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## **The Effects of Insurance Status on Pediatric Traumatic Brain Injury Outcomes: A Literature Review**

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### **ABSTRACT**

**Objective:** To review the literature that describes the effects of insurance status on traumatic brain injury (TBI) outcomes among pediatric patients to understand how policies related to access to health insurance changes TBI outcomes.

**Method:** This review was conducted using the Preferred Reporting Items of Systematic Reviews and Meta-Analysis (PRISMA). A search of OVID Medline was conducted in May of 2016 for all years for peer-reviewed articles that included keywords related to “brain injuries” and “insurance status”. Articles were included if authors conducted a separate analysis of children aged 0 to 18. Articles were excluded if the TBI was the result of abuse.

**Results:** After screening for inclusion and exclusion criteria, a total of 12 articles were analyzed.

**Discussion/Summary:** The findings of this review indicate that insurance status has a significant effect on the health outcomes of pediatric patients who experience TBI, with insured children having lower mortality rates than those with insurance from the government or uninsured. In addition, those insured from the government had a survival benefit when compared to those without insurance. We found evidence that insurance status plays a role in long term outcomes such as rates of placement into rehabilitation facilities and level of disability.

**Keywords:** Traumatic Brain Injury, Trauma, Pediatric, Insurance Status, Health Policy, Disparities

### **INTRODUCTION**

Trauma is a leading cause of death and disability among children living in the United States with 75-97% of all pediatric trauma deaths being attributed specifically to traumatic brain

injury (TBI). According to the CDC, patients between the ages of 0-19 are at the greatest risk of experiencing a traumatic event (excluding falls) leading to serious brain injury (CDC, 2016). Research has identified a number of racial, cultural, and economic characteristics that predict health outcomes among pediatric TBI patients. Many studies report disparities among minorities and patients with low socioeconomic status (SES), demonstrating that they tend to have increased mortality and impaired recovery (Ayanian, Cleary, Weissman, & Epstein, 1999; Gornick et al., 1996; Kressin & Petersen, 2001; Lu, Samuels, & Wilson, 2004). Studies have shown that low SES is associated with decreased likelihood of undergoing surgical procedures and admission to inpatient rehabilitation programs.

The existence of outcome disparities are clear, however the underlying causes are still unapparent. Research has shown that insurance status affects treatment and health outcomes among adult TBI patients, but no one has summarized the literature regarding how this relates to children aged 0 to 18. (Haider et al., 2008; Rosen, Saleh, Lipsitz, Meara, & Rogers, 2009). Conducting such a review would provide guidance to policy makers to support recent policy changes in government insurance. Recent changes in national health policies that were made, in large part, to increase the number of individuals who carry insurance on the effect on health outcomes for TBI patients. It is important, then, to understand this relationship to provide a benchmark for researchers, health workers, and policy makers. For these reasons, we conducted a systematic literature review that aims to examine whether insurance status is related to mortality, placement into rehabilitation treatment programs, and long term health outcomes among pediatric TBI patients.

## **METHODS**

Our review was conducted using the Preferred Reporting Items of Systematic Reviews and Meta-Analysis (PRISMA). We conducted a search of OVID Medline in May of 2016 for peer-reviewed articles that included keywords related to “brain injuries” and “insurance status”. No date limitations were made in the search. We focused on studies that included children (age 0-18 years) and health outcomes. We visually inspected all articles to ensure that children aged 0 to 18 were included in a separate group. We defined traumatic brain injury as any injury that resulted in a diagnosis of traumatic brain injury, as defined within the manuscript. We divided insurance status as commercial/private, government-based and none. Outcomes were broken into two primary categories, in-hospital mortality and long-term outcomes. Long term outcomes were defined as any outcome that was measured as care or measurements after the initial hospital stay and included placement into rehabilitation care and resulting disability and death. Articles that were not available in English were excluded in our analysis, as well as studies that focused on child abuse since research indicates that this patient population is quite different from those with accidental injuries. All studies conducted outside of the US were excluded because insurance structures are distinct in US versus in other countries.

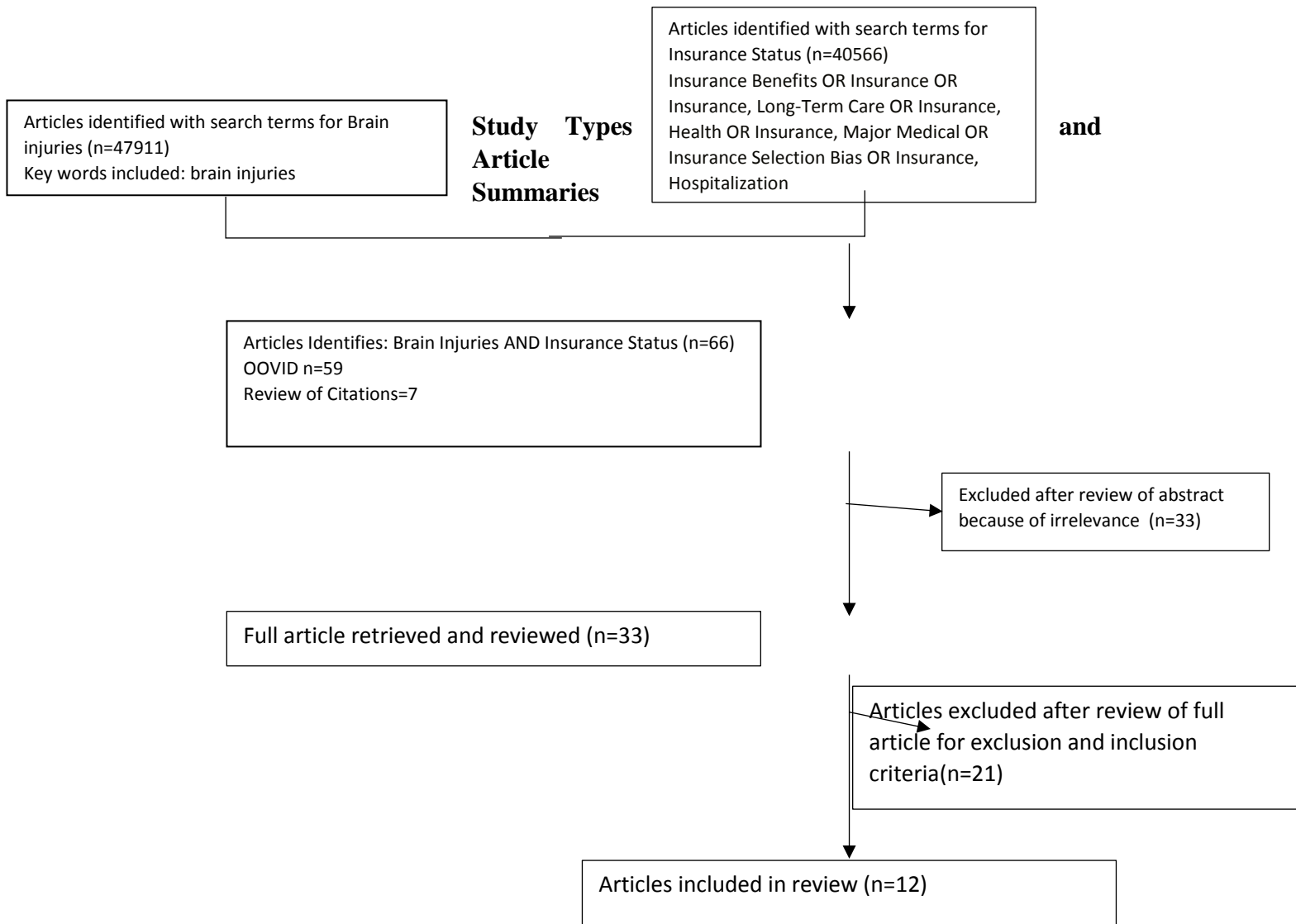
Two researchers independently screened the titles and abstracts of all potential articles that were found during the search to determine eligibility for the analysis. The articles were then read in closer detail by both researchers and a list was constructed to determine eligibility of the study. The lists were compared and any disagreement was reconciled before coming to a final list of articles that both researchers agreed upon.

## **RESULTS**

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Using the keywords for brain injuries we identified 47911 articles and we identified 40566 articles using the keywords for insurance status. A complete list of keywords used and a visual representation of the process can be found in Figure 1. Using both keywords, 59 potential articles were found. An additional 7 articles that appeared to meet criteria were found through a citation review, adding to a total of 66 potential articles. After review of the abstract 33 articles were excluded, six were excluded after reading the article, and 15 were excluded after review by the second reader. A total of 12 articles were included and considered relevant for review.

**Figure 1. Article Selection and Review Process for Brain Injuries and Insurance Status**



Eleven of the 12 articles were retrospective analyses (Bowman, Martin, Sharar, & Zimmerman, 2007; Cassidy et al., 2013; Falcone, Martin, Brown, & Garcia, 2008; Greene et al., 2010; Haider et al., 2008; Haider et al., 2012; Hakmeh, Barker, Szpunar, Fox, & Irvin, 2010; Piatt & Neff, 2012; Rosen et al., 2009; Shafi, de la Plata, et al., 2007; Tilford et al., 2005), eight of which collected medical records from the National Trauma Data Bank (some of these studies overlap in patients) (Bowman et al., 2007; Falcone et al., 2008; Greene et al., 2010; Haider et al., 2008; Haider et al., 2012; Hakmeh et al., 2010; Rosen et al., 2009; Shafi, de la Plata, et al., 2007), one from the PICU at a level 1 pediatric trauma hospital in Milwaukee, Wisconsin (Cassidy et al., 2013), one from the Kids' Inpatient Database (Piatt & Neff, 2012), and one from the Nationwide Independent Sample database (Tilford et al., 2005). One study (Falcone et al., 2008) sampled the National Trauma Data bank in order to compare to their data which was

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collected from The Cincinnati Children's Hospital Medical Center. The remaining study was a prospective cohort study design which collected data from The North Texas Traumatic Brain Injury Research Center which consists of two urban level 1 trauma hospitals (Shafi, Marquez de la Plata, et al., 2007).

Overall, the studies included in this analysis supported the hypothesis that insurance status had a protective effect on health outcomes. Eleven studies directly compared outcomes between insured and uninsured patients (Bowman et al., 2007; Cassidy et al., 2013; Greene et al., 2010; Haider et al., 2008; Haider et al., 2012; Hakmeh et al., 2010; Piatt & Neff, 2012; Rosen et al., 2009; Shafi, de la Plata, et al., 2007; Shafi, Marquez de la Plata, et al., 2007; Tilford et al., 2005) – with the nine that included in-hospital mortality demonstrating that insurance status and mortality were associated. (Bowman et al., 2007; Cassidy et al., 2013; Greene et al., 2010; Haider et al., 2008; Haider et al., 2012; Hakmeh et al., 2010; Piatt & Neff, 2012; Rosen et al., 2009; Tilford et al., 2005). Two studies included discharge to a rehabilitation facility as an outcome and both found that uninsured patients were less likely to be placed into such a facility (Bowman et al., 2007; Shafi, de la Plata, et al., 2007). One study included disability and functional measures 6 to 12 months after the injury as an outcome and found that uninsured patients had higher levels of disability than patients who were insured (Shafi, Marquez de la Plata, et al., 2007).

Nine studies divided insured patients into those with private/commercial insurance and those with government insurance (Bowman et al., 2007; Cassidy et al., 2013; Falcone et al., 2008; Haider et al., 2012; Hakmeh et al., 2010; Rosen et al., 2009; Shafi, de la Plata, et al., 2007; Shafi, Marquez de la Plata, et al., 2007; Tilford et al., 2005). In one study, government insurance status was further divided into Medicaid (Bowman et al., 2007). Of these nine studies, six studies reported in-hospital mortality (Bowman et al., 2007; Cassidy et al., 2013; Falcone et al., 2008; Haider et al., 2012; Hakmeh et al., 2010; Rosen et al., 2009; Tilford et al., 2005). Three of the seven studies reported insignificant results (Falcone et al., 2008; Haider et al., 2012; Tilford et al., 2005). Of the two studies that focused on rehabilitation, both found that government insured patients had lower odds of being placed into a rehabilitation program than privately insured (Shafi, de la Plata, et al., 2007; Shafi, Marquez de la Plata, et al., 2007), however one yielded insignificant results (Shafi, Marquez de la Plata, et al., 2007).

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Table 1: Article Summaries

Title	Author, Year, and Reference	Citation Number	Study Type	Data Source	Age Groups*	Outcome of Interest	Follow Up Length	OR(CI) Commercial insurance	OR(CI) Government insurance	OR (CI) No insurance
Association Between Hospitals Caring for a Disproportionately High Percentage of Minority Trauma Patients and Increased Mortality A Nationwide Analysis of 434 Hospitals	Haider et al., 2012	[11]	Retrospective	National Trauma Data Bank	All ages	Mortality	In-hospital		<b>Hospitals with &lt;25% minority patients</b> 1.13 (1.01-1.28) <b>Hospitals with 25-50% minority patients</b> 1.53 (1.33-1.76) <b>Hospitals with &gt;25% minority patients</b> 1.14 (0.96-1.36)	<b>Hospitals with &lt;25% minority patients</b> 1.56 (1.36-1.78) <b>Hospitals with 25-50% minority patients</b> 1.53 (1.33-1.76) <b>Hospitals with &gt;25% minority patients</b> 1.43 (1.26-1.63)
Despite overall low pediatric head injury mortality, disparities exist between races	Falcone et al., 2008	[7]	Retrospective	National Trauma Data Bank, Cincinnati Children's Hospital Medical Center	0-16 years	Mortality	In-hospital		2.2(1.0-5.1)	---
Hospital Care of Childhood Traumatic Brain Injury in the United States, 1997-2009, A neurosurgical prospective	Piatt and Neff, 2012	[18]	Retrospective	National Trauma Data Bank, Cincinnati Children's Hospital Medical Center	0-16 years	Mortality	In-hospital	0.86 (0.77-0.95) (reference is other or no insurance)	---	
Hospitalizations for Critically Ill Children with Traumatic Brain Injuries: A Longitudinal Analysis	Tilford et al., 2005	[24]	Retrospective	Nationwide Inpatient Sample Database	0-21	Mortality	In-hospital		0.929 (0.833-1.035)	2.917 (2.512-3.389)

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Title	Author, Year, and Reference	Citation Number	Study Type	Data Source	Age Groups*	Outcome of Interest	Follow Up Length	OR(CI) Commercial insurance	OR(CI) Government insurance	OR (CI) No insurance
Effect of Race and Insurance on Outcome of Pediatric Trauma	Hakmeh et al., 2010	[12]	Retrospective	National Trauma Data Bank	0-17 years	Mortality	In-hospital		1.14(1.02-1.26)	2.92(2.62-3.26)
Health Disparities Analysis of Critically Ill Pediatric Trauma Patients in Milwaukee, Wisconsin	Cassidy et al., 2013	[5]	Retrospective	Medical records from PICU at level 1 pediatric trauma hospital	0-18	Mortality	In-hospital		2.6(1.1-6.2)	4.6(1.7-12.6)
Insurance status is a potent predictor of outcomes in both blunt and penetrating trauma	Greene et al., 2010	[9]	Retrospective	National Trauma Data Bank	0-65	Mortality	In-hospital	Blunt (used as reference) Piercing 2.48(2.33-2.63)	---	Blunt 1.78(1.71-1.85) Piercing 5.39(5.11-5.69)
Lack of insurance negatively affects trauma mortality in US children	Rosen et al., 2009	[21]	Retrospective	National Trauma Data Bank	0-17	Mortality	In-hospital		1.19(1.07-1.33)	3.32(2.95-3.74)
Race and Insurance Status as Risk Factors for Trauma Mortality	Haider et al., 2008	[10]	Retrospective	National Trauma Data Base	All ages	Mortality	In-hospital		---	1.46(1.39-1.54)
Racial Disparities in Outcomes of Persons With Moderate to Severe Traumatic Brain Injury	Bowman et al., 2007	[4]	Retrospective	National Trauma Data Bank	All ages	Mortality, rehab placement	In-hospital		<b>MORTALITY:</b> Medicaid 0.75(0.64-0.89) <b>DISCHARGE TO REHAB:</b> Medicaid 0.76(0.53-1.03)	<b>MORTALITY:</b> 1.62(1.35-1.96) <b>DISCHARGE TO REHAB:</b> 0.57(0.47-0.69)
Ethnic Disparities	Shafi et	[22]	Retrospective	National	All ages	Rehab	In-	1.603(1.492-	1.459(1.350-	(used as reference)

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Title	Author, Year, and Reference	Citation Number	Study Type	Data Source	Age Groups*	Outcome of Interest	Follow Up Length	OR(CI) Commercial insurance	OR(CI) Government insurance	OR (CI) No insurance
Exist in Trauma Care	al., 2007			Trauma Data Bank		placement	hospital	1.722)	1.578)	
Racial Disparities in Long-Term Functional Outcome After Traumatic Brain Injury	Shafi et al., 2007	[23]	Prospective cohort	Recruitment from an urban level 1 trauma center	All ages	Disability/functional measures	6-12 months post-injury	0.27(0.14-0.51)	0.65(0.28-1.49)	(used as reference)

Note:

Reference category for OR is commercial insurer unless otherwise noted in the table.

\* All ages or 0-65 indicates that while study included pediatric patients, outcome was not stratified by pediatric or adult patients.

OR(CI): Odds Ratio (Confidence Interval)



## DISCUSSION

On the whole, the literature suggests that there is a protective relationship of having insurance on pediatric TBI outcomes. In all nine studies that looked at mortality among patients who lacked insurance had significantly increased odds of mortality. This trend in insurance status has been seen in other health issues (Ayanian et al., 1999; Gornick et al., 1996; Kressin & Petersen, 2001; Lu et al., 2004) such as breast cancer (Ayanian, Kohler, Abe, & Epstein, 1993), leukemia (Kent, Sender, Largent, & Anton-Culver, 2009), and diabetes (Pugh, Tuley, Hazuda, & Stern, 1992). Further dividing insurance status into commercial and government categories gives little insight about whether insurance type affects outcome as results were conflicting and most results were only borderline significant. The mechanism by which insurance effects outcomes is still unclear, however, it is complex with insurance effecting outcomes in a number of ways. The articles reviewed provide some insight into what they may be.

### SES

Socioeconomic status has been linked to poor health outcomes for many different health issues for a number of different reasons. It has been suggested that insurance status varies by SES because people of low SES are generally less likely to have insurance and are therefore more prone to have poor outcomes. Hospitals located in areas with lower economic success have historically seen lower quality in care and worse outcomes in a variety of diseases and surgical interventions (Baicker, Chandra, & Skinner, 2005; Ly, Lopez, Isaac, & Jha, 2010; Popescu, Werner, Vaughan-Sarrazin, & Cram, 2009). Piatt et al. found that patients who live in Zip codes with higher median income tended to have significantly decreased mortality rates, increased charges, and more major and minor neurological surgeries (Piatt & Neff, 2012). Interestingly enough, another study we reviewed, done by Tilford et al. (Tilford et al., 2005) found no increase in mortality among patients from low-income households. These conflicting results suggest that there is likely some difference between households with low incomes and larger areas with low median income. Hospitals who perform poorly have been noted to serve higher populations of minority, uninsured, and low income patients (Baicker et al., 2005; Ly et al., 2010; Popescu et al., 2009). Constrained budgets, generally manifests in staffing shortages, outdated equipment and technology, and the inability to invest in quality of care improvements (Baicker et al., 2005; Hasnain-Wynia et al., 2007; Ly et al., 2010). It is likely that a disproportionate number of uninsured individuals are treated in these challenged hospitals which could explain in part the disparities seen in uninsured children and TBI outcomes. While interesting, there was not enough evidence available in this review to draw any conclusions on the relationship between SES, insurance status, and health outcomes.

### Racial Factors

Racial disparities in pediatric TBI outcomes have been well established and in almost every study, race was a significant factor in mortality and rehabilitation placement. Shafi et al. (Shafi, de la Plata, et al., 2007; Shafi, Marquez de la Plata, et al., 2007), Cassidy et al. (Cassidy et al., 2013), Haider et al. (Haider et al., 2012), and Bowman et al. (Bowman et al., 2007) all showed higher percentages of uninsured patients in minorities compared to Whites. This suggests that insurance and race are associated in some way and could account for at least some of the apparent racial disparities. One study (Shafi, de la Plata, et al., 2007) found that after controlling for insurance status, associated injuries, overall injury severity, age, and gender there was no significant difference between African American patients placed into rehab and white patients. It is worth noting, however, there was still a significant difference in Hispanics. Piatt et

al. found that while Whites were more likely to receive a minor neurosurgical procedure when compared to Hispanics, there was no significant difference in the number of major neurosurgical procedures and total charges after adjusting for confounders (Piatt & Neff, 2012). The findings of Boeman et al. (Bowman et al., 2007) conflict with this finding. Even after adjusting for sex, severity, and insurance blacks and Hispanics were significantly less likely to be admitted to a rehabilitation program. When looking at mortality, this same study found no significant difference by race. This finding was contradicted by Haider et al. (Haider et al., 2008) who found that odds of mortality does increase even after stratifying by insurance status. Shafi et al. (Shafi, Marquez de la Plata, et al., 2007) attempted to address this and found that observed racial disparities in moderate to severe disability decreased in odds from 2.17 to 1.17 after including insurance status into the model. Given that there are known racial disparities in many health issues it is not likely that insurance status is able to account for the observed racial disparities in TBI. The two factors, however, are clearly not independent of one another and more research is needed to better understand this relationship.

#### Quality of Care

It has been hypothesized that patients without insurance are likely to receive lower quality of care. Piatt et al. (Piatt & Neff, 2012) found that self-pay status was highly associated with fewer major procedures and Bowman et al. (Bowman et al., 2007) found that self-pay patients were significantly less likely to be admitted to a rehabilitation program. Furthermore, Tilford et al. (Tilford et al., 2005) found that uninsured children were significantly less likely to receive intracranial pressure monitoring, a measure of treatment aggression that he showed had a protective effect on mortality, and that aggressiveness of treatment can account for up to one third of the disparity between insured and uninsured patients. It was unclear exactly why uninsured patients were receiving this demonstrably lower standard of care however there may be many reasons. For instance, TBI is expensive because it often requires emergency surgical intervention and long term treatment and rehabilitation services. Uninsured individuals are likely not able to pay for the services offered by hospitals and other practices which makes medical decision making more complicated as hospitals and clinicians may be reluctant to order expensive tests and procedures that they know will likely not be paid for. Unfortunately, current research cannot elucidate the mechanisms behind the disparities in quality of care.

#### Weaknesses and Limitations

There are a number of weaknesses to the studies reviewed. Only twelve articles were found that met the inclusion criteria. The underwhelming amount of literature that looked at children specifically made it impossible to draw any strong conclusions. While they seemed to align with other health issues, more studies that focus specifically on pediatric TBI cases need to be conducted in order to develop a real understanding of the situation. Because we excluded abused populations, our results are only generalizable to non-abuse pediatric TBI patients.

Of the twelve articles that were reviewed, only one was a prospective study. The remaining eleven analyzed retrospective data. Furthermore, eight of the eleven retrospective studies used data collected from the National Trauma Data bank while for the remaining three, one used the Kids' Inpatient Database, one used the Nationwide Independent Sample database, and the last one used the Nation the other used Medical records from PICU at a level 1 pediatric trauma hospital. While the national data bank provides data representative of the US, the fact that almost all of the studies reviewed made conclusions based on samples drawn from the same pool of data introduces potential bias into the review.

A large amount of the literature reviewed in this study had a primary focus on racial and ethnic issues with insurance being a secondary category included in the model. This is a concern because there may be confounding the relationship between insurance and outcomes specifically that these studies did not take into account because they were primarily focused on race and ethnicity.

#### Future Directions

This review helped to explore the effect of insurance on pediatric TBI outcomes but it also highlighted the need for more research in this field. The majority of the articles reviewed were retrospective and drew data from the National Trauma Data Bank. Prospective studies are needed in order to gain a better understanding of the relationship between insurance and TBI. In addition to adding diversity and volume to the limited literature currently available, these studies will have the added benefit of allowing for long term follow up data that could include rehabilitation placement, disability, comorbidity, and long term mortality measures. The mechanism by which insurance status effects health outcome is still relatively unclear. The results of this review should be considered in developing research to how current and future health care policy effects health disparities. In order to better understand this, studies that track the use and allocation of resources should be done. With this information it will be possible to determine whether insurance affects factors such as aggressiveness of treatment and type and quality of treatment. It will also provide data that could highlight where resources are needed in order to improve health outcomes.

#### **CONCLUSION**

The findings of this study indicate that Insurance status has a significant effect on the health outcomes of pediatric patients who experience TBI. It seems clear that insured patients have significantly lower odds of mortality following traumatic brain injury. Additionally, those insured by the government, while still faring better than uninsured patients still have higher odds of mortality than those who are insured commercially. This study also found evidence that insurance status plays a role in long term outcomes such as rehabilitation and disability. These trends are seen in other health issues such as cancer and heart disease which seems to indicate that disparities by insurance status are a complex problem that can affect many people in a number of ways. While the conclusions seemed to align with other health issues, more studies that focus only on pediatric TBI cases need to be conducted in order to develop a real understanding of the situation. This is especially the case now, given the recent change in US healthcare policy. With the intention of increasing the number of insured individuals and improving healthcare outcomes, it is important to establish healthcare states as they stand so future researchers and policymakers will have something to use as a benchmark to compare to.

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