Association of Interpersonal Violence With Self-Reported History of Head Injury

WHAT'S KNOWN ON THIS SUBJECT: Traumatic brain injury can cause functional short- or long-term changes in cognition, language, and emotion. These changes can include irritability, impulsivity, aggression, and violence. To date, most studies on effects of head injury have focused on clinical or prison-based samples.

WHAT THIS STUDY ADDS: Using longitudinal data, we provide insight into the relationship between head injury and violence in an urban community–based sample of youth and young adults. Understanding head injury during adolescence may provide insight into cognitive issues and problem behaviors.

abstract

OBJECTIVE: The purpose of this study was to examine differences in interpersonal violence among individuals who reported a head injury compared with those who did not report a head injury.

METHODS: We used data from an 8-year longitudinal study of youth selected by their grade point average to study those at-risk for high school dropout in 4 public high schools in a Midwestern city ($N = 850$). Participants were followed up from mid-adolescence to the transition into young adulthood. One-way analyses of variance were used to test for differences in levels of interpersonal violence, and repeated measures multivariate analyses of variance were used to assess differences in levels of violence over time among participants based on reports of head injury. A series of multivariate regression analyses examined whether head injury was associated with subsequent violent behavior.

RESULTS: Participants who had ever experienced a head injury before young adulthood reported more interpersonal violence in young adulthood than participants who had never had a head injury. In multivariate analyses, respondents who had a head injury in the past year reported more subsequent interpersonal violence than respondents who had not had a head injury.

CONCLUSION: Our findings support other studies that link history of head injury to later interpersonal violence. *Pediatrics* 2011;127: 1074–1079

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KEY WORDS

head injury, traumatic brain injury, violent behavior, longitudinal, emerging adulthood

ABBREVIATIONS

TBI—traumatic brain injury

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Traumatic brain injury (TBI) is a serious public health concern. An estimated 1.7 million people sustain a TBI annually, but this does not include individuals who receive health care in a setting other than an emergency department or who receive no health care.[1] TBI is caused when sudden trauma (a blow, jolt, or penetrating injury) disrupts the function of the brain.[2] Head injuries range in severity from mild (ie, brief change in mental status) to severe (ie, period of unconsciousness). Approximately 75% of TBIs are of a mild form.[3] In youth and young adults, head injuries are most often the result of motor vehicle accidents (>50%), being struck by or against something (3% due to sports injuries), and violence and assaults (20%).[2,4] A study of the armed forces indicated that 5% had experienced mild TBIs with loss of consciousness, especially due to blast explosions.[5]

TBIs can cause functional short- or long-term changes in cognition (eg, memory, reasoning), language (eg, communication, expression, understanding), and emotion (eg, depression, anxiety, personality changes, social inappropriateness).[2] These changes can include irritability, impulsivity, and violence and aggression.[2,6] Individuals with moderate to severe injury have more problems with cognitive deficits. However, a history of several mild TBIs may have an additive effect, causing cognitive and neurologic deficits equal to a moderate-to-severe injury.[2] In a group of college-aged athletes, Pontifex et al[7] found that individuals with a history of multiple mild TBIs demonstrated difficulties with considering alternative behaviors or controlling impulses, particularly during conflict.

Research on prisoners with a history of TBI indicates that these injuries are strongly associated with perpetration of various kinds of violence.[8,9] In a retrospective examination of potential predictors (ie, head injury, school problems, learning disabilities, illness) of committing violent crime, León-Carrión and Ramos[9] compared prisoners incarcerated for violent versus nonviolent crimes. The groups differed on self-reported history of head injury. Other researchers have found a high incidence of TBI histories in the prison population.[9–11] Children and teenagers who have been convicted of a crime are more likely to have had a TBI.[9]

Because adolescence and young adulthood is a time of continued cognitive development, understanding the affect of trauma to the brain during this period may provide insights into cognitive issues and problem behaviors. Adolescents with TBI are at greater risk of suffering developmental stagnation or the failure to mature emotionally, socially, or psychologically after trauma.[2] Head trauma, particularly to the prefrontal cortex, can cause delays in prefrontal maturation. This reduced functioning has been linked to aggression and violent behavior.[12–14] In a cross-sectional study of delinquent youth, Perron and Howard[15] found that youth with TBIs were more likely to be male, have a psychiatric diagnosis, report earlier onset of criminal behavior and substance use, have more lifetime suicidality, be impulsive, and have been criminally victimized in the year preceding incarceration than youth without TBI. In addition, they found that youth with a TBI were at higher risk for current depressive/anxious symptoms, antisocial behavior, and substance abuse problems. Grafman et al[16] also found links between frontal lobe injury and behavioral deficits and violent behavior. In particular, the ventral and polar frontal cortex plays a primary role in personal decision making and social behavior.[17] Damage to these regions may result in significant changes in emotion, social behavior, and self-awareness. Head injury may affect an individual's ability to problem solve and contribute to an individual's participation in violence.[7] Although much of the data thus far informs our understanding of the correlation between TBI and violence,[15] less is known about these effects among youth from a more general population sample. Consequently, the purpose of this study was to: (1) examine differences in interpersonal violence between individuals who reported head injury and those who did not; and (2) assess differences in the relationship between head injury and violence based on time since the occurrence of head injury. We first examined prior head injury as a predictor of later violent behavior. To more closely examine the proximal relationship between head injury and subsequent interpersonal violence we examined the effects of head injury in the past year on violent behavior the next year. We hypothesized higher levels of interpersonal violence in individuals who reported a head injury the prior year. We also hypothesized a stronger relationship between head injury and interpersonal violence the more recent the head injury.

METHODS

Study Sample

We used data from an 8-year longitudinal study of youth selected by their grade point average to study youth at-risk for high school dropout. The present study followed up youth from mid-adolescence to the transition into young adulthood in 4 public high schools in a Midwestern city ($N = 850$). Eligibility criteria included: (1) a grade point of 3.0 or lower at the end of the eighth grade; (2) not diagnosed as emotionally or developmentally impaired; and (3) self-identified as black, white, or both. The initial sample consisted of white (17%), black (80%), and

biracial (3%) adolescents. The sample was 50% female. Waves 1 to 4 correspond to the participants' high school years; waves 5 to 8 correspond to the second through fifth year after high school, regardless of whether they graduated from high school. At each wave, interviewers conducted structured 60-minute, face-to-face interviews in school or in a community setting. After the interview, participants completed a self-administered paper-and-pencil questionnaire about substance use, sexual behavior, and other sensitive information. A 90% response rate was maintained from waves 1 to 4; a 68% response rate was maintained from waves 5 to 8. The University of Michigan's Institutional Review Board approved the study procedures (UM-IRB#H03-0001309). Because history of head injury was first assessed at wave 5, this study used data from respondents who participated during waves 5 to 8.

Measures

Head Injury

History of head injury was first assessed at waves 5 and 6 with a single dichotomous item, "Have you ever had a head injury (concussion, fractured skull, knocked unconscious)?" At wave 7, participants were assessed about head injury in the past year.

Interpersonal Violence

We used a 4-item scale to assess interpersonal violent behavior in each year of the study (Cronbach's α = 0.63–0.76). Participants indicated how often they had engaged in each behavior during the preceding 12 months: gotten into a fight, taken part in a group fight, hurt someone badly enough to need bandages or a physician, and used a knife, gun, or some other item (eg, a club) to get something from a person. Response options ranged from 0 (0 times) to 4 (≥4 times). A composite score was computed by calculating the mean across the 4 items; higher scores indicated more violent behavior.

Alcohol Use

We used 2 items to assess self-reported frequency of alcohol use at wave 7: "How many times have you had alcoholic beverages to drink during the last 30 days?" and "How many times have you had alcoholic beverages to drink during the last 12 months?" (Cronbach's α = 0.82). Response categories were 1 = 0 times, 2 = 1 to 2 times, 3 = 3 to 5 times, 4 = 6 to 9 times, 5 = 10 to 19 times, 6 = 20 to 39 times, and 7 = ≥40 times. The items were summed; higher scores indicated more alcohol use. These items are the same as those used in the Monitoring the Future study.[18]

Marijuana Use

We used 2 items to assess self-reported marijuana use at wave 7: "How many times, if any, have you used marijuana (grass, pot, weed) or hashish during the last 30 days?" and "How many times have you used marijuana or hashish during the last 12 months?" (α = 0.87). Response categories were 1 = 0 times, 2 = 1 to 2 times, 3 = 3 to 5 times, 4 = 6 to 9 times, 5 = 10 to 19 times, 6 = 20 to 39 times, and 7 = ≥40 times. The items were summed; higher scores indicated more marijuana use. These items were also used in the Monitoring the Future study.[18]

Violent Observations

We used 2 items to assess whether respondents had observed violent behaviors in the past 12 months: seen someone commit a violent crime where a person was hurt and seen someone get shot, stabbed, or beaten up (Cronbach's α = 0.79) Response options ranged from 0 (0 times) to 4 (≥4 times). A composite score was computed by calculating the mean of the 2 items; higher scores indicated more observations.

Nonviolent Delinquency

We used a 9-item scale to assess nonviolent delinquent behaviors (Cronbach's α = 0.76). Participants indicated how often they had engaged in the following behaviors during the preceding 12 months: taken something not belonging to you, taken something from a store without paying for it, taken a car that did not belong to someone in your family without permission, taken parts from a car without the owner's permission, gone into a house or building when you were not supposed to be there, set fire to someone's property on purpose, sold illegal drugs, or gotten into trouble with police. Response options ranged from 0 (0 times) to 4 (≥4 times). A composite score was computed by calculating the mean across the 4 items; higher scores indicated more nonviolent delinquent behavior.

Demographic Characteristics

In wave 1, we asked participants to report their gender (male = 1, female = 2) and race (1 = black, 2 = white, 3 = mixed black and white, 4 = other).

Statistical Analyses

One-way analyses of variance were used to test for differences in levels of interpersonal violence among participants based on report of a head injury at wave 5. Repeated measures multivariate analysis of variance were used to assess differences in levels of interpersonal violence over time (waves 6–8) among participants based on reports of head injury at wave 5.

We used multivariate regression analyses to examine whether head injury was associated with interpersonal violence over time. First, we examined whether ever having a head injury (reported in waves 5 and 6) was predictive of interpersonal violence at wave 8

(model 1). To eliminate prior violence as an explanation of head injury effects, previous violence (measured at wave 5) was added to the model (model 2). To more closely examine the proximal relationship between head injury and subsequent interpersonal violent behavior, we then conducted a second set of multivariate regression analyses to examine whether head injury in the past year (reported at wave 7) was predictive of violent behavior at wave 8 after controlling for previous head injury (waves 5 and 6) (model 3). Again, to eliminate prior violence as an explanation of head injury effects, previous violence (measured at wave 5) was added to the model (model 4). To address possible spurious findings, we controlled for other potential correlates to interpersonal violence, including wave 7 alcohol use, marijuana use, observations of violence, and nonviolent delinquency (model 5). Race and gender were included in all models.

RESULTS

Descriptive characteristics of participants who reported a head injury in waves 5 to 7 are shown in Table 1. For each wave, participants who had experienced a head injury at wave 5 reported more violent behavior than participants who did not report a head injury, except in wave 7, which only approached significance ($P = .08$). Table 2 reports the group means, SDs, and Student's *t* test results from waves 5 to 8. Only 8 participants reported both a head injury in their lifetime at wave 5 or 6 and a head injury in the past year at wave 7.

TABLE 1 Descriptive Characteristics of Participants Who Reported Head Injury in Waves 5 to 7

	Wave 5 ($n = 88$)	Wave 6 ($n = 93$)	Wave 7 ($n = 14$)
Sex			
Male	52 (59%)	65 (70%)	10 (71%)
Female	36 (41%)	28 (30%)	4 (29%)
Race			
Black	65 (74%)	64 (69%)	8 (57%)
White	21 (24%)	26 (28%)	4 (29%)
Mixed race	2 (2%)	3 (3%)	2 (14%)

Waves 5 and 6 reported ever head injured; wave 7 reported head injury in past year. Values are given as *n* (% of head injured).

TABLE 2 Means, SDs, and Student's *t* Tests for Violent Behavior Over Time Based on Reported Head Injury at Wave 5

	Wave 5				Wave 6				Wave 7				Wave 8			
	Mean	SD	*t*	*df*	Mean	SD	*t*	*df*	Mean	SD	*t*	*df*	Mean	SD	*t*	*df*
Head injury	.43[a]	.65	−3.95	568	.30[a]	.56	−1.86	512	.23[b]	.51	−1.41	466	.32[a]	.71	−2.17	459
No head injury	.22	.42			.20	.45			.16	.38			.18	.44		

[a] $P < .05$.
[b] $P = .08$.

TABLE 3 β and SE for Models Predicting Violent Behavior at Wave 8 Controlling for Previous Violence (Waves 5 and 6) ($N = 480$)

	Violent Behavior			
	Model 1		Model 2	
	β	SE	β	SE
Constant	.40[a]	.10	.24[b]	.10
Head injury (waves 5 and 6)	.16[c]	.05	.08	.05
Gender	−.12[c]	.05	−.08[b]	.04
Race	−.03	.05	−.01	.05
Previous violence			.36[a]	.05
R^2	.04		.16	
Adjusted R^2	.04		.15	
F	7.28[a]		21.50[a]	

[a] $P < .001$.
[b] $P < .05$.
[c] $P < .01$.

We found between-respondent differences in reported levels of violent behavior ($F_{4,397} = 2.98$; $P = .02$) according to head injured group. We also found within-respondent effects (time effects) ($F_{3,398} = 2.95$; $P = .03$) but no between-respondent by within-respondent interaction ($F_{3,398} = 1.12$; $P =$ NS).

Previous head injury (lifetime head injury reported in waves 5 and 6) was associated with interpersonal violence at wave 8 ($F_{3,474} = 7.28$; $P < .001$) (model 1, Table 3). Respondents who ever had a head injury reported more interpersonal violence than respondents who had not had a head injury ($\beta = .16$; $P < .01$). After controlling for previous violence, respondents who ever had a head injury reported no higher levels of participation in interpersonal violence at wave 8 than respondents who had not had a head injury (model 2).

Even after accounting for race, gender, and previous head injury, respondents who reported a head injury at wave 7 reported more violent behavior at wave 8 ($\beta = .92$; $P < .001$) (model 3, Table 4). When previous violence was added to the model (model 4), head injury at wave 7 remained a predictor of higher levels of interpersonal violence ($\beta = .98$; $P < .001$). Finally, to further eliminate alternative explanations of the head injury findings, we controlled for other wave 7 risk behaviors associated with violent behavior: alcohol use, marijuana use, delinquency, and violence observation. Head injury at wave 7 remained a predictor of violent behaviors at wave 8 ($\beta = 1.07$; $P < .001$) after controlling for other risk behaviors (model 5).

TABLE 4 Head Injury at Wave 7 and Violence at Wave 8, Controlling for Previous Head Injury (Ever Reported in Waves 5 and 6) ($N = 480$)

	Model 3 Violent Behavior		Model 4 Violent Behavior		Model 5 Violent Behavior	
	β	SE	β	SE	β	SE
Constant	.43[a]	.19	.29[a]	.10	−.06	.15
Head injury (wave 7)	.92[a]	.15	.98[a]	.16	1.07[a]	.18
Previous head injury	.11[b]	.06	.06	.06	.05	.06
Gender	−.10[c]	.05	−.07	.05	−.03	.05
Race	−.19[c]	.05	−.08	−.05	−.09	.05
Previous violence			.32[a]	.05	.24[a]	.05
Alcohol use (wave7)					.001	.01
Marijuana use (wave 7)					.001	.01
Violence observation (wave 7)					.05	.03
Nonviolent delinquency (wave 7)					.22[d]	.09
R^2	.12		.24		.30	
Adjusted R^2	.12		.23		.27	
F	15.08[a]		26.35[a]		18.00[a]	

[a] $P < .001$.
[b] $P \leq .10$.
[c] $P < .05$.
[d] $P < .01$.

DISCUSSION

The link between head injury and violent behavior, including TBI during adolescence and young adulthood, is a burgeoning social issue. Our findings support other studies that have linked history of TBI to later violent behavior.[7–9,15,16] Our study contributes to this literature in several ways. We provide insight into the relationship between head injury and violence in a general population of urban youth and young adults. We found links between head injury and later interpersonal violence in a general population of urban youth (those not considered delinquent, incarcerated, or specifically studied due to head injury). Using longitudinal data, we examined the effect of head injury on interpersonal violence several years after a self-reported head injury. Although we found a link between head injury and later violence, this relationship was stronger when the head injury was more recent. For more proximal head injury, we found higher levels of violent behavior even after controlling for other risk factors (ie, alcohol/marijuana use, nonviolent delinquency). Our results suggest that proximal head trauma may be more predictive of violence than more distal head trauma.

Limitations of this study should be noted. We used a broadly defined, self-reported measure of head injury. Responses could have been influenced by respondent recall, but head injuries are a notable life event that may be easier to recall than other injuries. Yet, if some respondents had had a head injury and did not report them in the study, it would result in misclassifying respondents into the nonhead injury group, thus making it more difficult to find group differences. A related issue is that some of the respondents may have indicated a head injury when it was barely a bang on the head (although the question included a list of types of more severe head injury). This issue, however, is somewhat mitigated by the fact that we found effects of head injury on interpersonal violence despite this shortcoming, suggesting that our findings may be more robust with a more controlled study (eg, case control study). Future longitudinal research that includes medical records or some other diagnostic criteria is necessary, but the fact that we found effects with self-reported injury is notable.

A second limitation is that we could not distinguish the type, severity, or actual number of head injuries. This limits the conclusions we can draw from our results. Our results suggest, however, that future research that uses medical records to develop more precise specification of head injury groups might be warranted. In addition, assessing number of head injuries, not just the severity, remains an important aspect of head trauma that should be considered in future research.[2] Nevertheless, it is noteworthy that without precise diagnosis or number of head injuries we found that self-reported head injury was related to interpersonal violence. Future research that describes head injury in more detail in a general population study may also be useful to determine how the extent of the injury may be related to interpersonal violence. This may be useful for developing violence prevention strategies for this potentially high-risk group.

Third, it is plausible that our results simply confirm the obvious notion that more violent youth have more head injuries. Yet, our longitudinal results suggest that after controlling for prior violence, recent head injury remained a significant predictor of subsequent violent behavior. Although it may be possible that the subsequent interpersonal violence may have been retaliation for being victimized, this does not diminish the fact that violent behavior was predicted by prior head injury after controlling for prior violence. If our results were simply a reflection of violent behavior in the first place, then we should not have found consistent results after controlling for correlates of interpersonal violence (eg, alcohol/marijuana use, delinquency) or previous head injury.

These limitations notwithstanding, our results suggest that future research with more general populations on the

effects of head injury for adolescent violent behavior is necessary to more fully comprehend the extent to which head injury may affect adolescent behavior. Clearly, severe TBI with significant structural brain damage can have devastating effects on cognition and behavior, but our results suggest that older adolescents and young adults who have suffered a head injury that did not interfere with their ability to participate in an hour-long interview may experience significant adverse developmental effects. This is especially notable because most individuals reduce their violent behavior as they age.[19–21] This decrease in violence over time has been documented to occur as early as the senior year of high school.[22] This reduction over time creates less variance when measuring violent behavior. Thus, our finding that head injury predicted interpersonal violence even after controlling for other significant factors for violence is especially noteworthy.

Our results suggest that youth violence prevention which focuses on youths with head injuries may be particularly beneficial regardless of cause (eg, football, violence, car crash). These prevention efforts might focus on helping youth develop alternative strategies for problem solving and developing strategies to prevent head injury (eg, safety sports equipment).

CONCLUSION

Our findings support other studies that link history of head injury to later interpersonal violence.

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