error of the mean.

$^a$ Experimental group.

$^b$ Comparison group.

$^c$ SD.

$^d$ SEM.

$^e$ Minimum-maximum range.

$^f$ Confidence interval.

$^g$ Minimally clinically important difference (not established).
In this trial, the primary researcher performed a number of functions—assessment/examination, follow-up consultations, and treatment (but not blind assessment). However, to reduce clinician or treatment bias, the lead clinician could have a single role, with other functions being performed by independent clinicians. But the reason for this level of involvement by a primary researcher was due to limitations in funding, resources, and time available for completing such a randomized clinical trial as one component of a Masters’ degree in a chiropractic program (and may have increased the potential for additional bias).

**Future Studies**

For a future clinical trial testing manual or MT for ankle injury, the following recommendations are offered. Future research should consider testing a consensus-led yet evidence-based package of care that includes joint mobilization, soft tissue therapy, and manipulative in addition to a rehabilitation program, thereby mirroring clinical practice more closely, that is, manual and multimodal therapy package plus rehabilitation compared with rehabilitation only. Use a consensus-led evidence-based standardized rehabilitation program. In this regard, a framework to assess and treat the specific deficits in recurrent ankle sprain is recommended, where the 4 domains of range of motion, strength, balance, function, and the tenet of pain-free exercise form the basis of rehabilitation; outcome measures would suit the 4 domains as stated previously, with particular focus on measuring change in neuromuscular function.

Select a reasonable sample size that takes into account the effect size of the primary outcome(s), dropouts, and cluster effect (if more than 1 study site is considered). In this regard, an effect size index of 0.2 or less should be considered and sample sizes of more than 50 per group. Expand on data collection time-points by including follow-up at 1, 3, 6, and 12 months, as this study only explored the short-term but not disability when compared with the rehabilitation program alone. The clinical implication may be that MT might be useful in participants, where pain and restricted foot joint motion are problems, or where rehabilitation alone does not result in satisfactory outcomes.

**Conclusion**

This study showed that, for patients with RASFI, the addition of chiropractic MT to a rehabilitation program significantly reduced pain and joint restrictions in the short term but not disability when compared with the rehabilitation program alone. The clinical implication may be that MT might be useful in participants, where pain and restricted foot joint motion are problems, or where rehabilitation alone does not result in satisfactory outcomes.

**Funding Sources and Potential Conflicts of Interest**

No funding sources or conflicts of interest were reported for this study.

**Contributorship Information**


Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): D.L., E.L., J.W.B., C.K.


Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): D.L., J.W.B., G.F.P-S.

Literature search (performed the literature search): D.L., J.W.B., G.F.P-S.

Writing (responsible for writing a substantive part of the manuscript): D.L., E.L., J.W.B., G.F.P-S.


**Practical Applications**

- Both rehabilitation alone and MT plus rehabilitation resulted in a change in outcome measure scores.
- The addition of MT to rehabilitation significantly reduced pain and joint restrictions but not disability when compared with rehabilitation alone.
- The clinical implications are that MT may be useful in addition to rehabilitation, where pain and joint restrictions are key clinical issues.

**REFERENCES**

31. Mattacola CG, Dwyer MK. Rehabilitation of the ankle after acute sprain or chronic instability. Athl Train 2002;37:413-29.


The Foot & Ankle Disability Index (FADI) Score

Clinician's name (or ref) ...................................... Patient's name (or ref) ......................................

Please answer every question with one response that most closely describes your condition within the past week. If the activity in question is limited by something other than your foot or ankle, mark N/A.

<table>
<thead>
<tr>
<th>Activity</th>
<th>No difficulty at all</th>
<th>Slight difficulty</th>
<th>Moderate difficulty</th>
<th>Extreme difficulty</th>
<th>Unable to do</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Standing</td>
<td></td>
<td></td>
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<tr>
<td>2. Walking on even ground</td>
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<tr>
<td>3. Walking on even ground without shoes</td>
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<tr>
<td>4. Walking up hills</td>
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<tr>
<td>5. Walking down hills</td>
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<tr>
<td>6. Going up stairs</td>
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<tr>
<td>7. Going down stairs</td>
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<tr>
<td>8. Walking on uneven ground</td>
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<tr>
<td>9. Stepping up and down curves</td>
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<tr>
<td>10. Squatting</td>
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<tr>
<td>11. Sleeping</td>
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<tr>
<td>12. Coming up to your toes</td>
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<tr>
<td>13. Walking initially</td>
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<td>14. Walking 5 minutes or less</td>
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<td>15. Walking approximately 10 minutes</td>
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<tr>
<td>16. Walking 15 minutes or greater</td>
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<tr>
<td>17. Home responsibilities</td>
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<tr>
<td>18. Activities of daily living</td>
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<tr>
<td>19. Personal care</td>
<td></td>
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<tr>
<td>20. Light to moderate work (standing, walking)</td>
<td></td>
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<tr>
<td>21. Heavy work (push/pulling, climbing, carrying)</td>
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<tr>
<td>22. Recreational activities</td>
<td></td>
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</tr>
</tbody>
</table>

23. General level of pain                                               |                      |                   |                     |                    |             |

24. Pain at rest                                                        |                      |                   |                     |                    |             |

25. Pain during your normal activity                                    |                      |                   |                     |                    |             |

26. Pain first thing in the morning                                     |                      |                   |                     |                    |             |

Thank you very much for completing all the questions in this questionnaire.

The Foot & Ankle Disability Index (FADI) Score is 0

http://www.orthopaedicscore.com/scorepages/foot_and_ankle_disablement_index_fadi.html