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A REVIEW OF OPEN ACCESS TO EVIDENCE BASED MEDICINE FOR  
ATHLETIC TRAINERS

By

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A plan B research project submitted in partial fulfillment  
of the requirements for the degree

of

MASTER OF SCIENCE

in

Health and Human Movement

Approved:

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Logan, Utah

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## ABSTRACT

The most useful form of educating new and current athletic trainers is through evidence-based practice (EBP). Concussions are one of the most frequent injuries in sports and are seen at every setting of athletic training. Concussion research is essential for athletic trainers to make informed and educated decisions on the most current diagnosis, treatments, and return to play protocols for concussion injuries. **Purpose:** The purpose of this narrative review was to analyze the amount of peer-reviewed research on current concussion articles that is freely accessible to athletic trainers in settings without university affiliations or budgets for journal subscriptions. **Methods:** Two hundred and seventy six articles were screened for inclusion and exclusion criteria. One hundred and thirty seven articles met the requirements and were then sorted by their open access determination. **Results:** Out of the 137 articles, 56 were found to be freely accessible to the public by the standards of this review. Many articles that did not qualify as open access were still available through online academic social networking sites. Accessibility and reliability are important characteristics that are commonly being questioned of these sites. **Conclusion:** Although many articles were found freely through academic social networking sites, the reliability of these online sites may not be an adequate source to providing quality peer-reviewed research. In addition, there is a significant amount of concussion research that could potentially contribute to the EBP of athletic trainers.

## **Introduction**

Evidence based practice (EBP), defined as the integration of best research evidence with clinical expertise and patient values to make clinical decisions, has become the leading method of providing quality care to patients (Steves & Hootman, 2004). With the increase in EBP in the athletic training field, the necessity for access to the most relevant research has become crucial for clinicians (Hankemeier & Van Lunen, 2013). Access to scholarly published articles is important for every clinician, however the only feasible method for gaining knowledge on certain topics relevant to athletic training is through open access to scholarly literature. Open access to scholarly peer-reviewed research includes sources such as scholarly articles, books, and other formats that can be accessed in digital form with no subscription or institutional affiliation (Laakso, 2014). Although the benefits of open access to peer-reviewed research have been studied in several settings of the medical field such as nursing, mental health, and family practitioners, there has been minimal research on how the prevalence of openly accessible scholarly literature, specifically research, affects the athletic training profession.

Athletic trainer's open access to EBP research is not only limited by lack of relevant research in the field but also due to the obstacles inherent to open access in the digital world. One challenge that open access aims to overcome is the lack of research available to readers not affiliated with a university (Tamber, Godlee, & Newmark, 2003). Non-university affiliated readers tend to have low subscription rates to scholarly journals (Tamber, et al., 2003). Although organizations like the Public Library of Science and the Health InterNetwork Access to Research Initiative have been gaining funds to allow open access of peer-reviewed research to the public there are still some issues (Tamber, et al.,

2003). Another major challenge to the open access model is “predatory publishing” (Baric, Polsek, Andrijasevic, & Gajovic, 2013). That is, publishers provide the public free access to research to avoid losing money but do not have the articles vetted or peer-reviewed for quality (Baric et al., 2013). This type of publishing, although free, is dangerous to the public by skewing their knowledge towards lower quality information due to the availability of these low quality articles (Baric et al., 2013). The evolution of open access has demonstrated the many advantages associated with publishing freely, however, it still struggles with several disadvantages that can negate the positives of using an open access model.

These disadvantages arise from charging user fees for accessing research articles and can be difficult to eliminate when dealing with a non-open access model (Tamber, et al., 2003). The first adverse effect is the ability of publishers to force librarians into subscribing to journals due to their hold on copyrights from the authors (Tamber, et al., 2003). Second, publishers can track the amount subscription fees and adjust the costs for scientific literature, which dissuades individuals and universities from subscribing to academic journals (Tamber, et al., 2003). Third, not having free access to peer-reviewed research obstructs the dissemination of scientific knowledge to the masses thus decreasing community readership and involvement in scientific discussions (Tamber, et al., 2003). Lastly, the lack of freely available peer-reviewed research also diminishes the ability for new researchers to compare their own information to scholarly reviewed publications (Tamber, et al., 2003).

Open access publishing facilitates the development and progress of current research based on previously published studies, thus expanding the knowledge and information

developed through the scientific method (Tamber et al., 2003). Some advantages to having an open access model include increased citation and downloads resulting from increased usage by readers and increases in the ability for publications to be cited in a broader range of databases (known as scientific crossover) (Eysenback, 2013). Scientific crossover raises the visibility of the research thus increasing the likelihood it can be incorporated into EBP and its pertinence to the athletic training profession.

EBP allows health care professionals to have access to ‘concrete recommendations’, which in turn allows for several positive outcomes within patient care experiences, such as: promotion of education, decrease in care variance, health care process improvement, and a decrease in costs (Grol, 2001). One of the most commonly researched injuries in EBP and in every setting of athletic training is mild traumatic brain injuries or concussions (Broglia, et al., 2014). The most recent position statement on the management of sport concussions released by the National Athletic Trainers Society describes the most up to date information on the education, prevention, diagnosis, and treatments of concussions (Broglia, et al., 2014). Limited access to peer-reviewed research pertaining to these specific areas of concussions could be an issue for many athletic trainers.

Having access to the most relevant research in neurological testing could aid athletic trainers in producing the best outcomes for concussion related injuries. Neurological testing is a specific examination method that is frequently used as an objective approach of analyzing an athlete’s injury (Broglia, et al., 2014). Some of the most common tests that athletic trainers utilize are; Immediate Post-Concussion Assessment and Cognitive Test (ImPACT), Standardized Assessment of Concussion

(SAC), Automated Neuropsychological Assessment Metrics (ANAM), Sport Concussion Assessment Tool (SCAT), and many others (Broglia, et al., 2014). All of which include a symptoms checklist, as well as several cognitive tests to determine the patients' cognitive impairment. These tests allow for important cognitive results at baseline, post injury, and return to play (Broglia, et al., 2014). Having patient results at each time point can display a great amount of information on the nature of the concussion injury for clinicians to utilize in addition with other concussion tools as well as produce usable results for longitudinal research.

Access to research on concussions is imperative to keep clinicians up to date with the best possible tools for recognizing, treating, and returning concussive athletes back to sport. However, one of the biggest obstacles athletic training instructors have while incorporating EBP into their students' education is the lack of resources and availability to those resources (Hankemeier & Van Lunen, 2013). The question of whether or not open access produces a change in clinical use or EBP has not been frequently studied (Davis & Walters, 2011). The limited access to educational medical research shows how crucial open access is to athletic trainers in settings that do not have access like university athletic trainers. This review will analyze the current concussion research and determine how much of this research is freely available to athletic trainers in every setting.

## **Methods**

### *Search Strategy*

This review will include articles reporting neurocognitive tests on patients in a group setting with a pre and post injury reported test result. The search was conducted by completing a multiple database search including the following databases: Academic

Search Premier, PsycInfo, CINAHL, MEDLINE, SportDiscus, and Psychology and Behavioral Science Collection. Databases were all available through Utah State University's subscription to EBSCOHost. The search terms used throughout all databases included concussion related terms (“concuss\*” OR “mTBI” OR mild traumatic brain injury” OR “closed head injury”) and terms related to neurocognitive testing (“\*cognitive” OR “\*cognitive test”). The results from the search will be collected and screened for open access determination using the REDCap electronic data capture tools hosted at Utah State University (Harris, et al., 2009). “REDCap (Research Electronic Data Capture) is secure, web based application designed to support data capture for research studies (Harris, et al., 2009).”

#### *Criteria for Inclusion*

All articles within REDCap were screened for primary inclusion results by title. The articles must provide original peer-reviewed data. All systematic reviews, meta-analysis, book chapters, or consensus statements, dissertations, or theses were all excluded. Next, the articles must include at least one neurocognitive test that either evaluated specifically for concussion or used in the diagnosis or monitoring of neurocognitive outcomes of a concussion. Lastly, only data that incorporated groups of patients were used. For this specific review the neurocognitive tests that were analyzed were the most commonly used tests in the field and included ImPACT, SAC, CogSport, ANAM and SCAT. Each version of the above tests was included in this study.

#### *Open Access Determination*

The Scholarly Publishing and Academic Resources Coalition (SPARC) will be used to define open access in this review. SPARC defines open access as “free,

immediate, online availability of research articles coupled with the rights to use these articles fully in the digital environment.”

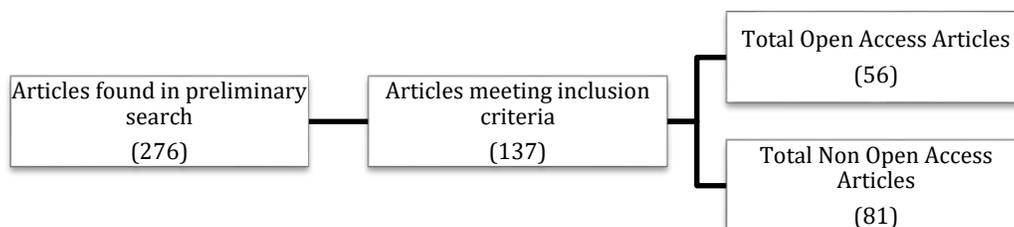
To determine if an article was accessible by the public reader on the Internet the articles were coded through the following steps: 1) The examiners’ browser was completely logged out of any institutional proxy and utilized a incognito Google chrome browser 2) Articles were screened through the SHERPA/ROME0 (SHERPA) database. This online resource allows the search of journal articles to be conducted to establish their level of open access to the public. Each article that met inclusion criteria was screened for its level of open access by searching the article’s journal on SHERPA’s online database. To establish a uniform process, articles were only accepted as open access if they met the blue or green qualification of the SHERPA archiving policy. The qualifications of SHERPA/ROME0 are explained in Table 1. 3) Article titles were screened through Google Scholar without any filters or added affiliations. If the articles produced a pdf or html link then each article was finally established as open access.

*Table 1*  
SHERPA/ROME0 Qualification Levels

Green	Pre-print and post-print of publisher’s version/ PDF
Blue	Post-print or publisher’s version /PDF
Yellow	Pre-print
White	Not formally supported
Ungraded/Unfound	Not formally supported

Table describing SHERPA/ROME0 online open access database archiving policy regulations and qualifications. (“Definitions and Terms, 2018)

## Results



*Figure 1.* Flow chart describing the different stages of article screening. Number of articles found at each stage is represented within parentheses.

After screening for inclusion and exclusion criteria a total of 137 articles were included in the review as seen in Figure 1. Fifty-six articles were then found to be completely freely accessible to the public with a green or blue level of access from SHERPA/ROMEIO and the production of a pdf or html link from Google scholar. Table 2 shows the findings of the articles' SHERPA/ROMEIO and Google Scholar statuses. Two of the 56 articles that met open access status were SHERPA/ROMESO blue level. 59.1% of the articles did not meet the open access qualifications for this review's open access determination. In addition, 22 of the 137 articles that met green or blue SHERPA/ROMEIO statuses were not available on Google Scholar, which makes up 28.9% of all articles that were green or blue level statuses. However, of those 81 articles there were many that still produced either SHERPA/ROMEIO green status or a pdf/html on Google Scholar. Out of the total 137 articles 97 could be accessed through Google Scholar regardless of their SHERPA/ROMEIO journal status. Out of the 97 articles available through Google Scholar, 61 of them were html links and 36 produced pdf results.

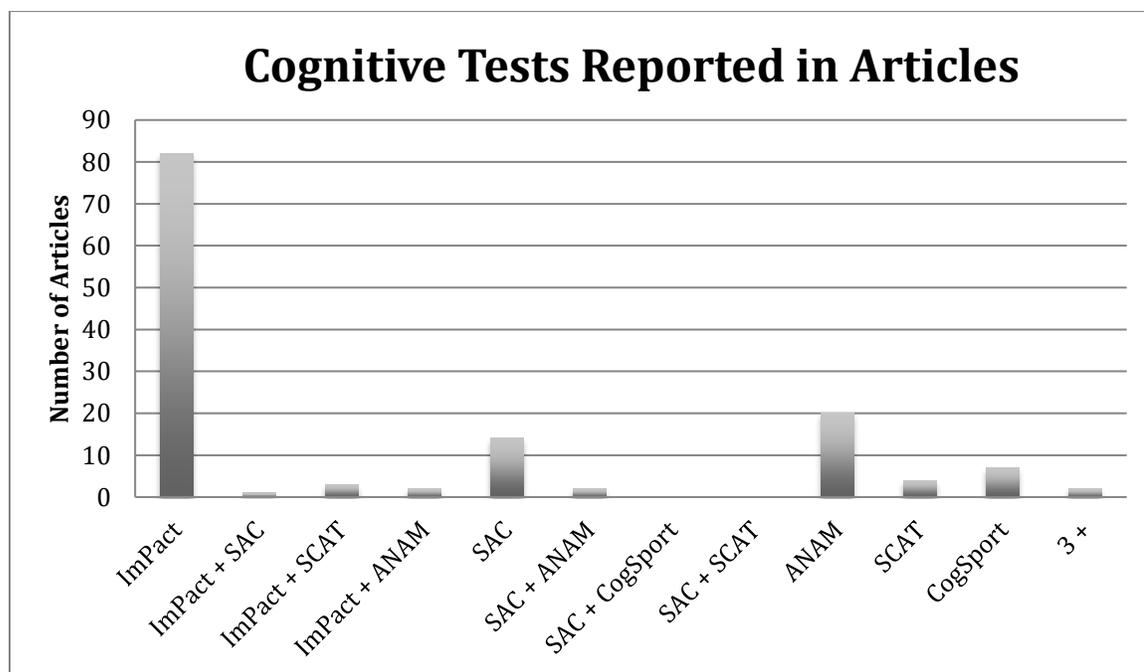
*Table 2*  
Open Access Determination Results

Sherpa Romeo Status	Google Scholar Status	Total Number of Articles
Green	Yes	54
Green	No	22
Blue	Yes	2
Blue	No	0
Yellow	Yes	13
Yellow	No	14
White	Yes	20
White	No	0
Ungraded	Yes	5
Ungraded	No	1
Not Found	Yes	3
Not Found	No	3

Table 2 The number of articles that met inclusion criteria at each level of SHERPA/ROMEIO and Google Scholar status. SHERPA/ROMEIO Status: defined in *Figure 1*. Google Scholar Status: The production of a pdf or html link.

Many articles searched in Google scholar were available through sites that openly publish research literature to allow for collaboration and scientific debates. The most common website that freely published articles was nih.gov. National Institute of Health produced 15 of the 97 articles available for the public. Proquest.com closely followed and produced the availability of 14 articles. Another organization that allowed for 11 articles to be searched was ResearchGate.net. In total, 62 articles were provided by organizations that were developed to increase readership and scientific availability to the masses. Other avenues that aided in producing free peer-reviewed research online were universities. Six articles were found on university websites even with no affiliation or subscription to their institution. In addition, 12 articles were categorized as ungraded or not found by SHERPA/ROMEIO. However, 8 out of the 12 articles were found to be freely accessible through Google Scholar and these organizations.

Furthermore, many of the articles in this study were published from the same journal. Analysis of the break down of the published journals and their SHERPA/ROMEIO status presented some interesting findings. For instance, the Clinical Journal of Sports Medicine was found to be a yellow level where as the American Journal of Sports Medicine was level green. Thirteen of the articles came from The American Journal of Sports Medicine, 5 of which did not produce a pdf or html within Google Scholar. In addition, the Journal of Athletic Training published 8 of the articles that met inclusion criteria. The journal itself was level white on SHERPA/ROMEIO but all of the articles were accessible through Google Scholar. The website that most commonly produced articles was natajournals.org. This website is a huge resource for the publication of athletic training related material, especially for the current concussion research.



**Figure 2** Graph showing number of articles that reported each neurocognitive test. Immediate Post-Concussion Assessment and Cognitive Test (ImPACT), Standardized Assessment of Concussion (SAC), Automated Neuropsychological Assessment Metrics (ANAM), Sport Concussion Assessment Tool (SCAT), CogSport

When analyzing the cognitive tests utilized in the articles, 64.2% of the articles reported using ImPact alone. As seen in Figure 2, the next most common test used at 14.9% was ANAM, followed by SAC at 10.1% of the total articles. Thirty-four of the reported ImPact articles were found to be freely accessible according to this studies' open access determination. ANAM produced 14 out of the 24 reported articles as open access. SAC was reported in 8 open access articles while ANAM was utilized in 14 articles, which was 58.3% of the total amount of ANAM articles reported. Lastly, SCAT was used least among all of the cognitive tests. Only 2 of the 9 articles reporting SCAT as their neurocognitive test were found to be freely accessible to the public.

## **Discussion**

The purpose of this review was to evaluate how much of the current longitudinal concussion research is freely accessible to the athletic trainers that only have access to peer-reviewed research through the digital world. Open access allows the availability of scholarly literature in many formats to be freely accessible to readers and is becoming very prevalent within certain areas of the biomedical field (Manca S., 2018). However, 59.1% of the articles found in this study were not labeled as open access, which could prevent them from being observed by practicing athletic trainers. If athletic trainers cannot view EBP articles that are locked behind pay walls it could negatively affect an athletic trainer's clinical practice in the field.

As the open access world expands, new platforms have developed to freely aid in the viewership and distribution of peer-reviewed research (Manca, 2018). Some of these platforms included academic social network sites, such as; ResearchGate, Academia, and

SemanticScholar (Manca, 2018). These sites provide digital ways of sharing research to increase dissemination across the scientific profession (Manca, 2018). All three of these organizations in this study provided full texts of articles searched in Google Scholar.

While, these organizations provided 45% of the html and pdf links found on Google Scholar these academic network systems may also present unheralded danger to readers. For example non-peer reviewed literature can be dangerous to readers looking for recommendations for their clinical practice. As well, articles may be posted for a short period of time posing the threat of not being legitimate or produced by a non-accredited user (Teixeira, 2017). Literature may also be posted without the author's permission that is not only unethical but also produces a negative connotation in digital academic literature (Teixeira, 2017). Articles may also be published and replicated from other sources showing the limited regulation of these sites as well as the need for greater "regulation and scrutiny" of articles published online (Teixeira, 2017). ResearchGate and other online networking systems have had numerous issues in the past with having account users post information directly to their public profiles that are pre-print and non-peer reviewed versions of their research (Manca., 2018). This could falsely lead readers searching for free valid data on a certain subject, such as concussions, to information that is not academically supported by recognized sources.

For health care professionals, concussions are serious injuries to be dealt with and can have life-threatening consequences if not handled correctly (Broglio, 2014). If the information that is being published on websites like ResearchGate and Academia is incorrect, it could bias athletic trainers and negatively impact their ability to treat concussion injuries. In addition, neurocognitive tests are an important and necessary tool

to help diagnose and treat concussions (Broglio, 2014). Accessibility to current information on the effectiveness of neurocognitive testing is crucial for athletic trainers to continue to treat concussions effectively. The most common test used currently is ImPact and this review found that only 38.6% of the articles that reported using ImPact were freely accessible to the public. That leaves a significant portion of neurocognitive testing research as unseen by athletic trainers that do not have access to pay walled journals. However, the academic networking sites that have provided forums for readers to collaborate and evaluate more scholarly literature could produce a way for concussion research to be seen by a larger portion of athletic trainers.

To further evaluate the consistency of these networking sites, many disadvantages are present when analyzing their reliability. Semantic Scholar.org is another publishing website dedicated to publishing biomedical information as well as computer science literature. They have stated that they do include some data published that is locked behind pay walls but are still trying to increase and fund this information. ResearchGate unlike the Directory of Open Access Journals (DOAJ) only publishes their works in English, which does diminish their goal of disseminating their information back to readers (Manca, 2008).

In contrast, National Institute of Health aspires to become one of the largest digital open access libraries that provide peer-reviewed literature at no cost to any user (Tamber et al., 2003). Their mission includes the ability to increase the viewership and use of this information by tracking their citation rates (Tamber et al., 2003). In addition, organizations similar to Health InterNetwork Access to Research are important for providing a lower cost or free access to their research articles in hopes of increasing the

scientific knowledge to the masses (Tamber, et al., 2003). In addition, the DOAJ is another reliable source for accessing peer-reviewed scholarly literature in a safe and rebuttable online forum (Morrison, 2008). The DOAJ has a selective application process for journals wishing to freely publish on their site (Morrison, 2008). Having an extensive application process could help to reduce some of the possible predatory publishing occurring in the digital world.

Several limitations were presented through the process of this study that could be analyzed in further research on this subject matter. First, one limitation to this study that needs to be analyzed is the specific effect of one area of concussions rather than the general and broad spectrum that was reviewed in this study. For example, further research can be used to look at the amount of open access literature on specific treatments for concussions or one specific sport. Another limitation includes the minimal evaluation of the effect of this study has on the clinical use of information that is locked behind subscriptions and pay walls. Lastly, the utilization of longitudinal research limited the search results to a fewer amount of overall articles. Expanding the inclusion criteria to accepting cross-sectional research may provide insight into how much of the total amount of concussion research is openly accessible to the public.

## **Conclusion**

In conclusion, knowledge in the field of EBP and open access should be further analyzed to provide a better understanding of the importance EBP has on the quality of care and clinical decisions of medical professionals. By the results of this review indicate that a significant portion of the concussion research is not freely accessible to the digital world. This study also shows that although some concussion research may not be

accessible, there is also a great portion of the concussion research that is available through other self-archiving online organizations. In general, broad access to scholarly peer-reviewed research could aid numerous athletic trainers, patients, and other allied health care professionals by increasing the positive outcomes of diagnosis, evaluation and treatment of athletic injuries.

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