A COMPARISON OF PLAINTIFF AND DEFENSE EXPERT WITNESS H-INDEX SCORES IN MILD TRAUMATIC BRAIN INJURY CIVIL LITIGATION

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This study examines the background and qualifications of plaintiff and defense experts using the H-Index score as quantification of expert background and qualifications. The goal is to better understand the similarities and differences among the professionals offering paid expert witness testimony in mild traumatic brain injury (mTBI) civil litigation. In this quantitative study, descriptive statistics include the mean and standard deviation scores for the data to support examining measures of central tendency and variance, respectively. The study includes the use of logistic regression and the Wilcoxon signed-rank test, and their statistical assumptions were tested to determine whether they would be used or if it was more appropriate to use a non-parametric test. The study included two research questions: How do the qualifications of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation compare? and to what extent does a higher h-index correlate with a favorable litigation outcome in a mild traumatic brain injury case? The findings for the hypothesis tests associated with the research questions led to the acceptance of the null hypothesis in each test. There was a lack of asymptotic significance in Hypothesis 1 and a lack of significance in Hypothesis 2. The findings from these tests shall support the discussion of the implications of this research and the direction of future research.

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CHAPTER 1

INTRODUCTION

The human brain, then, is the most complicated organization of matter that we know.

—Isaac Asimov

1.1 Overview

According to the Centers for Disease Control and Prevention [CDC], (2022) there was approximately 61,000 traumatic brain injury (TBI) deaths in 2019, and the number of people who sustain brain injuries is far greater. The impact of those who survive a TBI can be long-lasting, and not all injuries result in apparent physical trauma. This can be especially true with brain injuries. The condition of mild traumatic brain injury (mTBI) is most often referred to as a concussion, and it involves a complex neurological impact resulting from an event. “Many individuals with a mild TBI and the majority of those who survive moderate to severe brain injuries, are left with significant long-term neurobehavioral sequelae” (Masel & DeWitt, 2010, p. 1534). It is believed that TBI, including mTBI, should not be viewed as a single event but rather a disease process whereby the patient may have ongoing symptoms or conditions, according to Masel and DeWitt (2010). This dissertation applies a bibliometric approach to examining the H-Index scores of expert witnesses in mild traumatic brain injury negligence lawsuits from 2013 to 2019.

A traumatic brain injury can occur when there is “a disruption in the normal function of the brain that can be caused by a bump, blow, or jolt to the head, or penetrating head injury” (CDC, 2022, para. 1). According to the most recent data available from the CDC on emergency department (ED) visits, “there were approximately 223,135 TBI-related hospitalizations in 2019 and 64,362 TBI-related deaths in 2020” (CDC, 2022, para. 2). TBI is a risk factor for everybody, especially the elderly and young children (CDC, 2022). Brain injuries can lead to significant neurological problems, and according to Gardner and Yaffe (2015), mTBI is a risk factor for dementia. Understanding the risks and implications of brain injuries is essential, and the CDC actively engages in surveillance of this public health issue.

TBI can range from mild, moderate, to severe, and the severity is generally determined by each patient's neurologic condition when evaluated at the time of injury (CDC, 2022). Worldwide, there are an estimated 42 million cases of mild traumatic brain injury annually (Gardner & Yaffe, 2015). Their research primarily focuses on brain injuries that are classified as soft. When a person suffers an mTBI, it may be difficult to provide objective evidence of the damage or an accurate prognosis. In addition, established standards or guidelines for identifying the long-term impact of an mTBI are limited. At this time, reliable methods for objective diagnoses are heavily disputed. Since some of the most advanced neuroimaging techniques are new and evolving, the ability to fully evaluate and confirm the accuracy of an evidence-based diagnosis remains elusive. "The rapid advances in brain imaging become more challenging to the legal system, where judges are asked to determine the admissibility of expert neuroimaging testimony in the courtroom" (Shenton et al., 2018, p. 51). These issues and concerns often arise in civil litigation when a plaintiff has suffered from an mTBI. Frequently, these cases involve using compensated medical expert witnesses to provide testimony on behalf of either the plaintiff or the defendant. Typically, both sides will have their experts testify, and these witnesses are often extensively trained and experienced professionals in their field. They provide opinions on relevant matters discussed in litigation by relying on their deep knowledge and subject matter expertise.

Technological advances in imaging over the past two decades have spurred debate and controversy while intruding on the possibility of objectively identifying mTBI or mTBI related symptoms with advanced precision. Wintermark et al. (2015) suggest that new neuroimaging techniques are interested in identifying injuries when traditional methods such as magnetic resonance imaging (MRI) fail to show signs of damage. However, Wortzel et al. (2011) caution against advanced techniques that may lack an evidence basis. Shenton et al. (2018) support the latter opinion stating "its probative value is also not clear as it may be both prejudicial and misleading given that standardization is not yet established for use in either the clinic or the courtroom, and thus it may be premature for use in either" (p. 50).

In researching expert witness testimony, or evidence, the landmark United States Supreme Court cases *Daubert v. Merrell Dow Pharmaceuticals, Inc.,* 509 U.S. 579 (1993) and *Frye v. the United States,* 293 F. 1013 (1923) must be considered. In light of the litigation mentioned above, trial court judges are regarded as gatekeepers of evidence allowing or refusing the testimony of expert witnesses based on each individual's credibility. The use of, and debate around, expert witnesses is not limited to brain injury cases and dates back many years in both civil and criminal cases. Expert witnesses testify in civil lawsuits for this research, and this study will not address criminal law issues. The precedent established in these landmark cases guides federal and state courts in setting forth standards to be followed. Additionally, Rule 702, in the Federal Rules of Evidence, provides specific criteria for all expert witnesses testifying in federal court. These witnesses are intended to assist the jury in rendering fair verdicts.

In brain injury litigation, generally, expert witnesses have a neurology (medical doctor) or neuropsychology (psychology) background. According to the American Psychological Association [APA] (2022), neuropsychology is a specialty in professional psychology that applies principles of assessment and intervention based upon the scientific study of human behavior as it relates to normal and abnormal functioning of the central nervous system. The definition has evolved and changed over time, and this is the most recent definition assigned by the APA. Since this is an area of psychology, the typical degree held by a clinical neuropsychologist is a Ph.D., and many also obtain additional postdoctoral training, specifically in neuroscience. Therefore, becoming a clinical neuropsychologist does not require completion of medical school.

1.2 Purpose of the Study

The purpose of this study is to critically evaluate and understand the extent to which the H-Index scores of plaintiff and defense experts may affect the outcomes of mTBI litigation. This information can be insightful in various ways and applied to future research.

1.3 Problem Statement

The human brain is highly complex, and many aspects are still not well understood by the scientific community. The fields of neuroscience, clinical neurology, and human neurobiology continue to evolve while innovative technologies and scientific advancements come about. New ways to scan the human brain and diagnose injuries have created unprecedented situations from a legal standpoint. In mTBI lawsuits, expert witness testimony is usually presented on behalf of both the plaintiff and defense and each side's opinions often conflict. Generally accepted requirements for witness qualifications, objective diagnosis methods, and supporting research guidelines currently do not exist. At present, there is a gap in the literature addressing consistent qualifications or requirements of expert witnesses in mTBI negligence lawsuits.

In some cases, as technology advances in the diagnostic arena, more objective measures are available; however, the validity of these techniques is disputed. “With more advances in brain imaging, the legal system will face greater pressure to determine which imaging techniques will have probative value in a given case and which may be prejudicial or even misleading" (Shenton et al., 2018, p. 51). Despite existing literature exploring mTBI as a condition and research exploring factors in mTBI litigation, no known studies are using H-Index scores to operationalize and compare the quality of plaintiff and defense expert witnesses testifying in mTBI civil litigation.

1.4 Research Questions

RQ1. How do the H-Index scores of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation compare?

RQ2. To what extent does the difference in H-Index scores between plaintiff and defense expert witnesses correlate with a favorable litigation outcome in a mild traumatic brain injury case?

1.5 The Researcher

The information science (IS) doctoral program at the University of North Texas (UNT) is well established as interdisciplinary, and students are encouraged to explore other relevant subject areas during their educational experience. According to Williams, "information science brings together and uses the theories, principles, techniques, and technologies of various disciplines toward the solution of information problems" (1987, p. 17). The researcher's interests and background led to exploring healthcare issues and health law under the interdisciplinary information science health informatics Ph.D. program.

Over 15 years of experience, education, and knowledge of the theories and methods of information science provide the requisite foundation for conducting this doctoral research. As Borko stated (1968), "Information Science is that discipline that investigates the properties and behavior of information, the forces governing the flow of information, and the means of processing information for optimum accessibility and usability" (p. 3). The interdisciplinary nature of the discipline provides a good starting point for exploring the data associated with expert witness testimony in mild traumatic brain injury civil litigation. In addition, this research heavily incorporates bibliometric analyses and methods, which are well known to have originated in the information science domain.

1.6 Definitions

The challenge of exploring brain injury litigation is the complex nature of the medical and legal fields. There are essential terms and contextual considerations related to the concepts unique to each discipline as used in this research.

- *Civil litigation*: Any action brought in a civil court; this refers to matters that are not criminal.
- *Defense expert witness*: A defense expert witness is usually paid and has a specific and highly defined specialty or expertise. This individual provides their knowledge and testimony to the case on behalf of the defense.
- *Expert*: An expert is a highly skilled professional in their field of study.
- *H-Index*: The H-Index is a quality metric that identifies the scholarly output of a researcher. This is a measure of impact and performance.
- *Litigation*: Within the scope of this research, lawsuit and litigation will refer to any civil action brought by a plaintiff in a federal or state court of law, and it will not include any criminal proceedings. As litigation is discussed throughout this study, it is interchangeable with the term lawsuits. Litigation will encompass any case, as defined above, that results in various outcomes, including, but not limited to: settlement, verdict, or decision. The study data are limited to only outcomes that resulted in a verdict or settlement.

- *Mild traumatic brain injury (mTBI)*: A mild traumatic brain injury is a hit or blow to the head; this term can be interchangeable with concussion.
- *Neuroimaging*: In this study this term is used to define any type of brain scan conducted on a patient in relation to an mTBI. This can include X-ray, magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI), diffuse tensor imaging (DTI), positron emission tomography (PET), electroencephalography (EEG), and computed tomography (CT).
- *Plaintiff expert witness*: A plaintiff expert witness is usually paid and has a specific and highly defined specialty or expertise. This individual provides their knowledge and testimony to the case on behalf of the plaintiff.
- *Qualification*: This refers to any education or experience that would enhance the chosen practice of a professional.
- *Witness*: A witness in this study is a paid expert by the plaintiff or defense that is providing testimony in a mTBI civil lawsuit.

1.7 Assumptions

In conducting this study, several assumptions are made. First, it is assumed that the Westlaw legal database provides a representative sample of all cases across all jurisdictions in the United States. Second, selecting the seven years, 2013 to 2019, provides an adequate sample size and reliable results.

Additionally, the data regarding the background of expert witnesses in Westlaw and other sources used in this research are accurate. Finally, any changes in laws over time do not materially impact results and are therefore not accounted for in this study.

1.8 Limitations and Delimitations

Westlaw was used to search for cases, and although this is regarded as a comprehensive legal resource, some cases matching the inclusion criteria may not have been selected if unavailable in Westlaw. The case data is derived from publically available records, and some jurisdictions may or may not submit all information. Only cases that resulted in a jury verdict or settlement are included. Any privately resolved or sealed matters were automatically excluded from the dataset. Also, it is possible that a mTBI case is not included if it is inaccurately classified as a moderate or severe brain injury case and litigation proceeded under that assumption.

During the early part of 2020, while this research was underway, the COVID-19 Pandemic changed the landscape of society in immeasurable ways. The outbreak caused many operations, businesses, government entities, and individuals to overhaul their way of doing things thoroughly. The data and information related to the occurrence, frequency, and litigating of matters related to mTBI were changed significantly. In every city and state, the U.S. court system was impacted by how cases were handled and the timing of all legal matters. As employees stayed home and nearly all youth sports were halted, the number of incidents also declined. Further, the legal system had limited ability and resources to proceed with cases already being litigated due to the pandemic. Ultimately, this created a backlog in many courts which would likely result in irregularities in the data after the date that stay-at-home orders were enacted in the U.S.

Only civil cases from federal and state courts comprise the data set. Brain injuries that are not explicitly identified as mild are not considered for inclusion, and this eliminates injuries noted as moderate, severe, or of unspecified severity. To limit the scope of the study, the size of the initial Westlaw data set only includes cases from 1/1/2013 to 12/31/2019. Additionally, this cutoff date of 12/31/2019 was selected due to the potential skewing of any results and data that could occur after the COVID-19 stay-at-home orders were enacted in early 2020. The information obtained regarding expert witnesses, including qualifications, publications, and other related data, was collected at the time of this research rather than at the time of the litigation outcome. There is one exception to this, and it is years in practice. Applying this approach could result in a slightly varied H-index as changes may have occurred after the lawsuit. However, it is assumed that any variance is insignificant to this research.

1.9 Significance

There is a long history of brain injury litigation dating back over 100 years, and historically, the relationship between law and medicine has been challenging in the legal arena (Taylor, 2015). Litigation of any mTBI involving negligence claims is considered a civil matter and subject to the applicable rules of evidence, which govern expert witness testimony. Since most mTBI lawsuits include plaintiff and defense expert witnesses, it is an area of importance to explore. With the persistent lack of agreement among professionals regarding diagnostic methods and mTBI prognosis, it is challenging to litigate and treat this condition. First, findings and conclusions from the study can illuminate inconsistencies that may warrant additional investigation. Second, it could give governing entities or societies valid data points or guidance on standards to set forth or amend while providing a clear picture of the typical qualifications held by mTBI expert witnesses. Finally, the research can inform and guide other studies examining expert witnesses in different areas of litigation.

1.10 Summary

Identifying expert witnesses' common qualities and qualifications in mild traumatic brain injury cases is critically important. Expert witnesses represent a small portion of the total professionals in the field, and the impact that they collectively have on trial outcomes is significant. Those who undertake this responsibility must be highly qualified and objective and represent the universe of skilled professionals. This chapter introduced the purpose of the study, problem statement, research questions, definitions, assumptions, and limitations of the study and finally the significance of this research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A thorough survey of mild traumatic brain injury epidemiology, diagnosis, prognosis, and related litigation marked my starting point. These critical elements are foundational to understanding the role and duty of a medical expert witness in an mTBI civil lawsuit. This chapter is a review of the literature related to the overarching focal points and more narrowly defined subject areas. To orient the reader and provide context, this portion is organized into the following three main parts a) mild traumatic brain injuries, b) litigation and legal history, and c) information science and bibliometric methods of research.

2.2 Mild Traumatic Brain Injuries

Brain injuries have garnered increased awareness and controversy in recent years. This attention has likely resulted from new research that supports the potentially harmful long-term impact of sports-related head trauma. Maas and Menon (2017) stated that a frequent cause of traumatic brain injuries, receiving more attention in recent years, were due to sports-related injuries. Emery et al.'s (2017) study suggested that most sports-related mild traumatic brain injuries impact youth ages 11 to 18 and that of this group, 10% sustained a sports-related concussion annually.

Although TBI and mTBI are common in sports, there are many other brain injury causes that are also common. Taylor et al. (2017) claimed the primary reasons for TBI-related emergency department (ED) visits were injuries from unintentional motor-vehicle crashes, falls, objects (striking by or against), and others. These injuries encompassed a wide range of severity in TBI cases and included those categorized as mild. It was determined by Cassidy et al. (2004)

that 70% to 90% of all brain injury cases were classified as mild. Since mTBI may or may not always result in an ED visit and symptoms may not immediately be present, the annual number of cases is likely higher than reported. According to the research by Taylor et al. (2017), those at most significant risk were children between 0 to 4 years old and adults over the age of 75.

As attention to mTBI has increased over the past decade, so have many brain injury lawsuits. This increased attention sparked research and publications discussing the long-term impact of mTBI with experts stating that “lawsuits alleging brain injuries have tripled in the past 20 years” (Woodard et al., 2016, p. 28). The long-term impact of mTBI is often a central argument in civil litigation, and agreement regarding the objectivity of the diagnosis is a crucial factor. As neuroscience advances, evaluating traumatic brain injury (TBI) and, specifically, litigation is becoming an increasingly complex medical-legal issue (Gaudet et al., 2016). The term “neurolaw” was first introduced in 1991 and was used to refer to the complex field of law and neuroscience in the context of traumatic brain injuries (Taylor, 2015). Neurolaw has evolved, and a recent resurgence of attention has been placed on this field of study extending well beyond law and neuroscience in the context of brain injuries. Shen (2012) demonstrated in his law and neuroscience bibliography that “in the past five years, we have witnessed extraordinary growth in the amount of legal scholarship, legal practice, and public policy at the intersection of law and neuroscience” (p. 352).

Injuries of the brain can vary substantially and have lasting effects on individuals. Scientific understanding of the human brain, with its numerous complexities, continues to expand and evolve with advances in neuroscience and medicine. In conjunction with outcomes, this knowledge serves as the basis for developing an evidence-based approach to treating the cognitive and physical symptoms of TBI. According to the CDC (2015), although there has been progress in understanding and developing adequate interventions for TBI, a significant amount of work remained. Examining the spectrum of severity in TBI, generally, there is a positive correlation between the severity of the trauma and the presence of objective evidence to support the injury. As such, mild traumatic brain injury does not always have widely accepted methods for confirming the diagnosis or prognosis after sustaining this type of injury. However, scientific advances in imaging create new ways to identify potential abnormalities associated with mild injuries and support a better understanding of brain and behavior connections injured and uninjured brains (Shenton et al., 2018).

2.2.1 Public Health Issue

Brain injuries impact more than just the individuals who sustain an injury. Brain injuries can also dramatically alter the lives of family members who may take on additional responsibilities and the burden of caring for someone. There can also be significant community and economic implications of TBI. "Although data are limited, estimates based on data from two states indicate that 3.2 million – 5.3 million persons in the United States are living with a TBI-related disability" (CDC, 2015, p. 2). The limitation of such must also be considered when evaluating the long-term implications of suffering any brain injury.

2.2.2 Glasgow Coma Scale

Using the Glasgow Coma Scale (GCS) score has become standard practice to evaluate head injuries. "The Glasgow Coma Scale has permeated and influenced practice for over 40 years, being well-established worldwide as the key tool for assessing the level of consciousness" (Braine & Cook, 2017, p. 280). Teasdale and Jennett (1974) first introduced this assessment tool in 1974. It was presented as a clinical scale that "has been evolved for assessing the depth and duration of impaired consciousness and coma" (Teasdale & Jennett, 1974, p. 82). It is important to note that the GCS must be used differently in pediatric settings for children under five due to verbal skill development. Several modified pediatric GCS models were used, and there was not one specific universally adopted version for children in this age group (Shobhit et al., 2021).

Table 1

Glasgow Coma Scale

Parameter: Total Score	Response	Score
Eye Opening [E]: Total 1 to 4	Spontaneous	4
	To Sound	3
	To Pain	2
	None	1
Verbal [V]: Total 1 to 5	Oriented	5
	Confused	4
	Inappropriate Words	3
	Incomprehensible Sounds	2
	None	1
Defendant H-Index: Total 1 to 6	Obeys Commands	6
	Localizing Pain	5
	Withdraws From Pain	4
	Abnormal Flexion to Pain	3
	Abnormal Extension to Pain	2
	No Motor Response	1

Note. Adapted from “Glasgow Coma Scale,” by J. Shobhit, G.M. Teasdale, & L.M. Iverson, 2021, StatPearls.

The GCS is a scored evaluation based on three critical areas of observation a) eye-opening response, b) verbal response, and c) motor response. This scale is used to describe impaired consciousness and is also used to evaluate the three areas separately to effectively ascertain a patient’s state (Shobhit et al., 2021). The scores from each of the three regions are aggregated, and the total score indicates the severity of the head injury. The range of an aggregate score is 3-15, the lower the score, the greater the severity of the brain injury. The GCS

(Table 1) specifically categorizes TBI as mild 13-15, moderate 9-12, and severe 3-8 (CDC, 2015).

Brasure et al. (2012) suggested improving the accuracy of TBI classification. There was a risk of misclassifying the severity of a TBI if the GCS was used alone, and additional criteria was considered when evaluating a head injury (CDC, 2015). There is also a risk when assessing results since the GCS is a tool used by trained professionals who apply their subjective knowledge in observation. It is recommended that additional criteria are considered in evaluating the severity: structural imaging, loss of consciousness, post-traumatic amnesia, and abbreviated injury scale score should also be incorporated.

2.3 Civil Litigation and the Expert Witness

In a civil suit, the plaintiff files a complaint to initiate a lawsuit, and the defendant may respond. Based on the outcome at the trial level, either party generally has the right to appeal. Applying the law to fact was noted as how the judicial system was designed with researchers recognizing, “the parties are adversarial the judge is the trier of law, and the jury is the trier of fact” (Jerrold, 2007, p. 889). In a jury trial, the judge in the case will determine which laws are applicable, and it is then the jury's role to render a decision based on the facts of the case. It is critical to ascertain a complete and accurate picture of the events and situation. There are instances where the jurors, judges, and attorneys do not have the specialized knowledge necessary to understand a case's facts thoroughly. Sometimes this can only be explained by highly skilled or trained professionals in a given field. This is when an expert witness may be introduced to the court by either the plaintiff or the defense, and this person’s role is to interpret or describe the circumstances or facts. It is also important to note that there are different venues to resolve cases, such as arbitration which may also support using an expert witness to testify on behalf of the plaintiff or defense.

One of the required elements for most negligence cases is a duty owed by someone and a subsequent breach of that duty. In a typical legal approach to medical malpractice lawsuits, the medical provider owes responsibility and an alleged violation of that duty. In a TBI or mTBI negligence case, a medical professional may be, but is not necessarily, the defendant who purportedly owed and breached a duty. More often, the negligent party in an mTBI/TBI civil suit is an employer, business, driver, etc. Expert witnesses in medical malpractice cases are traditionally medical experts testifying and discussing injury causes. Whereas in a TBI or mTBI lawsuit, this is not necessarily the case, and the medical expert witness more often focuses on the diagnosis and potential long-term implications of the brain injury rather than the cause. This is also a critical part of litigation as damage is another required element of a successful negligence case. The potential financial recovery for these two types of cases, medical malpractice, and personal injury, can differ substantially as damage caps for medical malpractice and personal injury cases vary by state.

2.3.1 Evidence

The legal system in the United States is divided into individual state court structures and the federal court system. These court systems run in parallel, and there are 51 jurisdictions. The federal courts follow the Federal Rules of Evidence set forth by the Supreme Court and its appointees. Each state, and its respective court system, is responsible for its own rules of evidence; however, states often closely follow and use the Federal Rules of Evidence as a roadmap in their jurisdiction. Since management of proof can vary by jurisdiction, an examination of all rules of evidence would be too detailed and complex for this research. Further, since most states adopt and utilize a version of the Federal Rules of Evidence, this is informative and relevant to examine. Finally, it is essential to note that law is continually evolving, and some of the cases and rulings discussed in this research may be superseded by new precedential orders or recently enacted statutes.

The evolution of rules and standards around expert witness testimony includes considering the statutory and common law developments. The statutory law most often referred to concerning expert witnesses is Rule 702 in the Federal Rules of Evidence. The following significant cases have influenced the common law: (1) *Daubert v. Merrell Dow Pharm* (1993); (2) *Frye v. the United States* (1923); and (3) *Kumho Tire Co. v. Carmichael* (1999). In *Frye v. the United States* (1923), the court held that evidence must be generally accepted in the scientific community to be admissible. This was the standard followed until the Supreme Court ruled in *Daubert* that the Federal Rules superseded common law (*Frye v. the United States, 1923*), and the holding indicated that general acceptance is not a required element of admissibility for expert witness testimony. This ruling ultimately empowered the trial court judge to apply the law in Rule 702 and use discretion in determining if testimony could be admitted. After *Daubert v. Merrell Dow Pharm* (1993), Rule 702 was amended and reinforced the role of trial court judges. Then the *Kumho* court established that the trial court judge's position concerning expert witnesses was not limited to those only in the domain of science.

In the federal court system, admissibility of expert witness testimony is governed by Rule 702 in conjunction with the U.S. Supreme Court case *Daubert v. Merrell Dow Pharm* (1993). Currently, Rule 702 is the standard followed by federal courts, and it supersedes any other prior law. The *Daubert v. Merrell Dow Pharm* (1993) court’s holding is still relevant, and the case has precedential significance. It established the standard approach that trial court judges use to determine the admissibility of expert witness testimony; this is known as the “Daubert Test.” It involves evaluating the evidence to determine appropriate fit given the facts of the case and the scientific merit of the opinion.

2.3.2 Medical Malpractice

Medical malpractice is a cause of action in civil litigation and claims often arise when a medical professional omits information or fails to provide the level of care that is considered reasonable within the field. Medical professionals are often hired to provide expert witness testimony in medical malpractice lawsuits. The defendants in medical malpractice lawsuits are usually medical providers, and expert witnesses are often peers. In mTBI cases, medical professionals do not represent the largest portion of the defendant pool; yet there are important parallels in these two cases concerning the expert witnesses. When considering the role of the medical expert witness in both civil litigation of mTBI and medical malpractice, it is essential to know that there is a heavy reliance on physicians testifying on behalf of both the plaintiff and defense. Historically, medical expert witnesses had immunity when providing testimony, but some state medical licensing boards still had jurisdiction over the legal ramifications (Bal, 2009). Medical malpractice cases are distinct and different from other types of negligence cases in that a medical professional is the one who purportedly breached a duty, and a medical expert witness (e.g., peer) must weigh in on the situation. In other types of civil litigation, expert witnesses are not necessarily medical professionals and can be an expert in their respective fields. The background and overview of the expert witness in medical malpractice is an important consideration for this research, given that the expert witnesses for both medical malpractice and mTBI civil cases tend to both be physicians in a medical practice setting.

Medical malpractice litigation is an ongoing concern in healthcare and is contributing to increasing costs. Additionally, risk factors associated with malpractice litigation increase physician medical malpractice insurance premiums. Certain specialties experience a greater number of malpractice lawsuits annually. Jena et al. (2011) noted the following as the top ten specialties by percentage of malpractice claims annually: a) neurosurgery, b) thoracic-cardiovascular surgery, c) general surgery, d) orthopedic surgery, e) plastic surgery, f) gastroenterology, g) obstetrics and gynecology, h) urology, i) pulmonary medicine j) oncology, and k) cardiology. When medical malpractice disputes arise, expert witnesses are relied upon for their extensive knowledge of the subject matter, years of experience, and professional opinions. "The roles of the expert witnesses include interpreting the medical terminology and testimony for the jury, providing an opinion on the standard of care, and offering an explanation of the injury sustained in terms of such factors as severity, permanency, and ramifications" (Huang et al., 2015, p. 588).

2.3.3 Rutgers New Jersey Medical School: Studies in Medical Malpractice Litigation

Research addressing expert witness testimony in medical malpractice litigation in various specialties examined and compared the qualifications of plaintiff and defense expert witnesses in medical malpractice litigation (Eloy et al., 2013, 2014; Huang et al., 2015; Radvansky et al., 2015; Sunaryo et al., 2014). The researcher selected certain Rutgers published studies for inclusion in the present literature review with topics covering neurology, otolaryngology, ophthalmology, anesthesiology, and urology. These studies were publications of research conducted by Eloy et al. (2013, 2014), Huang et al. (2015), Radvansky et al. (2015), and Sunaryo et al. (2014), respectively. All research took place from 2013 to 2015, and all studies were published in a variety of scholarly peer-reviewed journals.

Each of the studies were structured similarly, and no significant differences were identified in the methodological approaches. The studies sought to compare plaintiff and defense expert witness qualifications by examining descriptive qualities such as years in practice, fellowship, academic affiliation, etc. Data was obtained using four sources: a) Westlaw, b) SCOPUS, c) Lexis Nexis, and d) Google Scholar. Specifically, the bibliometric measure of the H-Index for each expert witness, where available, was determined using the Scopus database. Lexis Nexis and Westlaw were employed and cross-referenced to validate the remaining data. If critical information regarding an expert witness was not available in Lexis Nexis or Westlaw, a Google Scholar search of state medical boards, licensing agencies, or academic institutions was conducted. “The H-Index was an objective measure of the relevance and impact an author’s research contributions have had on scholarly discourse within his or her field” (Eloy et al., 2013, p. 185). Statistical analyses such as a Student *t*-test, Mann Whitney *U* test, and Chi-square analysis were conducted using SPSS software.

The results of these studies may be seen as provocative and, in some instances, directly suggest that governing societies or associations should re-evaluate expert witness guidelines. In four of the five studies, it was found that expert witnesses for the plaintiff had a lower mean H-Index than the defense. The only study that did not reflect a significant difference in the H-Index between the two groups was ophthalmology, and the results were an H-Index of 8.6 and 8.3 for the defense and plaintiff, respectively. A statistically significant difference in academic practice setting was noted in all five studies and leaned towards expert witnesses for the defense. In all five studies, both sides' total mean years of the experience exceeded 30 years. The medical school graduation date for each expert was used to determine the first year of experience since this information was more universally available to the researchers, according to Eloy et al. (2014).

In all of the studies, the data were collected at a specified point in time, which appears to coincide with the data needs of the researchers for each particular study; therefore, the qualifications of the expert witnesses were all determined after the testimony was given, and the time between deposition and data collection could vary for each witness. In effect, there is a chance that the H-Index or other descriptive data may have changed from the time the testimony was given (e.g., an expert witness could publish more articles or receive more citations) to when the study was completed. A comparison of the results from all five studies is detailed in Table 2.

Table 2

Rutgers Medical School Studies

	Year Published	Unique Witnesses	Defense Mean H-Index	Plaintiff Mean H-Index
Neurology	2014	270	8.76	5.46
Otolaryngology	2013	161	10	6.3
Ophthalmology	2015	132	8.6	8.3
Anesthesiology	2015	273	8.1	4.8
Urology	2014	247	10.2	6.8

A revealing study was conducted in Amsterdam by de Reuver et al. (2008) addressing the agreement of expert witnesses in bile duct injury (BDI) medical malpractice litigation. The purpose of the research was to investigate the reliability and agreement of experts in litigation, and it was indicated that there are very few studies of this nature. This research approached the issue differently than the Rutgers' studies. It was designed as an empirical study, with a sample size of 13 expert witnesses evaluating ten of the exact same medical record files. All ten records were derived from an insurer's medical case file database (de Reuver et al., 2008). The experts knew the outcomes of the cases in advance, and the morbidity and mortality details were indicated in the records.

Additionally, unlike the expert witnesses evaluated in the Rutgers' studies, where it can be reasonably assumed that they were compensated during litigation, the expert witnesses in the bile duct injury study were not. The researchers made a point to state that “monetary compensation may bias the outcome, and therefore testimonies should never be provided for financial gain” (de Reuver et al., 2008, p. 815). Despite the controls put in place by the researchers and the absence of compensation, there was poor agreement among expert witnesses in nearly all of the cases. Only one case garnered unanimous agreement, and most experts believed that negligence occurred. The findings also indicated that “group agreement did not improve among experts working in an academic setting or by selecting experts with experience in BDI litigation” (de Reuver et al., 2008, p. 815).

2.4 Information Science

For many years the study of information science-primarily encompassed documentation, bibliography, and librarianship. Buckland (2012) suggested that the movement towards the social sciences and a broader definition of information science, driven by the focus on interdisciplinary studies, affirm what was argued historically about this social science. Buckland stated that “Patrick Wilson was right: Information studies involves a broad range of the social sciences (and humanities) and some highly specialized engineering” (Buckland, 2012, p. 7). The inherently interdisciplinary nature of information science and the lack of a clear, measurable, and rigorous definition rendered it a very different field than other sciences. Buckland (2012) further argued that since a rigorous definition or quantifiable physical property was lacking, “it was characteristic of softer social sciences that neither was available and one must do the best one can with the least unsatisfactory surrogates” (Buckland, 2012, p. 5).

Scholars have had significant discussions and debates around the specific definition or understanding of information science (Bates, 2005; Buckland, 2012). “Many major and minor efforts have been made over the years to develop the term and to provide a framework for theory development and further general development of information science" (Bates, 2005, p. 239). Both Bates (2005) and Buckland (2012) precisely articulated factors that contributed to the broad and varied definitions. "One source of the variety of approaches may be the many different disciplinary origins of writers on the information. Engineering, the natural sciences, a wide array of the social sciences, and the humanities have all contributed to the discussion." (Bates, 2005, p. 239). Although attention was given to this over the years, what ultimately perpetuated the debate in the broad field of information science, was the continued lack of standards in the research environment (Buckland, 2012).

2.4.1 History of Bibliometrics

The origins of bibliometrics can easily be traced back to its roots in Library and Information Science. It is widely accepted that bibliometric methods and measures applied to peer-reviewed research can measure output and quality. This quantitative method is data-driven and allows for tracking journal and author productivity. Applying the appropriate bibliometric methods to a body of research can identify an author's or a journal's significance, influence, and authority.

The early pioneers of bibliometrics laid the foundation for what has been modernized and adopted across several disciplines and used today. Three primary researchers, Lotka, Bradford, and Zipf, were credited with developing this discipline's initial framework and laws in the early 20^{th} century, long before being introduced to the term bibliometrics. "Lotka, Bradford, and Zipf used simple mathematical statements and graphical devices to express the empirical relationship between sources and the items they produce" (De Bellis, 2009, p. 9). These founders heavily influenced the currently used laws and methods in bibliometric studies.

Lotka analyzed the frequency distribution of scientific productivity and developed what is known today as Lotka's Law. "This law, one of the most widely used in bibliometrics, assesses patterns in author productivity" (Andrés, 2009, p. 125). Lotka's Inverse Square Law of Productivity is focused on an individual author's productivity and measures output when the sample size is large enough. The application of Lotka's Law can approximate the number, or percentage, of individual contributors to a specific area of research or body of knowledge. Samuel Bradford's Law of Distribution of Scattering is applied to journals rather than authors. The application of this law can identify the core journals in each scientific field. These would represent the primary and, arguably, the most authoritative or influential publications. It is suggested that researchers and institutions should then subscribe to these identified as the "nucleus" of periodicals, according to Shenton and Hay-Gibson (2011). Applying Bradford's Law and identifying core journals in each discipline would provide researchers access to the most important and relevant work. Zipf's research was focused on the distribution of words within a body of text and primarily examines word frequency. His development of Zipf's Law is based on power laws and postulates that the frequency and use of any given word increases with the length of the text (Andrés, 2009, p. 39).

As science and technology advanced, bibliometrics evolved, and information aggregation became less labor-intensive and manual. In the mid-20th century, progress was made in indexing. "Garfield developed a Science Citation Index, i.e., a multidisciplinary database in which authors could find articles from across many fields" (Andrés, 2009, p. 3). After the volume of data and number of journals became too cumbersome and limitations related to smaller publications were apparent, the database was modified from the author citation index to a journal citation index. At the end of the 20th century, traditional indexing systems were replaced with online tools

(Andrés, 2009). Present-day, bibliometric studies leverage online databases, but this was not widely available until the 1990s when much of the data collection process became automated.

It is essential to draw a clear distinction between peer-reviewed or refereed scholarly articles and all other content. Often, a bibliometric study involves collecting and aggregating academic publication data that would be considered peer-reviewed research. Large databases noted as superior sources are Web of Science and Scopus (Kulkarni et al., 2009). Other content includes scholarly research (not refereed or peer-reviewed), industry or trade publications, Law Review articles, and popular literature. Although relevant and informed articles may not be peer-reviewed, relying on literature put through the peer-review process ensures that extensively trained and knowledgeable professionals in the discipline have vetted the research. It is important to note that Law Review articles are considered scholarly but are not peer-reviewed and are generally edited by law students under the supervision of law school faculty.

2.4.2 Bibliometrics and Information Studies

Bibliometrics is considered one of the more scientific areas of information studies and is rooted in citation analysis with heavy quantitative, algorithmic, and technical aspects. It is noted as the "epicenter of quantification in information science" (Buckland, 2012, p. 6). The origin of bibliometric methods preceded, by several decades, the now widely accepted term bibliometrics coined by Pritchard in 1969 in the Journal of Documentation. He suggested that continued use of the term "statistical bibliography" to describe this type of research was confusing and not well received by the academic community. Pritchard (1969) defined bibliometrics as an application of mathematics and statistical methods to books and other media of communication. A more recent definition offered is "bibliometrics is the process of extracting measurable data through statistical analysis of published research studies and how the knowledge within a publication is used"

(Agarwal et al., 2016, p. 297). This definition accurately described how bibliometric methods were used in the present study.

Employing a bibliometric approach can be highly scientific and quantifiable; however, since the context can vary based on the individual study and topic, some ambiguity persists. About bibliometric analysis and studies, Buckland (2012) believed such “yielded useful results but also necessarily compromised, incongruous processes” (p. 7). Despite the varied nuances found in different areas of study, there are fundamental principles that are consistent in bibliometric research and methods. Ultimately, “the objective of bibliometrics is basically to assess scientific literature in a given field, hence its broad applicability to all manner of disciplines” (Andrés, 2009, p. 1).

The overarching intent in a bibliometric study was to examine a body of published material and identify patterns, growth, relationships, trends, and themes to assess significance. Bibliometric studies were undertaken to analyze performance and scientific mapping (Zupic & Cater, 2015). Scientific mapping identified relationships among institutions, topics, and researchers not immediately apparent. The use of co-citation analysis allowed researchers to place links and patterns in the research structure. Zupic and Cater (2015) believed it was the most valid, widely used, and reliable bibliometric method despite the limitation of only first author data being available in Web of Science.

It is common to have descriptive information about the data set presented in a bibliometric study. This is based on the final data set and can include location, year, institution, and the like. Typically, findings are illustrated in a graph and demonstrate trends in growth or decline; often, percentages can be assigned to the results provided in a table. An example of a percentage used in descriptive bibliometrics could be the percent of publications in the data set originating from a specific country or academic institution. Any other relevant descriptive information may be included and communicated in a bibliometric study to the reader.

Performance analysis encompassed the methods that determine the scientific output of authors and journals, including both content analysis and citation analysis. Citation analysis was chiefly associated with influence. In discussing performance analysis, it was essential to note that taking a quantitative approach may not provide a holistic quality view. “While the total number of publications alone may be used to derive the productivity of the researcher and their institution, it did not indicate the quality and significance of a research publication, nor did it indicate the impact of the research or the researcher” (Agarwal et al., 2016, p. 296).

Citation analysis is a core concept in bibliometrics and is a crucial tool used to measure the influence or impact of scholarly peer-reviewed work. Citation analysis can be applied to individual authors or journals; two standard citation measures are the H-Index and journal impact factor, respectively. Agarwal et al. (2016) assumed that the greater the number of citations received, the more significant the impact. Andrés (2009) explained that citation was typically a means by which an author provided credit to a source or author, and analysis of such citations indicated the quality of a researcher or specific journal. Descriptive indicators such as total publication count can provide a cursory view of an author’s productivity, whereas author citation analysis provides a deeper view of how others have used a researcher’s work overtime.

Several key factors are essential to understand when evaluating a researcher’s output. Elements that can be influential are the number of publications, the number of citations received, and the quality of the journals. The H-Index can be a valuable tool to identify the impact of a researcher and compare researchers quickly. Before the development of the H-Index, this was almost always a subjective exercise lacking a comprehensive approach when ascertaining a researcher’s impact. Hirsch (2005) proposed a practical way to characterize the scientific output. It was quite possible that two scientists can have very different scores but the same number of total publications. Conversely, two researchers can have a vastly different number of publications and the same score. Hirsch (2005) concluded that if two researchers had similar scores, their impact was comparable irrespective of differences in the total number of publications. All things being equal, the scientist with the higher H-Index score was, according to Hirsch, “the more accomplished scientist” (Hirsch, 2005, p. 16569).

This bibliometric tool is intended to quantify and show the relevance of a researcher in one single score. The two components of the score are the researcher’s productivity and the impact of the researcher’s output. Hirsch (2005) defines his formula as “a scientist has index h, if h of his or her N_p papers have at least h citations each, whereas the other ($N_p - h$) papers have no more than h citations each” (p. 16569). If a researcher had an H-Index of 25, they would have 25 publications and 25 citations for each publication.

According to Saleem (2011), the H-Index was a reliable tool used and touted by influential journals such as The Journal of Neuropsychology, Harvard Review of Psychiatry, and Academic Radiology. The requisite citation data needed to calculate an H-Index generally comes from Scopus, Google Scholar, or Web of Science. Rousseau (2007) noted that even when a small number of highly cited papers were not included in the index, it did not materially change the scientist's H-Index. This was noted as a critical element to understand when choosing which source to use for citation counts, and ultimately, even if one of the databases failed to have a specific publication, it can be assumed that the H-Index would not vary significantly based on the data source used (Rousseau, 2007).

2.4.3 Other Disciplines

Historically, Library and Information Science has been the primary area concerned with the quantifiable and algorithmic methods of bibliometrics. In recent years, its use has extended beyond information science and expanded in its application to several other fields such as business, technology, and medical science. Increased attention has been placed on in the use of bibliometric methods in management and organization, which influences and impacts the broader business discipline. Research conducted by Zupic and Cater (2015) examined bibliometric studies involving management and organization; they established that over half of the investigation occurred after 2011, suggesting that the trend was an increase in the growth of this type of analysis. It is also understood that bibliometric study has been fuelled by the more readily available publication data in scientific databases such as Web of Science (Zupic & Cater, 2015).

Although bibliometrics is growing in several areas outside of information science, it has yet to take hold, in any significant way, in legal research. In 1985, when the original study was first published, the term "legal cytology" was assigned to the methodology of citation analysis used in this discipline, and Shapiro was credited with its creation (Shapiro & Pearse, 2012). Shapiro and Pearse (2012) conducted three different studies exploring citation counts in the legal field from 1985 to 2012. In the most recent study, Shapiro and Pearse (2012) used Web of Science and Hein Online databases to compile several top 100 article ranking lists evaluating characteristics of law schools, authors, and other relevant data. This data was the most comprehensive of the three studies and included a review of thousands of social science journals dating back to 1900 from Web of Science and nearly all law school Law Review articles published to date were available in the Hein Online database.

Table 3

Medline Publications Under MeSH Heading: Bibliometrics

Years	Total Publications	Increase Over Time Period	Growth Over Previous Period
1962 - 1989	7		
1962 - 1990	14	7	100%
1962 - 1995	104	90	643%
1962 - 2000	338	234	225%
1962 - 2005	1016	678	201%
1962 - 2015	3514	2498	246%
1962 - 2016	3814	300	9%
1962 - 2017	4099	285	7%
1962 - 2018	4337	238	6%

In medical sciences, bibliometrics has grown considerably over the past 20 years. In 1990, when bibliometrics first became a Medical Subject Heading (MeSH), 12 articles were published under the MeSH *bibliometrics* in the Medline database. By 2013, that number had risen to 686, a 57-fold increase (Thompson & Walker, 2015). In a Medline search conducted on July 15, 2019, the following articles under the MeSH heading bibliometrics were found for inclusion in this study. From 1962 to 1989 there were 7, and from 1962 to 1990 a total of 14. Expanding the search to include all articles from 1962 to 2018, there were a total of 4,337. Over the past 30 years, this growth shows the most significant 5-year aggregate percentage growth of over 200% occurring in each of the 5-year periods measured from 2000 to 2005, 2005 to 2010, and 2010 to 2015. More recently, growth from 2015 to 2018 has ranged from 6 to 9% annually (see Table 3). This growth demonstrates the increased interest and potential funding in bibliometric research in the medical sciences. As Thompson and Walker (2015) stated, the application of bibliometric principles to health sciences and pharmacotherapy is a natural progression for health care professionals with background training in Library and Information Science. These individuals have the necessary database searching skills and clinical application backgrounds to readily apply the tools of bibliometrics to clinical, informational, and academic areas of interest. (p. 551)

2.5 Summary

The exploration of the current literature suggested that many aspects of mTBI litigation and the use of expert witnesses warrant further research. The opinions of expert witnesses could be subjective in this context as it is difficult to obtain objective information to assess and evaluate mTBI. It would be beneficial to identify how expert witnesses could best provide objective testimony and aid the jury in rendering a fair verdict. The current situation does not lend itself to a set of standards that can be relied upon or applied uniformly. There are several varied approaches, undefined standards, and conflicting opinions. These are not easily solvable matters. This chapter has presented the literature and the framework for this study.

CHAPTER 3

METHODS

This chapter details the methodology used in this exploratory study. It is organized into two sections: a) methodology and study design and b) data analysis. To begin this chapter, there is a general overview of the research questions and then, the first section includes a description of the methodology, followed by the second section detailing the procedures for data analysis.

3.1 Overview

This study employs a bibliometric approach incorporating both descriptive analyses and hypothesis testing. Westlaw legal database was used to select mild traumatic brain injury negligence cases that resulted in either a jury verdict or settlement and included expert witness testimony from a professional testifying for either the plaintiff or defense. Cases from 1/1/2013 to 12/31/2019 were selected for inclusion based on predefined parameters such as date and availability of expert witness information. Due to the COVID-19 pandemic, the years selected for inclusion do not extend beyond 12/31/2019. The court system has been backlogged and still is at the time of this writing, and to prevent skewed data, it does not include any court dates after the start of the shutdowns associated with the COVID-19 pandemic. Expert witnesses chosen for inclusion in this study are evaluated using additional Westlaw, Lexis Nexis, state medical licensing boards, medical schools, and medical specialty society databases. Data was collected and analyzed using quantitative data models in this research. Statistical analysis involved the use of logistic regression. All statistical analyses are done using IBM SPSS Version 27. Plaintiff and defense expert witnesses are compared to identify key differences and similarities between the two groups. Public information obtained from legal databases is used to create the data sets. In addition to the case data, each expert witness is evaluated, and factors such as education, years in practice, academic affiliation, licensing, and scholarly publication are collected and analyzed. This study provides critical distinctions between the two groups of expert witnesses, guidance for future research, and an overview of key themes that emerged from the data. The study incorporates bibliometric methods and measures applied to quantitative data.

Neuroimaging, brain scanning, imaging, or scanning will refer to any type of technology and machine-based diagnostic method used to evaluate a patient's brain injury. This can include X-ray, magnetic resonance imaging ("MRI"), functional magnetic resonance imaging ("fMRI"), diffuse tensor imaging ("DTI"), positron emission tomography ("PET"), electroencephalography ("EEG"), and computed tomography ("CT"). One of the terms above may be used; however, the exact imaging technique will be identified when specificity is required. In some instances, when imaging is discussed in this research, it is not relevant to expressly state what type of technology was employed, or it may not have been indicated in the source data.

3.2 Methodology and Study Design

This study explores the qualifications of expert witnesses by considering each individuals' H-Index, and it seeks to identify any similarities or distinctions between the two groups of plaintiff and defense expert witnesses. This research involves the collection and analysis of secondary data from several sources. The methodology used to answer the research questions is statistical and bibliometric, and it includes quantitative data.

In the first section of this chapter, the primary database sources used for obtaining expert witness data and bibliometric data are described in detail; this includes Westlaw legal database and Scopus, respectively. The second section, research design, provides the step-by-step process for selecting the data. Third, the procedures section of this chapter includes the specific search techniques, refinement methods, and analysis methods. The first phase of this chapter is focused on the data collection and organization, while the third phase is dedicated to analyzing the data using bibliometric and statistical methods.

3.2.1 Data Sources

Additional data regarding each expert witness' qualifications is collected from various sources. The bibliometric analyses are conducted using two key data sources, Westlaw, and Scopus. These data sources are discussed herein.

3.2.2 Westlaw

The Westlaw online legal research service is a Thomson Reuters Company. This service provides more than 40,000 legal databases and receives information from various sources. The data available on Westlaw includes court rulings, records, documents, appellate decisions, and court dockets (Palaniappan & Sellke, 2021). This widely used tool provides access to data at the state and federal levels and relies on many peer-reviewed scholarly research publications. Articles using data obtained from Westlaw have been published in *Aesthetic Surgery Journal* (Paik et al., 2014), Otolaryngology-Head and Neck Surgery (Eloy et al., 2013), and Journal of Neurosurgery (Eloy et al., 2014). The information contained in Westlaw is public; however, it is a subscription-based service, and the primary users are legal firms and academic institutions.

The Westlaw service provides users with powerful search features that incorporate Boolean searches to find information across several different databases. In searching for a specific topic, the criteria can include multiple or single identified states. Additionally, state, federal, or Supreme Court cases can be searched. There are also political network databases and news databases with vital information from many sources. Customizing the user view is possible within the platform, and there are several search and filter options to obtain precise information based on search needs. Notes can also be added and lists of cases can be saved within Westlaw by each user. The data output can be emailed, printed, or downloaded, and multiple cases can be aggregated and processed at one time.

3.2.3 Scopus

Scopus is a comprehensive database of abstracts and citations, and Elsevier owns it. Scopus is "source-neutral" and contains more than 75 million records, 24,600 titles, 194,000 books, and 5,000 publishers. The database includes global scientific journals, conference data, and books. "Scopus offers comprehensive author and institution profiles, obtained from advanced profiling algorithms and manual curation, ensuring high precision-recall (Baas et al., 2020, p. 377). There are advanced search capabilities, and this includes the ability to look up documents by author, institution, affiliation, year, language, funding, etc.

Keywords, author names, titles, and abstracts are indexed in the Scopus database. Scopus is a reasonably balanced database with the following percentages of content: health sciences (25%), physical sciences (27%), social sciences (32%), and life sciences (16%) (Baas et al., 2020, p. 377). This content can at times cross multiple subject areas. The information found in Scopus is available and generally used by researchers, librarians, and academia. It is updated daily and is considered a high integrity source for information.

Authors of scientific journals frequently cite other scientists, and these citations are part of the bibliographical information. This becomes part of the references and is an author citation. Generally, the greater the number of citations, the more recognized and authoritative a scientist or an author is. These citations are counted and can inform others, based on citation frequency, of perceived author relevance in a particular domain. The citation count is the total number of citations received by any given author. In bibliometric science, a citation index is a commonly used tool that links citations between documents, usually in database form. Scopus is one of two widely recognized and trusted citation indexes in the sciences used to rank citations, productivity, H-Index, and journal impact factor (Renjith & Pradeepkumar, 2021). Scopus is the selected database used for this study to calculate the H-Index of expert witnesses. Web of Science is another well-recognized and reliable source for citation data (Renjith & Pradeepkumar, 2021). However, I have elected to use Scopus for this study due to my familiarity with its user interface and an existing subscription.

3.2.4 Additional Data Sources

The expert witnesses selected for inclusion in this study have critical background information relevant to the research obtained from additional data sources. The initial search for cases in Westlaw provided the sample and expert witness list. Using Westlaw, a preliminary background of each expert witness is obtained. If the information is available, it may include other cases where the witness has testified, schools attended, or the states in which the professional practices. Additional data sources used to supplement the background information is detailed below.

3.2.4.1 Lexis Nexis

Lexis Nexis is a widely used legal research database with various products available to professional users. Its product Lexus+ data is geared toward the legal community and provides powerful analytics and search tools. Professional profiles of expert witnesses can be found and include curriculum vitae, cases testified in, academic affiliations, medical specialties, contact information, area of law experience, and jurisdiction experience.

3.2.4.2 Google

All expert witnesses selected for inclusion in this study are searched by name using the

Google search engine. Any results that provide data from academic institutions, medical specialty society databases, or state licensing boards are included in the professional profile for this study.

3.2.5 Data Collection

The final data set was downloaded from Westlaw into one data file on 3/3/2020. The Westlaw search yielded cases that met inclusion criteria for the dates ranging from 1/1/2013 to 12/31/2019, and the initial search returned a total of 185 cases before refinement and scrubbing. Due to the COVID-19 pandemic unfolding during this time, the decision was made to include only data through 12/31/2019. The pandemic shutdown impacted court systems in every jurisdiction for years, and the risk of skewed data was too significant to consider adding anything beyond 12/31/2019. At the time of this publication, the COVID-19 pandemic is still impacting court systems in most states. Therefore, this research and the data used for analysis is considered a pre-COVID-19 representation.

The 185 cases were identified using the advanced search function in Westlaw. A key term search using “mild traumatic brain injury” was conducted, and the search type was Boolean T&C (terms and connectors). The Boolean T&C search in the legal field is standard, and it connects words to identify a relationship between two or more search terms. The content field searched in Westlaw was populated as “all jury verdicts and settlements.” The jurisdiction field searched was populated as “all state and federal cases.” From the initial 185 cases, the data set was refined to only include cases where the terms “neuro!” or “psyc!” were present. This filter selected only cases where a neuro or psych expert witness was hired. Applying this criterion resulted in a reduction of 81 cases for 104 total cases. Then, the file was saved in Westlaw and downloaded as a Microsoft Excel (Excel) file for further refinement and scrubbing. Additionally, each of the 104 cases was downloaded from Westlaw as complete PDF file. The PDF documents ranged in length from 1 page to 6 pages. Within the 104 cases, there were 371 expert witness testimonies. This total included expert witnesses for both the plaintiff and defense. After reviewing each of the 104 PDF case files, an additional 23 cases were removed to arrive at the final count of 81 cases which comprises Data Set 1. The total number of expert witness testimonies provided in the 81 cases was 278.

Once Data Set 1, containing 81 cases, was finalized, another file was created in Westlaw titled "Data Set 1". The review of all 81 cases in Data Set 1 resulted in 158 unique expert witnesses. The number of witnesses per case varied, and there were as many as 5 for one side or as few as 0. Every expert witness identified in Data Set 1 was researched in Westlaw. If an active hyperlink for the witness was available, all information was downloaded from Westlaw and saved in a separate file labeled by witness name. All of the supplemental expert witness data from Westlaw was collected during September 2021. The exported Westlaw supplemental expert witness data files, when available, contained trial information (any other cases), transcripts, and content such as practice area or specialty. Using these data files, any information related to the cases the witnesses testified in, the jurisdictions, the case outcomes, and whether it was for the plaintiff or defense was noted.

The next step was to conduct a google search using each experts' name to identify academic affiliations, sanctions, licensing issues, defined medical specialty, years in practice, licensing, degree received, and practice locations. The source of this information for each expert witness was not necessarily the same; however, most information was available from the respective academic institution and state licensing boards. The final data point collected for each witness was the H-Index using Scopus. The results ranged in an H-Index from 0 - 68. An H-

Index of zero indicates that an expert witness was identified in the Scopus database and the H-Index value according to Scopus was zero. If an expert witness was not found in Scopus, the score was marked as "NA." The author search function in Scopus was used to find this score. The first and last name of the author was entered, and a match could be found where applicable based on cross-referencing other personal information such as affiliation, geography, or institution. Scopus access was granted through the University North Texas library system.

3.3 Research Design

This study aims to approach the topic in an exploratory manner and better understand the qualifications of expert witnesses in the selected specialties that provide testimony in mTBI civil lawsuits. The research design employed in this study was a non-experimental, correlational research design. This research design was used to examine the strength and significance of the relationship between H-Index for expert witnesses and the outcomes of cases.

3.3.1 Research Questions

RQ1. How do the H-Index scores of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation compare?

RQ2. To what extent does the difference in H-Index scores between plaintiff and defense expert witnesses correlate with a favorable litigation outcome in a mild traumatic brain injury case?

3.3.2 Sample

Data Set 1 includes information from 81 civil mTBI cases obtained from Westlaw that resulted in a jury verdict or settlement from 2013 to 2019. Cases that met inclusion criteria had an opinion from an expert witness with the narrowly defined specialty of neurology, neuropsychology, psychology, psychiatry, neuroradiology, neurosurgery, and counselor. All cases were in the jurisdiction of either a state or federal court in the United States.

3.3.3 Instruments

The files of 81 cases totaled 279 pages and included all information used to create Database 1. The original Westlaw document was downloaded and printed. Each case was then separated, numbered, and organized for analysis. A Microsoft Excel database was created with custom fields containing critical information about each case and was called the "Case Database." A second database, Database 2 was created with data obtained from additional sources called the "Comprehensive Expert Witness Database." The primary instrument was developed using Microsoft Excel to conduct this research. The data was manually entered into Excel files and checked three times for reliability and validity. All data in the data set also underwent a final cross-check to ensure accuracy.

3.4 Procedures

In Westlaw, the initial Data Set was developed by searching for cases that resulted in a jury verdict or settlement and involved or included the keywords mTBI or mild traumatic brain injury within the defined date range. The expert witnesses were identified once the case set was finalized. Any cases that did not meet inclusion criteria or had no expert witnesses or expert witnesses in the correct specialty or field were eliminated. Only expert witnesses in the following areas were included in the study: neurology, neuropsychology, psychology, psychiatry, neuroradiology, neurosurgery, and counselor.

Data Set 2 is a collection of additional expert witness information that is descriptive and, when looked at collectively, can be considered the additional qualifications of the witnesses. The qualification information was obtained from four primary sources: Scopus, Google, Lexis Nexis, and Westlaw. The Scopus database was used exclusively for obtaining each expert witnesses' H-Index. Lexis Nexis and Westlaw were employed and cross-referenced to validate the remaining data. If critical information regarding an expert witness was not available in Lexis Nexis or Westlaw. Google was used to search for state medical boards, licensing agencies, or academic institutions.

Each case was evaluated to determine the expert witness total. There are 81 unique cases, 53 cases have multiple expert witnesses, and 28 cases have only one expert witness opinion. Of the 81 unique cases, 158 unique expert witnesses gave 278 expert witness testimonies. Of the 158 expert witnesses included in the count, a total of 32 provided testimony in more than one case within data set 1, leaving 126 single case testifiers and 32 multiple case testifiers. The 32 individuals who testified in more than one case together collectively provided 152 expert witness opinions, and within this group of 32 expert witnesses, the number of cases that each expert witness provided an opinion for ranged from 2 to 11 cases out of the total of 81 cases.

3.4.1 Sample

The public information collected to create Data Set 1 came from Westlaw and was extracted from 81 cases. There are specific data points for each expert witness and each case. The case data collected and aggregated in Microsoft Excel for each case includes the following: case number, case name, jurisdiction, outcome, result, monetary award, date, and type of case (traffic or other). The expert witness data was aggregated in Microsoft Excel and includes the following information: case name, expert witness name, city, state, specialty, and testimony (plaintiff or defense expert witness).

The "case database" was organized in the following manner.

- Data Set 1 - Descriptive Case Data

- Case No. = The case number assigned to the case in the case database. This was done based on the order in which the documents were automatically grouped and downloaded from Westlaw. These were not numbered in any specific order. Once a case number was assigned, it was final.
- Case Name = The name as Westlaw noted, obtained directly from each court.
- Jurisdiction = The location in which the case took place.
- Outcome = The summary, either a *Verdict* or *Settlement.*
- Result = The prevailing party in the case, either the *Plaintiff* or *Defense.*
- Award = The total amount of any monetary award, if applicable.
- Date = The date of the verdict or settlement noted only as the year.
- Type = Type of case, either a motor vehicle incident (MVI) or other.

- Data Set 1 - Descriptive Expert Witness Data
  - EW Case = The case the witness testified in. There are many cases with multiple expert witnesses. Some expert witnesses have testified in multiple instances from Data Set 1.
  - EW Name = The first and last name of the witness and any middle initial if available.
  - EW City = The city noted for the witness.
  - EW State = The state noted for the witness.
  - EW Specialty = The specialty or practice area as stated in the case documents from Westlaw.
  - EW Testimony = The side for which the expert witness testified, either the *Plaintiff* or *Defense*.

Data Set 2 comprised the additional information about each expert witness from Westlaw noted as "descriptive expert witness data" and includes additional information regarding each witnesses' qualifications.

- Data Set 2 - Descriptive Expert Witness Data
  - Case No. = The case number assigned to the case in the case database. This was done based on the order in which the documents were automatically grouped and

downloaded from Westlaw. These were not numbered in any specific order. Once a case number was assigned, it was final. The case number referenced in Data Set 1 was the same case number assigned in Data Set 2, so this identifier is constant in both data sets.

- EW Name = The first and last name of the witness and any middle initial if available.
- EW Education Degree earned MD = (Y/N)
- EW Education Degree earned = Name of Degree (e.g., PhD, MD, Masters, etc.)
- EW Education Specialty = Degree specialty
- EW School 1 = Name of school attended
- EW School 2 = Name of school attended
- EW School 3 = Name of school attended
- EW Experience = Years in Practice (number of years since graduating)
- EW Current Academic Affiliation = Y/N
- EW Current License = Y/N
- EW License Type = Type, define if applicable
- EW Certification = Y/N
- EW Certification Type = Type, define if applicable
- EW H-Index = number from Scopus (0 – 68 or NA)

Descriptive Expert Witness Data from Data Sets 1 and 2 were combined to create the Comprehensive Expert Witness Database. To conduct statistical analyses, the two primary databases are the “case database” and the “comprehensive expert witness database.” These two databases were created in Microsoft Excel; Database 1 is the “Case Database,” and Database 2 is the “Comprehensive Expert Witness Database.” These are organized in the following manner:

- Database 1 - Case Database
  - Case No. = The case number assigned to the case in the case database. This was done based on the order in which the documents were automatically grouped and

downloaded from Westlaw. These were not numbered in any specific order. Once a case number was assigned, it was final.

- Case Name = The name as Westlaw noted it obtained directly from each court.
- EW Name = The first and last name of the witness and any middle initial if available.
- Jurisdiction = The location in which the case took place.
- Outcome = The summary, either a *Verdict* or *Settlement.*
- Result = The prevailing party in the case, either the *Plaintiff* or *Defense*
- Award = The total amount of any monetary award, if applicable.
- Date = The date of the verdict or settlement noted only as the year.
- Type = Type of case, either a motor vehicle incident (MVI) or other.

- Database 2 - Comprehensive Expert Witness Database
  - Case No. = The case number assigned to the case in the case database. This was done based on the order in which the documents were automatically grouped and downloaded from Westlaw. These were not numbered in any specific order. Once a case number was assigned, it was final. The case number referenced in Data Set 1 was the same case number assigned in Data Set 2, so this identifier is constant in both data sets.
  - EW Name = The first and last name of the witness and any middle initial if available.
  - EW City = The city, noted for the witness.
  - EW State = The state noted for the witness.
  - EW Specialty = The specialty or practice area as stated in the case documents from Westlaw.
  - EW Testimony = The side for which the expert witness testified, either the *Plaintiff* or *Defense*.
  - EW Education Degree earned MD = (Y/N)
  - EW Education Degree earned = Name of Degree (i.e. PhD, MD, Masters, etc.)
  - EW Education Specialty = Degree specialty
  - EW School 1 = Name of school attended

- EW School 2 = Name of school attended
- EW School 3 = Name of school attended
- EW Experience = Years in Practice (number of years since graduating)
- EW Current Academic Affiliation = Y/N
- EW Current License = Y/N
- EW License Type = Type, define if applicable
- EW Certification = Y/N
- EW Certification Type = Type, define if applicable
- EW H-Index = number from Scopus (0 – 68 or NA)

3.4.2 Procedures: Phases of Research

The procedures section of this chapter includes the specific search techniques, methods for refinement, and methods of analysis broken down into three phases; phases are a) expert witness data, b) bibliometric data, and c) analysis. The first two phases focus on the data collection and organization, while the third phase is dedicated to analyzing the data using bibliometric and statistical methods.

3.5 Analysis

The procedures for statistical analysis included three phases: descriptive statistics, testing for statistical assumptions, and hypothesis testing. The first phase, testing for descriptive statistics, included measuring for several aspects of the data. The H-Index difference, the H-Index for plaintiff, the H-Index for defendants, and the amount won in cases were included in the analysis as factors included in the study. Descriptive statistics were measured based on central tendency, variance, and the distribution of data. Central tendency was measured based on the mean score for the factors included in the study. Variance was measured based on standard deviation. The distribution of data was measured using several statistics. First, skewness and kurtosis were used to determine the distribution of data. Further examination focused on whether the distribution was normal. The Shapiro-Wilk test was used to determine whether there was a normal distribution to the data. Charts were used to further understand the normality of the distribution of the data. Histograms and Q-Q plots were used. The descriptive statistics were also used to examine statistical assumptions.

Statistical assumptions were then examined. Statistical assumptions were examined for the paired-samples *t*-test and logistic regression. The test for statistical assumptions was used to determine whether a non-parametric test would be necessary. The Wilcoxon signed-rank test was used as a non-parametric test to replace the paired-samples *t*-test. The hypothesis tests were performed with statistical significance at $p < .05$. Additional tests were completed following tests of the hypotheses to further explore the data. The tests used included the χ^2 test and the Kruskal-Wallis test. Below are the research questions and hypotheses.

- RQ1. How do the H-Index scores of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation compare?
    - $H_1 0$: The H-Index scores of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation are not significantly different at $p < .05$.
    - $H_1 A$: The H-Index scores of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation are significantly different at $p < .05$.
- RQ2. To what extent does the difference in H-Index scores between plaintiff and defense expert witnesses correlate with a favorable litigation outcome in a mild traumatic brain injury case?
    - $H_2 0$: The difference between expert witnesses' H-Index scores for the plaintiff and defendant and litigation outcomes is not significant at $p < .05$.
    - $H_2 A$: The difference between expert witnesses' H-Index scores for the plaintiff and defendant and litigation outcomes is significant at $p < .05$.

3.6 IRB Review

Institutional Review Board approval by the University of North Texas is not required in this research. There is no direct contact with human subjects, and all information used is publically available.

3.7 Summary

Chapter 3 included the method and design for this quantitative, non-experimental study. The chapter began with a focus on the methods and design of the chapter and concluded with a discussion of data analysis. The overview of the chapter included a description of the bibliometric approach taken toward the study, where cases involving mTBI were selected from the 1/1/2013-12/31/2019 period. The expert witnesses were selected from cases found in Westlaw. The study design depended on collecting H-Index score of expert witnesses used by plaintiffs and defendants, with the objective being to determine whether differences in H-Index scores resulted in an advantage for the plaintiffs or defendants. This chapter also included a description of the process for bringing datasets together into one comprehensive dataset, using the sample of 81 cases. The chapter concluded with a description of the processes that would be used for the analysis. The analysis includes the use of descriptive statistics to test statistical assumptions test the hypotheses. A non-parametric test was described because of the failure of the data to meet statistical assumptions.

CHAPTER 4

RESULTS

Chapter 4 includes the results of quantitative analysis associated with the research questions in this study. The objective of the research was to examine the H-Index scores of plaintiff and defense experts as quantification of expert qualifications. The findings from the study could be useful in various ways and applied to future research. First, findings and conclusions from the survey can illuminate inconsistencies that may warrant additional investigation. Second, it could give governing entities or societies useful data points or guidance on standards to set forth or amend while providing a clear picture of the common qualifications held by mTBI expert witnesses. Finally, the research shall inform and guide other studies examining expert witnesses in different areas of litigation.

Chapter 4 includes a discussion of the findings related to descriptive statistics, the tests of statistical assumptions, and hypothesis tests for the study. Descriptive statistics were examined using several approaches. Descriptive statistics included the mean and standard deviation scores for the data to support examining measures of central tendency and variance, respectively. Skewness and kurtosis were examined to support understanding the distribution of data. The Shapiro-Wilk test was also run to examine the data distribution of data vis-à-vis further whether evidence of a normal distribution exists. Additional descriptive statistic examination follows with graphs that illustrate frequencies within the data. The tests for statistical assumptions are then examined for the tests that shall be used on the data in this study. The study includes the use of logistic regression and a between-samples *t*-test, and their statistical assumptions were tested to determine whether they would be used or if it was more appropriate to use a non-parametric test. The chapter concludes with the completion of hypothesis testing.

4.1 Descriptive Statistics

The descriptive statistics support understanding the data with greater specificity. Based on Table 4, the mean and standard deviation for the H-Index difference (*M* = 0.18, *SD* = 11.58) illustrate that many H-Index scores were negative. The mean score is below 1, while the standard deviation was greater than 11, resulting in a coefficient of variation for the H-Index difference of 0.02. The low coefficient of variation, coupled with a high standard deviation when compared to the mean score for the H-Index difference, is expected because of how the measurement for H-Index difference supported examining differences between plaintiff and defendant H-Index scores. When the defendant's score was higher, the H-Index difference was negative. The mean H-Index difference is consistent with the difference in mean scores between the mean H-Index for plaintiff (*M* = 5.63, *SD* = 10.23) and defendants (*M* = 5.45, *SD* = 8.19), respectively.

Table 4

Descriptive Statistics for the Factors in the Study

	M	*SD*	Skew	Kurt
H-Index Difference	0.18	11.58	2.01	14.64
Amount Won	$1,875,739.05	$5,452,615.16	$5.46	$32.05
Plaintiff	5.63	10.23	3.97	18.90
Defendant	5.45	8.19	2.79	9.59

The skewness and kurtosis are evidence of there being extremes in data distribution. The skewness includes proof that the H-Index difference, amount won, plaintiff H-Index, and defendant H-Index each have a positive skew. A positive skew is a skew where there is a long right tail. A generally accepted threshold for skewness is $-2<skew<2$, while the threshold for kurtosis is $-7<kurt<7$ (Hair et al., 2010). Thus, the skewness in the data for each of the four factors indicates an extreme right skew. The scores for kurtosis are also more significant than the threshold for normal levels of kurtosis, meaning that each factor has a leptokurtic shape to the distribution of data. A leptokurtic shape of data indicates a broader shape with larger tails. The data distribution was examined further using the Shapiro-Wilk test to determine whether there is significant evidence of a non-normal distribution of the data.

From the total of 81 cases, the final expert witness count was 158. These witnesses had a background in one of the following specialties: neurology, neuropsychology, psychology, psychiatry, neuroradiology, neurosurgery, or counselor. The frequencies for both the plaintiff and defense were very similar as illustrated in Figures 1 and 2. The most significant difference is that there were no counselors who offered expert witness testimony for any plaintiffs, yet there was for the defense. The difference was considered marginal as there was only one counselor who had provided expert witness testimony for the defense. Overall, the plaintiff and defense both had the greatest number of testifiers in the specialties of neurology and neuropsychology. The plaintiff and defense had the fewest number of testifies from the specialties of neuropsychiatrist and neurosurgeon.

Figure 1

Plaintiff Expert Specialty Frequencies

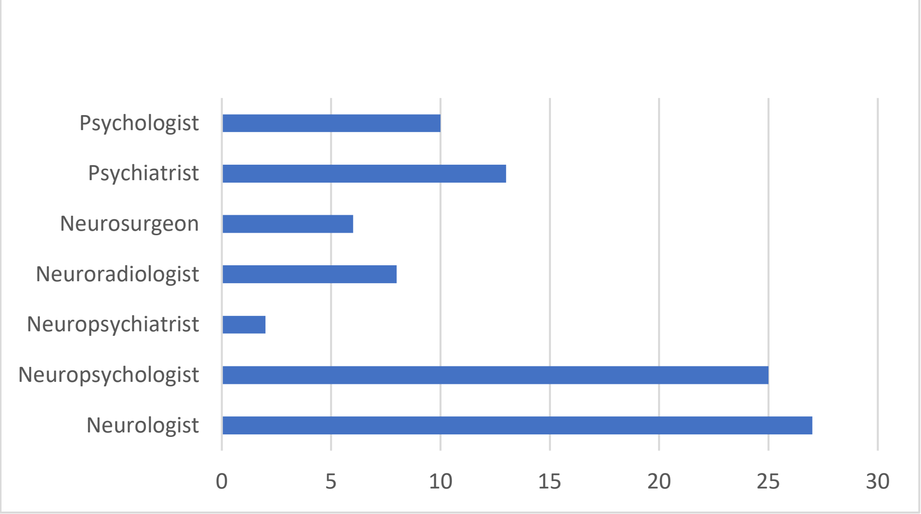
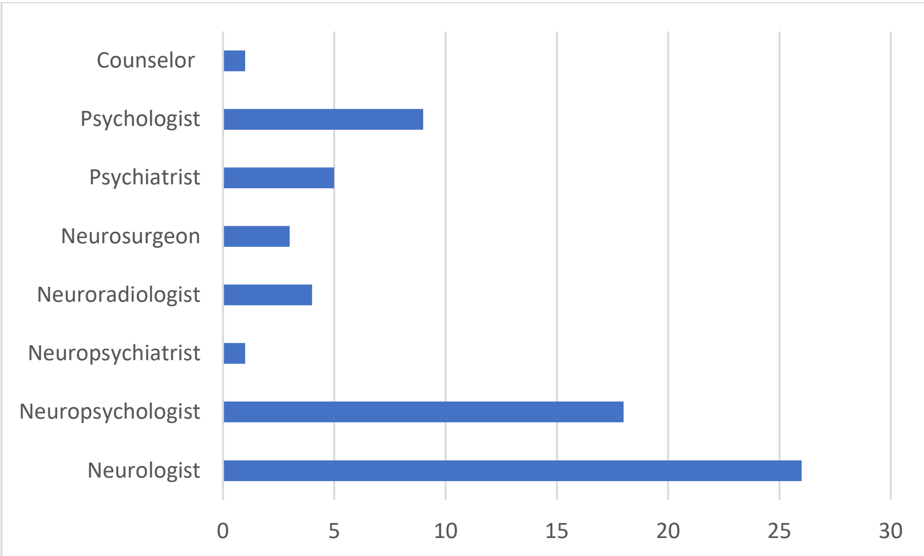


Figure 2

Defense Expert Specialty Frequencies



The Shapiro-Wilk test was used to examine the distribution of data further. The test demonstrated whether there was a normal distribution of the data. While the results for skewness and kurtosis included findings indicating that each factor had an extreme right skew and was leptokurtic, the Shapiro-Wilk test was used to determine if the distribution was normal. The results in Table 5 show that there was statistical significance indicating evidence of a non-normal distribution for the H-Index difference (S-W = 0.78, p = 0.00), the plaintiff H-Index (S-W = 0.54, p = 0.00), and the defendant H-Index (S-W = 0.67, p = 0.00). Thus, the data in this study should be considered to be highly skewed, extremely kurtic, and lacking a normal distribution.

Table 5

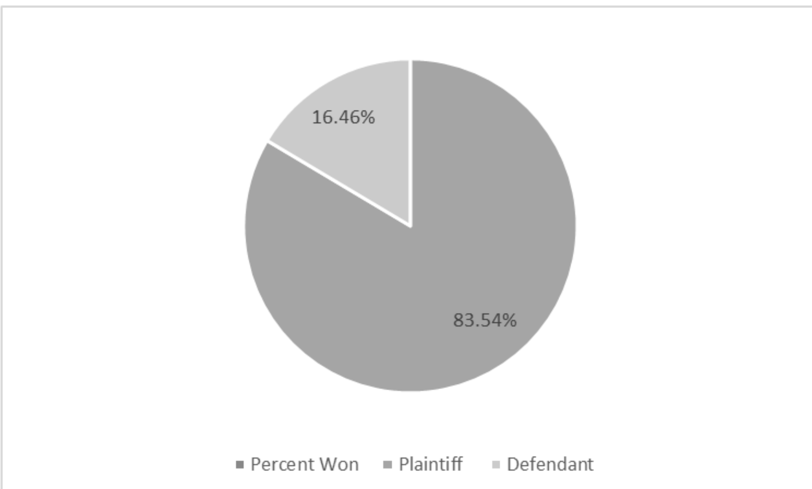
Results of Shapiro-Wilk Test for Normality

	Statistic	*df*	Sig.
H-Index Difference	0.78	81	0.00
Plaintiff H-Index	0.54	81	0.00
Defendant H-Index	0.67	81	0.00

The data also included details on cases won by the plaintiff and the defendant in civil litigation. Figure 3 is a chart illustrating the percentage of cases won by the plaintiff and the percentage of cases won by the defendant. The percentages indicate that the number of cases the plaintiff won was 5.08 times greater than the number of cases where the defendant prevailed. Therefore, the data include a greater frequency of wins for plaintiffs than wins for defendants.

Figure 3

Percentage of Cases Won by Plaintiff and Defendant



There were also differences in the mean scores between instances where the plaintiff won the case and when the defendant won the case. Figure 4 illustrates H-Index differences between cases where the plaintiff and defendant won the case. The findings indicate that the H-Index difference mean was positive when the plaintiff won and negative when the defendant won. This is expected because the H-Index calculation involves subtracting the defendant's H-Index score from the plaintiff's H-Index score. The negative mean score for the H-Index difference when the defendants won was more significant than the positive mean score when the plaintiffs won. Therefore, there is some evidence that a greater H-Index may be needed for defendants to win than for plaintiff.

Figure 4

Mean H-Index Difference when a Defendant or Plaintiff Won

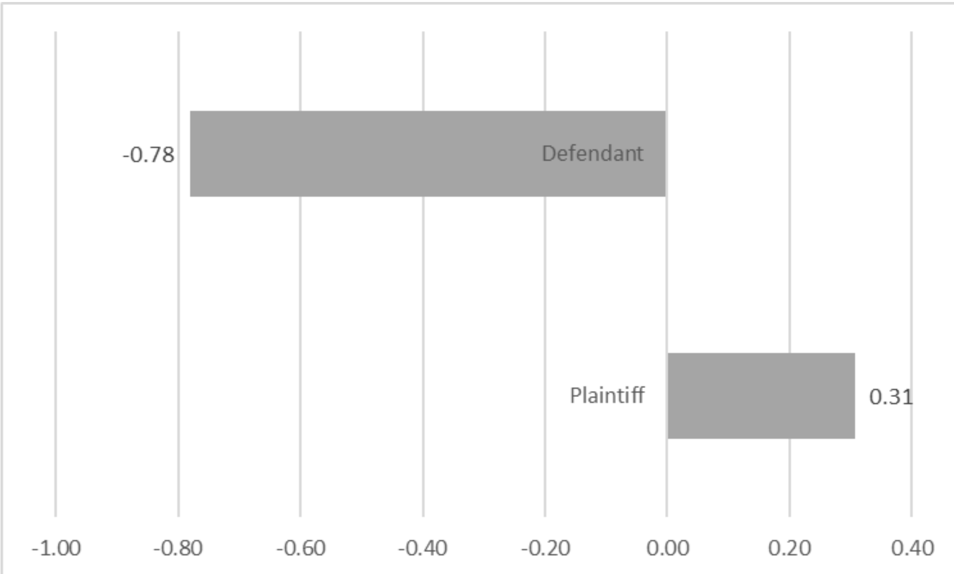
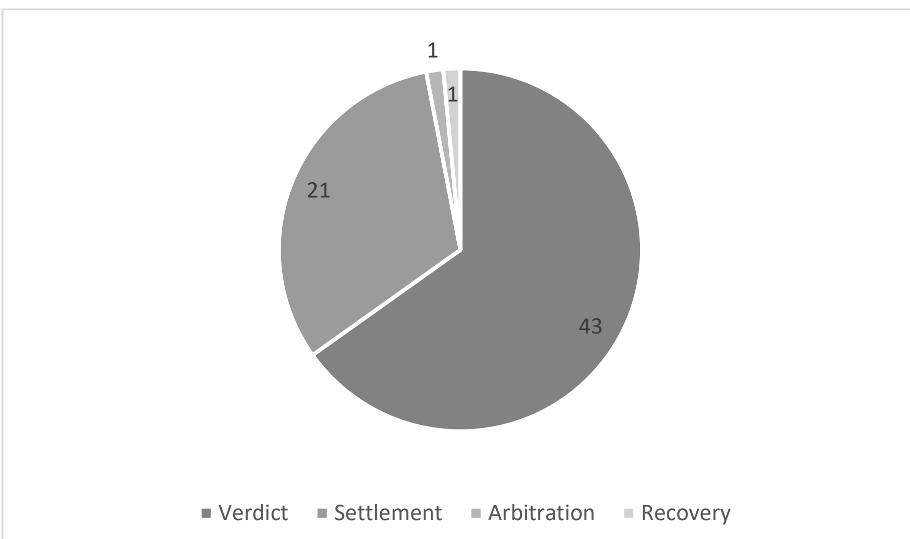


Figure 5

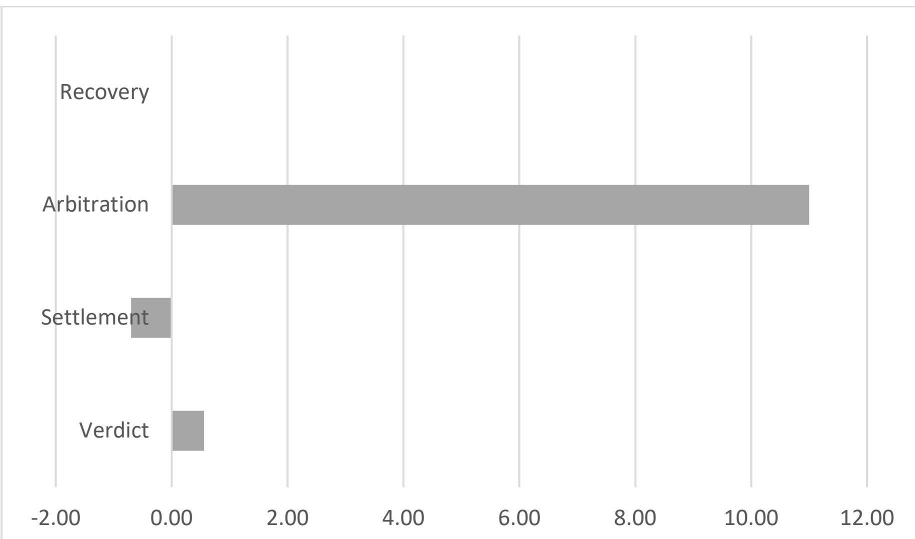
Frequency of the Type of Win in Cases the Plaintiff Won



Two verdicts were most common among the cases where the plaintiff was victorious. Figure 5 illustrates the frequencies for the type of favorable outcome in cases won by the plaintiff. Verdicts where the court ruled and cases where a settlement occurred were the most frequent types of wins among the cases included in the data. Court verdicts were the most frequent (*Count* = 43), and settlements were the second-most frequent (*Count* = 21). Thus, the frequencies support courts making decisions as happening 2.05 times more often than in cases where there was a settlement. There was only one instance of arbitration and one instance of recovery.

Figure 6

Mean H-Index Difference Scores by Type of Plaintiff Victory

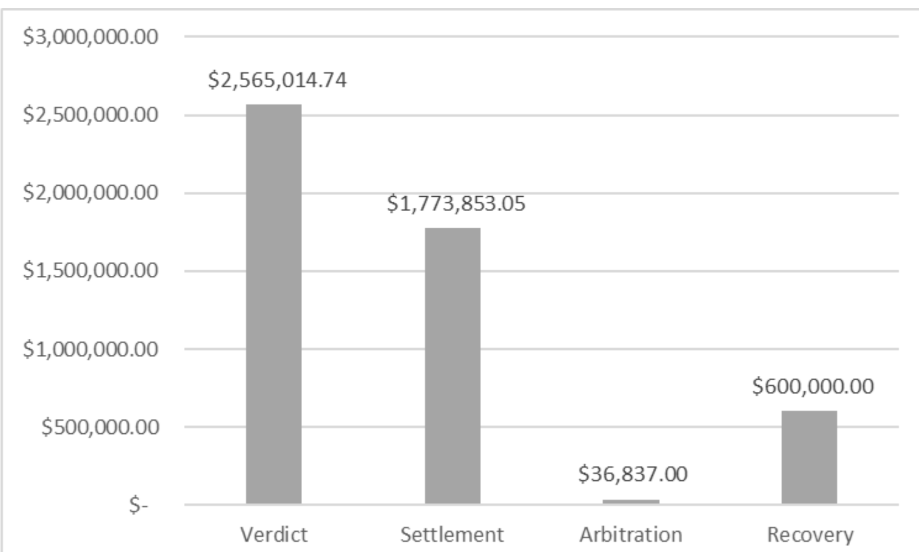


The data included differences among the mean scores for different types of plaintiff wins. Figure 6 is a bar graph illustrating the differences between the four types of conclusions for cases where plaintiffs were victorious. The cases where there was a recovery and cases that went to arbitration are included in Figure 6; however, there was only a single instance of each. The mean H-Index difference for cases with a settlement differed from cases where there was a verdict. In cases where there was a settlement, there was a negative mean H-Index difference between the plaintiff and defendant; this negative score indicates that the experts in cases where plaintiffs won by settlement were better for defendants than for plaintiffs. The cases where the court came to a verdict had a positive mean score, meaning that, on average, the experts were better for plaintiffs than defendants in cases where the court arrived at a verdict.

There were differences in the amount won by the plaintiff according to the type of verdict in the case. Figure 7 illustrates the difference between amounts won depending on the ruling. The single arbitration and recovery cases represented the lowest amount won. Verdicts, where the case was decided by the court and by a settlement, represented the highest amounts. Cases where the court decided (*M* = $2,565,014.74) was higher than when there was a settlement (*M* = $1,773,853.05). Winning the case in the court rather than settling resulted in 1.45 times more significant awards. Therefore, the findings from the data support a verdict passed by the court as most preferable in terms of award amount.

Figure 7

Amount Won in Cases Where the Plaintiff Won by Verdict Type



Histograms were also created to illustrate the distribution of the data further. Figure 8 included the histograms for the H-Index difference, plaintiff H-Index, and defendant H-Index.

There was a clear skew to the right, and the distribution appeared leptokurtic. Thus, the histogram was further evidence of the nature of the data distribution. Further evidence regarding data distribution was gathered by creating a Q-Q plot. Figure 9 included a Q-Q plot for the H-Index difference, plaintiff H-Index, and the defendant H-Index. The results of the Q-Q plots were that the data did not fit with the regression line. While there did not appear to be a bell curve distribution in Figure 8, Figure 9 was an illustration confirming that there is no normal distribution of the data.

Figure 8

H-Index Difference, Plaintiff H-Index, and Defendant H-Index

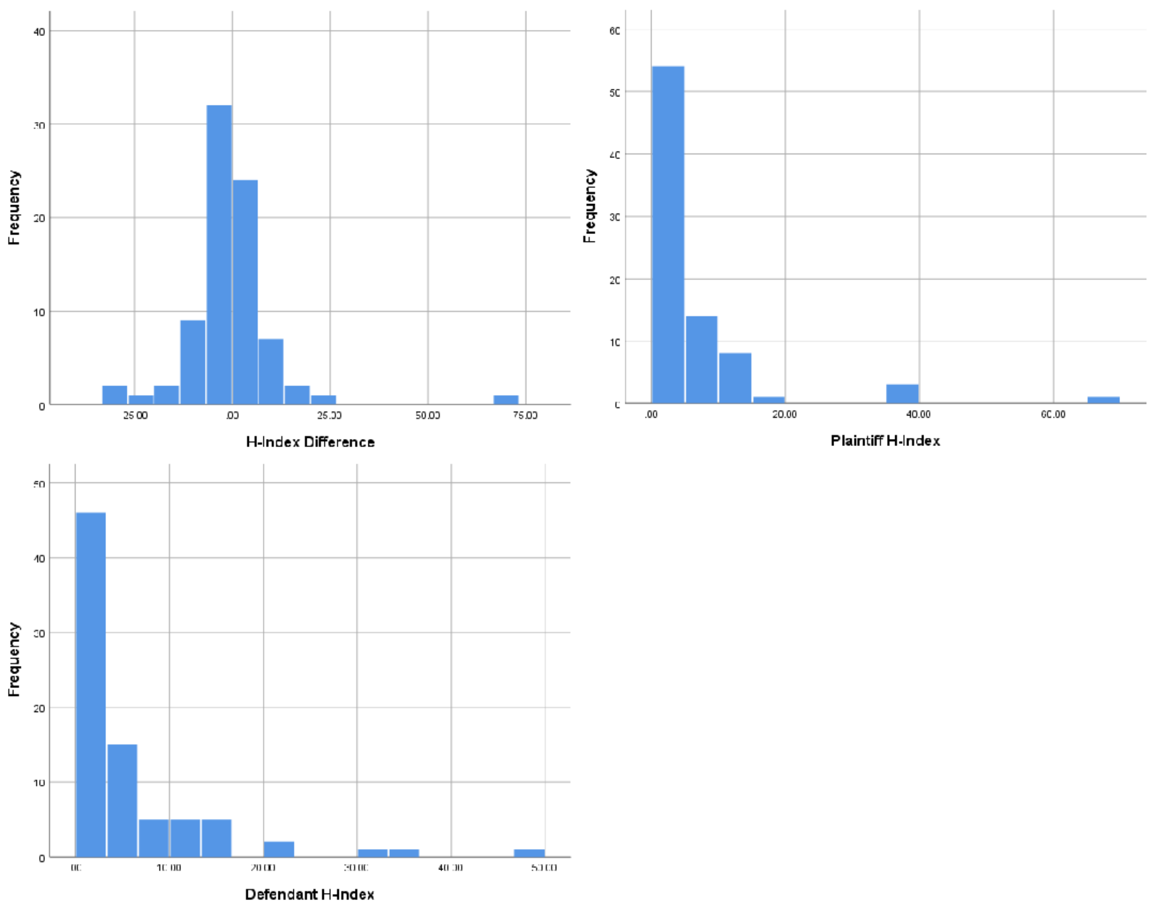
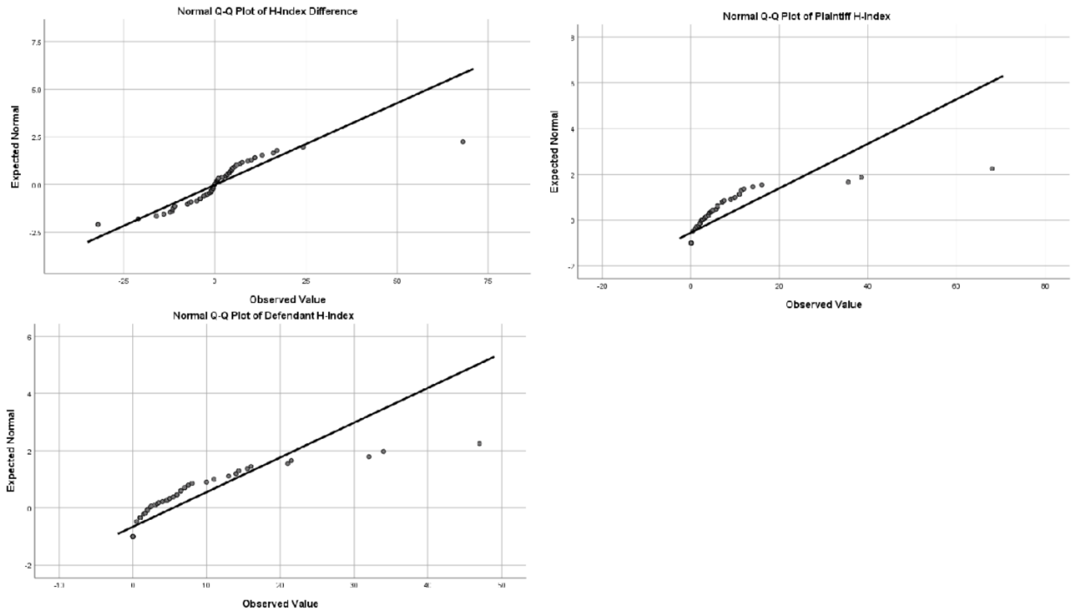


Figure 9

Q-Q Plots of the H-Index Difference, Plaintiff H-Index, and Defendant H-Index



4.2 Hypothesis Testing

Hypothesis testing was used to examine the data so that it would be possible to respond to the study's research questions. The study included two research questions: RQ1. How do the H-Index scores of plaintiffs and defense expert witnesses in mild traumatic brain injury civil litigation compare? and RQ2. To what extent does the difference in H-Index scores between plaintiff and defense expert witnesses correlate with a favorable litigation outcome in a mild traumatic brain injury case? This section includes a discussion of the statistical assumption tests and the tests of hypotheses. A paired-samples *t*-test was selected to test RQ1. Logistic regression was selected to test the hypothesis related to RQ2. Thus, the statistical assumptions for paired-samples *t*-tests and logistic regression were tested.

4.2.1 Statistical Assumptions – Paired-Samples *t*-Test

Four statistical assumptions exist related to the paired-samples *t*-test. The four statistical assumptions are the data is continuous, observations are independent of one another, the data is normally distributed, and there are no outliers. The first assumption is met, as the data is continuous. The second assumption is met as the cases are independent of one another. The descriptive statistics include evidence identifying the lack of normal distribution. Figure 8 has findings indicating no normal distribution of the data. A test of the data resulted in the finding that there were outliers. While the existence of outliers could be addressed by removing cases where outliers existed, the evidence that the data is not normally distributed leads to the conclusion that there is a violation of a critical statistical assumption. A non-parametric test was required to test the hypothesis related to RQ1. The Wilcoxon signed-rank test was selected for the hypothesis related to RQ1.

4.2.2 Statistical Assumptions – Logistic Regression

Six statistical assumptions exist for logistic regression. The six statistical assumptions include the binary response variable, independent observations, a lack of multicollinearity in the explanatory variables, no extreme outliers, a linear relationship between the explanatory variables and the logit, and sufficient sample size. The first assumption that the response variable is binary was met. The response variable was whether the plaintiff or defendant won. The second was that observations are independent. Only a single observation is taken for each case, meaning that the assumption that observations are independent is met. The assumption related to multicollinearity among explanatory variables was not valid for this study because there is only one explanatory variable. The assumption that there are no extreme outliers was not met. However, it could be addressed by removing cases with extreme outliers. The relationship between the explanatory variables and the logit was linear. The final assumption of sufficiently large sample size was met. Thus, logistic regression was used in this study.

4.2.3 Hypothesis Tests

The study included two research questions regarding mTBI cases, to which one hypothesis was designed for each question. One research question involved comparing the qualifications of plaintiff and defense witnesses. A paired-samples *t*-test was selected, with the threshold for statistical significance set at $p < .05$. However, limitations with the data meant that a Wilcoxon signed-rank test would need to be used instead of the paired-samples *t*-test. The other research question involved determining the extent of the relationship between the H-Index differences and the outcome of litigation. Logistic regression was used, with the threshold for statistical significance set at $p < .05$.

- RQ1. How do the H-Index scores of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation compare?
  - $H_1$0: The H-Index scores of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation are not significantly different at $p < .05$.
  - H_1A: The H-Index scores of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation are significantly different at $p < .05$.

The Wilcoxon signed-rank test was conducted instead of the paired-samples *t*-test. The variables included in the Wilcoxon signed-rank test included the defendant H-Index and plaintiff H-Index scores. The results lacked asymptotic significance ($Z = -0.06$, $p = 0.95$). The findings are included in Table 6. The data were examined further to determine whether the results could be different when the plaintiff or defendant was victorious in the case. Only cases where the plaintiff was victorious were included in the test. The results included a lack of asymptotic significance ($Z = -0.60$, $p = 0.95$). When only cases where the defendant was victorious were included in the trial, the results included a lack of asymptotic significance ($Z = 0.31$, $p = 0.76$). The findings from each test support the null hypothesis. Thus, the null hypothesis for Q1 is accepted. The qualifications of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation are not significantly different at $p < .05$.

Table 6

The Results of the Wilcoxon Signed-Rank Test for Entire Sample

		N	Mean Rank	Sum of Ranks
Defendant H-Index - Plaintiff H-Index	Negative Ranks	35	37.86	1325.00
	Positive Ranks	37	35.22	1303.00
	Ties	9		
	Total	81		

- RQ2. To what extent does the difference in H-Index scores between plaintiff and defense expert witnesses correlate with a favorable litigation outcome in a mild traumatic brain injury case?
  - $H_2 0$: The difference between expert witnesses' H-Index scores for the plaintiff and defendant and litigation outcomes is not significant at $p < .05$.
  - $H_2 A$: The difference between expert witnesses' H-Index scores for the plaintiff and defendant and litigation outcomes is significant at $p < .05$.

Logistic regression was completed to examine the quantitative data related to the research question. Included with the logistic regression was the Hosmer and Lemeshow test. The Hosmer and Lemeshow test findings indicated a lack of significance ($\chi^2 = 1.52$, $p = 0.99$). Table 7 includes the results of the logistic regression test (*Wald* = 0.09, $p = 0.76$). The relationship between H-Index score differences between the plaintiff and defendant with favorable litigation outcomes for the plaintiff and the defendant is not significant at $p < .05$. Thus, the evidence from the logistic regression test supports the null hypothesis.

Table 7

The Results of a Logistic Regression Test

	B	*S.E.*	*Wald*	*df*	*Sig.*	*Exp(B)*
H-Index Difference	-0.01	0.03	0.09	1	0.76	0.99
Constant	-1.63	0.30	28.62	1	0.00	0.20

4.3 Further Exploration of the Data

Another test involved completing the test for the H-Index Differences categorized by whether they were positive, negative, or neither, meaning zero and the type of case verdict (Table 8). The findings included results approaching significance. The Pearson test result included asymptotic significance of p = 0.05 (χ^2 = 12.30). The findings from the χ^2 test also included a likelihood ratio of 9.19 (p = 0.16) and a linear-by-linear association of 3.28 (p = 0.70). These findings do not support the existence of a significant association between H-Index differences in court cases among experts where the plaintiff had experienced an mTBI. However, they do indicate that when viewed as a category whether, there is a positive, negative, or neutral H-Index, is approaching the penumbra of offering a significant association with the type of verdict.

Table 8

The Results of a χ2 Test of H-Index Differences and the Type of Case Verdict

		Positive or Negative H-Index Difference			Total
		Neither	Positive	Negative	
Case Verdict	Verdict	6	20	30	56
	Settlement	2	12	7	21
	Recovery	1	0	0	1
	Arbitration	0	1	0	1
Total		9	33	37	79

The distribution of the data prevented the completion of regression analysis and the completion of an ANOVA test. However, the Kruskal-Wallis test is a test that can be used as a non-parametric test in place of the one-way ANOVA. The Kruskal-Wallis test was first run to determine whether there was a significant link between a positive, negative, or neutral H-Index difference and the amount won in a case. The findings failed to support the existence of a significant link between the H-Index categorical difference and the amount won, as there was a lack of asymptotic significance (*K-W* = 1.51, *p* = 0.47). However, the Kruskal-Wallis test was also performed to determine whether a significant link existed between the type of verdict and the amount won in a case. The findings included asymptotic significance at *p* = 0.20 (*K-W* = 9.91) (Table 9). Specifically, the pairwise comparison of Verdict-Settlement resulted in asymptotic significance at *p* = 0.00, but when accounting for the inclusion of multiple tests, the Bonferroni correction resulted in an adjusted asymptotic significance of *p* = 0.02 (*t* = -17.50, *Std. t* = -2.98).

Table 9

Results of the Kruskal-Wallis Test of Verdict Type and Amount Won

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Arbitration-Verdict	16.38	23.10	0.71	0.48	1.00
Arbitration-Recovery	31.00	32.38	0.96	0.34	1.00
Arbitration-Settlement	33.83	23.44	1.44	0.15	0.89
Verdict-Recovery	-14.62	23.10	-0.63	0.53	1.00
Verdict-Settlement	-17.45	5.86	-2.98	0.00	0.02
Recovery-Settlement	2.83	23.44	0.12	0.90	1.00

4.4 Summary

Chapter 4 includes the results of quantitative analysis related to the problem of the study and the testing of hypotheses connected to the research questions in the study. The chapter begins with the descriptive statistics for the analysis. The findings from the descriptive statistics supported understanding the characteristics of the sample taken for the study. The descriptive statistics included measures for central tendency, variance, frequencies associated with the data, and several measures related to the data distribution. These statistics supported understanding the specific data collected, and I further discuss findings and limitations in Chapter 5 of the study. Chapter 4 also includes hypothesis testing and the statistical assumptions associated with the selected tests to test the hypotheses. The tests included the paired-samples *t*-test and logistic regression. Following an examination of the data regarding statistical assumptions, the conclusion was made that the paired-samples *t*-test could not be used. The Wilcoxon signed-rank test was then selected as a non-parametric test to replace the paired-samples *t*-test. The data was found to support the use of logistic regression. The findings for the hypothesis tests associated with Research Questions 1 and 2 led to the acceptance of the null hypothesis in both tests. There was a lack of asymptotic significance in Hypothesis 1 and a lack of significance in Hypothesis 2. The findings from these hypothesis tests shall support the discussion of the implications of the research and the direction of future research.

The following chapter, Chapter 5, includes a discussion and conclusions of the research. The discussion consists of the links between the findings in the current study with prior research. Limitations that occurred in the study shall are also acknowledged. The chapter also includes a discussion on how the findings herein shall influence the body of research in the future.

CHAPTER 5

DISCUSSION

The contribution of this study was to use the H-Index scores of plaintiff and defense witnesses as an operationalization of witness quality, and then to test the extent to which differences in the H-Index scores across plaintiff and defense witnesses affected litigation outcomes. Chapter 5 includes a discussion of the findings and what the findings mean within the more significant body of research regarding the use of experts in civil litigation in cases where the plaintiff had experienced an mTBI. The results of hypothesis testing related to the research questions are discussed in conjunction with the findings from prior research to determine possible implications. The chapter also includes a discussion of what the results can mean for future research. While the findings from the examination of the hypotheses included a complete lack of significance, the findings can be influential as far as exposing where future researchers can take the study of the use of experts in cases involving civil litigation. The completion of the research herein also involved some deviation from the research plan included in the discussion of limitations to the research.

5.1 Discussion of the Findings

- RQ1. How do the H-Index scores of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation compare?
  - $H_1$0: The H-Index scores of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation are not significantly different at $p < .05$.
  - H_1A: The H-Index scores of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation are significantly different at $p < .05$.

The first research question for the study involved a comparison of the qualifications of defense expert witnesses in mTBI civil litigation. The findings supported the null hypothesis that the qualifications of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation are not significantly different at $p < .05$. The lack of significance was evidence that in mTBI cases where expert witnesses are used by the plaintiff or defense, that there was an insignificant difference. The finding indicates that the use of an expert witness likely will not result in a significant influence on the decision-making of the court.

- RQ2. To what extent does the difference in H-Index scores between plaintiff and defense expert witnesses correlate with a favorable litigation outcome in a mild traumatic brain injury case?
    - $H_2 0$: The difference between expert witnesses' H-Index scores for the plaintiff and defendant and litigation outcomes is not significant at $p < .05$.
    - $H_2 A$: The difference between expert witnesses' H-Index scores for the plaintiff and defendant and litigation outcomes is significant at $p < .05$.

The second research question for the study involved measuring the correlation between the H-index score and litigation outcomes in mTBI civil cases. The results of the study supported the null hypothesis that the relationship between H-index score differences between the plaintiff and defendant with favorable litigation outcomes for the plaintiff and the defendant is not significant at $p < .05$. Based on the lack of significance, the finding was evidence that the H-index score holds an insignificant impact on the outcome of litigation. Like the results discussed in Research Question 1, the results with Research Question 2 do not support the hypothesis. However, the findings discussed in Research Question 2 are evidence that the strength of the expert used will not hold an influence on the outcome of litigation in an mTBI case.

The findings from both Research Questions 1 and 2 contribute evidence that expert witnesses and the strength of expert witnesses will not hold a significant influence on the outcome of civil litigation involving mTBI cases. While the results of analysis related to Research Question 1 indicates a lack of significance in the difference between the expert witnesses used by plaintiffs and defendants, the findings for Research Question 2 indicate that the strength of expert witnesses does not matter. Based on these findings, law professionals should not be concerned about selecting expert witnesses based on strength because their strength does not hold a significant influence on case outcomes.

5.2 Directions for Future Research

While the analysis concluded with insignificant findings, there are areas that future research could examine to understand further the use of experts in civil litigation in cases where the plaintiff had experienced an mTBI. One area for future research would be to understand whether the quality of experts was responsible for a higher settlement. While the focus of this study was on understanding the role of expert quality and the difference between plaintiffs and defendants in expert quality on the verdict of the case, another critical outcome of concern involves the amount won by the plaintiff if they are the victor. Future research should examine the role of the difference in H-Index as influencing the amount won in a case, and the influence of the amount won based on the H-Index of the plaintiff in a case. Another direction for future research should be to understand the H-Index difference among defendants in cases where the defendant loses.

There is also room for future research where a qualitative methodology would be useful to explore the use of experts in civil litigation involving mTBI. A qualitative case study of a case where the plaintiff experienced an mTBI and experts were used could be useful. The researcher could successfully triangulate by observing the case, interviewing key individuals such as the plaintiff, defendant, their lawyers, and the judge, and reviewing court documents after the case. A qualitative descriptive study would also support exploring the use of experts to understand how lawyers and judges interpret the quality of expert witnesses in a case. In addition to these directions for future research, limitations to the study could support future research following the same methods and design as the current study while addressing limitations that occurred during data collection and analysis.

Specifically, future research could include having a greater sample size of cases which could impact the results. The final sample of 81 is identified as a limitation in this particular study. Additionally, the H-Index of each expert witness could be further evaluated to identify whether self-citation was a factor in a high H-Index score. Understanding this and accounting for it could impact the results and research outcomes. It could also be beneficial to go beyond evaluating only the H-Index and looking at other critical factors that may influence case outcomes. Finally, the possibility of classifying each professional by their role, categorically, based on their academic tenure could be a way to identify a normal data distribution. Ultimately, this research serves as a starting point for understanding how experts can influence litigation outcomes which can provide courts, lawyers, plaintiffs, and the defense with important information as they engage in the litigation process.

5.3 Limitations

Several limitations must be noted based on deviations from the original data collection and analysis plan described in Chapter 3. One key limitation in the study involved the small number of cases won by defendants. The ratio of plaintiff-to-defendant victories, in this case, was 5.08. A sample with equal successes between plaintiffs and defendants could have resulted in different findings. Another limitation to the study involves the distribution of the data. A normal distribution of the data was preferred because it would support one of the critical statistical assumptions made in the study, where the use of a paired-samples *t*-test would be performed. The non-normal distribution of the data led to using a non-parametric test, the Wilcoxon signed-rank test. The use of the Wilcoxon signed-rank test is acknowledged as a limitation because parametric tests lead to results with more significant trustworthiness and greater power.

The study was also limited to examining data where a mean score was used for individual cases where multiple mTBI experts were present. The cases included in the study contained units of analysis that were singular in each case, where there was only one measure of expertise for the plaintiff and one measure of knowledge for the defendant, even when there were multiple experts. A mean in cases with multiple experts for the defendant or the plaintiff was used because a sum could not possibly measure the expertise with accuracy. To account for this limitation in the future, researchers should limit their sample to those where there is a single expert for both the plaintiff and the defendant. The inclusion of cases with multiple experts also reduced the analysis where it was impossible to examine the data based on the type of experts. There were several types of experts included in the sample. However, some cases had multiple kinds of experts included in their cases. Limiting a sample only to have one expert for the plaintiff and the defendant would support the inclusion of the type of expert in analysis in the future. Possibly, if these limitations were addressed in future research, there is the possibility that significant findings will be found

5.4 Conclusion

In closing, the influence of experts in civil litigation where the plaintiff experienced an mTBI remains unknown. The results from quantitative data analysis indicated that the extent to which the quality of experts in these cases influences the outcome of the case was small. The qualifications of plaintiff and defense expert witnesses in mild traumatic brain injury civil litigation are not significantly different at $p < .05$. The relationship between H-Index score differences between the plaintiff and defendant with favorable litigation outcomes for the plaintiff and the defendant is not significant at $p < .05$. Based on the findings, there is importance in exploring the problem further. Chapter 5 included a discussion of the direction that future research should take to understand the role of experts. Cases, where individuals have experienced an mTBI can be complex for a judge and jurors because these cases involve injuries that are not always recognizable to the court, but they could be causing adverse problems and may hold implications for an individual for the rest of their lives. However, while it would appear that expert testimony would be crucial in these cases, the role of the quality of expert testimony toward whether there is a victory or not was found to be small. Thus, further research is needed to understand how experts can hold a role in supporting victims.

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