EVALUATION OF EDUCATIONAL INTERVENTION ON CONCUSSION KNOWLEDGE AND BEHAVIOR IN STUDENT ATHLETES

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ABSTRACT

Background and Significance: The purpose of this study was to evaluate the effectiveness of the Barrow Brainbook (BBB) concussion education program as a tool to increase concussion knowledge among Arizona high school athletes and to modify attitudes and behaviors regarding concussion.

Methods: This was a cross sectional study of Arizona high school athletes utilizing a 31 question multiple-choice de-identified survey. Attitude, knowledge, and behavior questions, as well as sport and level of participation were analyzed using the Wilcoxon Rank Sum test. Means between groups were analyzed using a two-way ANOVA. Linear regression was used to determine if there was a relationship between number of years since completing BBB and concussion knowledge.

Results: Surveys were distributed to 382 student athletes with 363 of those being completed. 224 students participated in BBB (62%). Knowledge and behaviors regarding concussion were not statistically significant when comparing students who had and had not participated in BBB. Those who participated in BBB scored more poorly on questions regarding attitudes about concussion than those who had not (p=0.033). Subsequent two-way ANOVA testing showed that students who sustained a concussion scored worse (p<0.01) while completing BBB did not significantly affect attitude (p=0.399) when history of a concussion was brought in to the analysis. 90 students (25%) reported sustaining a concussion. Football and varsity level participation were significant for a higher mean number of concussions (p<0.05, p<0.05). There was no relationship between time since taking BBB and concussion knowledge (R² was 0.007).

Conclusions: In this study, there was no evidence to show that participating in the BBB program improved concussion knowledge, attitudes, or behaviors. Number of years since taking BBB was not a good predictor of concussion knowledge. Students who played football and participated at a varsity level were significantly more likely to sustain a concussion. Sustaining a concussion was associated with a higher attitude risk sum score. This is an evaluation of an educational tool specifically designed for adolescents that demonstrated no statistically significant change in increasing knowledge or modifying attitudes and behaviors in a population of high school athletes in Arizona.
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INTRODUCTION

Background

Sports related concussions affect nearly 300,000 young Americans yearly and account for 8.9% of all high school athletic injuries\(^1\). Concussions are caused by an impulsive force to the head or other part of the body that causes rapid acceleration or deceleration injury in the brain. This injury can lead to common symptoms, such as headache, imbalance, dizziness, sensitivity to light and sound, fatigue, emotional lability, sleep disturbances, and cognitive impairment\(^2\).

Immediately following a sports related concussion, sideline assessment is important in evaluating severity and developing a plan to manage the concussion. Appropriate concussion management includes immediate removal from play and rest until a full evaluation can be performed by a qualified healthcare professional\(^3\). A sideline assessment typically includes assessment of attention, memory, cognition, and postural control to determine if the athlete has sustained a concussion. If a concussion is suspected, more comprehensive evaluation or computer based neuropsychological testing may be performed as part of a more formal evaluation to aid in developing a treatment plan and return to play guidelines\(^4\). The American Medical Society for Sports Medicine recommends a stepwise return to play program in the management of concussions. An athlete should be free from concussion symptoms at rest and during exertion, as well as having a neurological and cognitive exam back to baseline, before returning to full level of play\(^5\). Early return to play can increase the possibility of diffuse cerebral swelling, increased susceptibility to recurrent or more severe concussion\(^5\).

If an athlete does not cease participation after a head injury, continued play can lead to prolonged recovery, coma, or death. An estimated 900 deaths occur nationally every year due to sports and recreational activities traumatic brain injuries\(^2\). In 2013 alone, there were eight concussion-related fatalities in American high school football players\(^2\). One potentially fatal consequence of returning to play after a concussion is second impact syndrome (SIS). SIS can occur when an athlete sustains a second head injury while still having residual symptoms from the first head injury. Although the exact mechanism of SIS is unknown, it is thought to occur from loss of autoregulation of the brain’s blood supply, causing increased blood flow, increased intracranial pressure, and brain herniation, leading to coma or death\(^5\).
With increasing attention to concussion related consequences, more studies are investigating the long-term effects of concussion, such as neuropsychiatric outcomes. Other research has focused on persistent symptoms, known as postconcussion syndrome, in which student athletes continue to have somatic, cognitive, sleep, or emotional symptoms for several months after their injury\(^6\). Recent research has shown that student athletes that sustain a concussion can develop post-injury psychiatric symptoms, including depression and suicidal ideation\(^7\). Chronic neurocognitive impairment refers to neurologic, cognitive, or behavioral impairment that can occur repetitive traumatic brain injury. Similarly, recent research has identified chronic traumatic encephalopathy, the pathologic accumulation of tau in the brain, in professional athletes exposed to multiple and persistent head injuries\(^8\).

One crucial part of managing and preventing long-term consequences of concussions is recognition and immediate evaluation after injury. However, in a chaotic setting of sports games, healthcare professionals on the sideline responsible for evaluating student athletes must often rely on the athlete coming forward to report symptoms. In a recent study of high school football players, researchers found that of the players who sustained a concussion, only 47.3\% reported their injury\(^9\). In an effort to get back in the game, some student athletes will also minimize or report resolution of their symptoms. Accurate self-reporting is essential in allowing healthcare professionals to evaluate student athletes and prevent the long-term effects of untreated concussions.

In response to the concussion crisis, many educational interventions have been implemented to focus on prevention, identification and reporting of concussions. The Centers for Disease Control developed an educational program for high school coaches, athletic directors, and athletic trainers. This educational program, called “Heads Up: Concussion in High School Sports”, was released in September 2005 and focuses on concussion education, recognition, and management\(^10\). Based off of the CDC program, the Barrow Brainbook program is a web based educational intervention that was launched by the Barrow Neurological Institute on August 18, 2011. Designed specifically for high school athletes, it provides information on how to prevent, recognize, and respond appropriately to concussions. Students must score at least 80\% on the BBB program posttest to be eligible to participate in Arizona Interscholastic
Association sponsored high school sports in Arizona. At the time of this study, Arizona was the only state that has a specific educational program designed with student athlete participation in which athletes are required to participate in to be eligible for participation in high school athletics.

*Rationale*

Concussion education in high school student athletes is an important part of promoting safety and health. However, educational interventions are only useful when students understand and remember the material. Even more importantly, students should appropriately apply what they have learned. The purpose of an educational intervention is to educate students in order to empower them to make positive choices. A recent study showed that although educational interventions show immediate improvement in knowledge, long-term retention is poor\textsuperscript{11}. In addition, studies evaluating the effectiveness of educational interventions in changing behavior have found very little effect of the intervention on athletes’ attitude towards concussion and their concussion management strategies\textsuperscript{12}.

*Research Questions*

Does the BBB educational program effectively provide student athletes with concussion knowledge?

Does the BBB educational program effectively promote appropriate concussion related attitudes and behaviors in student athletes?

*Goals*

Evaluate the effectiveness of the BBB concussion education program as a tool to increase concussion knowledge among Arizona high school athletes and to modify attitudes and behaviors regarding concussion.
MATERIALS AND METHODS

Data collection

IRB approval was granted through Phoenix Children’s Hospital. This was a prospective cross sectional study of Arizona high school and incoming 8\textsuperscript{th} grade student athletes, including students who have and have not participated in the BBB program. The study instrument was a multiple-choice de-identified survey with 31 questions addressing demographics, sport participation, concussion history, knowledge, attitudes, and behaviors. The students who had sustained a concussion since taking BBB also answered questions about when their concussion occurred, reporting their concussion, if they stopped playing immediately, who cleared them to return to play, and whether there was a return to play program that was followed for recovery. The study instrument was grounded in the health belief model with several of the questions adapted from other studies addressing concussion knowledge and behavior. The knowledge-based and scenario-based questions were adapted from the Wilson study Concussion education for coaches and referees in Arizona youth sports leagues\textsuperscript{13}. The attitude and belief-based questions were adapted from the Cusimano study Effectiveness of an educational video on concussion knowledge in minor league hockey players: A cluster randomised controlled trial\textsuperscript{11}. The survey content was evaluated and modified by an expert panel in the field of concussions. Surveys were administered at high school sports physicals from 2014 to 2015. Students completed these after receiving a verbal overview of the study and/or reading an informational letter provided to parents and students. Participation was optional.

Statistical analysis

Demographics were analyzed using frequency. Knowledge, attitude, and behavior questions were analyzed by weighting responses to give overall score based on degree of risk. Sums of attitude, knowledge, and behavior sections were analyzed using the Wilcoxon Rank Sum test. For significant results, two-way ANOVA testing was used. Linear regression was used to compare years since taking the BBB program with knowledge sum. Sport and level of participation were analyzed using the Wilcoxon Rank Sum test.
In the attitude question section, student athletes frequently misinterpreted question 17, “I tell my coach or trainer when I’ve hit my head”. Some students expressed confusion during the survey, and some wrote in explanations under the question. Several students explained that they picked “Never” as their answer because they had never sustained an impact to the head, rather than reflecting risky concussion behavior in choosing not to tell a coach or trainer. This question was removed from the attitude sum, as the scoring was very ambiguous.
RESULTS

Three hundred-eighty two students from eight different public high schools in Arizona participated in this study. Surveys were considered a dropout if any knowledge, attitude, or behavior question was left incomplete. The dropout rate was 5% (n=19), leaving 363 completed surveys. 263 males and 100 females participated. 4% (n=16) of participants were eighth grade students, 26% (n=93) were freshmen, 33% (n=120) were sophomores, 27% (n=98) were juniors, and 10% (n=36) were seniors. In response to the ethnicity question, 54% (n=209) of students identified with Caucasian ethnicity, while 29% (n=112) were Hispanic, 9% (n=33) were African American, 3% (n=10) were Asian, 2% (n=6) were Pacific Islanders, 1% (n=5) were Native American, and 2% (n=9) identified with “other”. Students were allowed to identify with more than one ethnicity. 62% of all students (n=224) reported that they participated in the Barrow Brainbook program, while 38% (n=139) did not. 25% of all students (n=90) reported concussions (Figure 1). Students that reported “maybe” when asked if they had sustained a concussion were included in the concussion group.
Figure 1: Demographic distribution of participation in this study.
Student athletes who sustained a concussion after participating in the Barrow Brainbook answered questions regarding reporting, evaluation, treatment, and return to play. 67% of students (n=31) told a coach or athletic trainer immediately, 27% (n=12) told a coach or athletic trainer after the game or practice ended, 20% (n=9) told their parent or guardian, and 7% responded other, indicating that a friend or coach pulled them out of the game or practice. In contrast, 13% (n=6) of student athletes told no one (Figure 2).
Figure 2: Results from question 10 regarding concussion reporting.

**Question 10:** When you had your most recent concussion, who did you tell?

- Tell coach or athletic trainer immediately
- Tell coach or athletic trainer after the game/practice ended
- Tell a parent/guardian
- Tell no one
- Other

![Bar chart showing responses to Question 10](chart.png)
After a concussion, most students were evaluated by someone, including 72% (n=33) by an athletic trainer, 13% (n=6) by a sports medicine physician, 11% (n=5) by a primary care physician, 11% (n=5) by an emergency room physician, 4% (n=2) by a school nurse, 4% (n=2) at an urgent care facility, 2% (n=1) by a neurologist, and 2% (n=1) by a coach. 18% (n=8) of students reported that they were not evaluated by anyone (Figure 3).
**Figure 3:** Results from question 12 regarding concussion evaluation.

**Question 12:** When you had your most recent concussion, who were you evaluated by?

- Neurologist
- School nurse
- Other
- Emergency Room Doctor
- Primary Care Physician
- Sports Medicine Doctor
- No one
- Athletic trainer

![Bar chart showing the distribution of respondents by healthcare provider. Athletic trainers are the most common choice, followed by primary care physicians and emergency room doctors.]
Most students also were treated for a concussion, with 59% (n=27) not able to return to play until they no longer had symptoms, 20% (n=9) sat out of practice or game until symptoms resolved and then returned to play, 11% (n=5) were held from participation for one week, 4% (n=2) were held from participation in the game or practice but returned at the next game or practice. One student responded that he or she was not allowed to return to playing again. 11% (n=5) had no treatment and returned immediately to the practice or game (Figure 4).
Figure 4: Results from question 11 regarding concussion treatment.

Question 11: When you had your most recent concussion how did you treat it?

- I did not play the rest of the game, but returned at the next practice/game.
- No treatment, my team needed me, I got right back in the game.
- I was held from participation for one week.
- I sat out until my symptoms were better and then I returned to play during the same game.
- I was not able to return until I no longer had symptoms from the concussion.

Percent Respondents
Students’ return to play clearance mirrored that of evaluation, with 64% (n=29) cleared to return to play by an athletic trainer, 22% (n=10) cleared by a primary care physician, 11% (n=5) cleared by a sports medicine physician, 4% (n=2) cleared by a neurologist, and 2% (n=1) each cleared by a school nurse, emergency medicine physician, coach, and unspecified doctor. However, 22% (n=10) were not cleared to return to play by anyone (Figure 5).
Question 13: When you had your most recent concussion, who cleared you to return to play?

- Athletic trainer: 60%
- Primary Care Physician: 20%
- Emergency Room Doctor: 10%
- Neurologist: 5%
- Other: 5%
- Sports Medicine Doctor: 2.5%
- School Nurse: 2.5%
- No one: 0%
Similarly, 54% (n=25) of students followed a return to play program, while 20% (n=9) did not. 26% (n=12) of students did not know if they followed a return to play program for recovery (Figure 6).
Figure 6: Results from question 14 regarding return to play program.

**Question 14:** When you had your most recent concussion, was there a return to play program that you followed for recovery?

<table>
<thead>
<tr>
<th>Option</th>
<th>Percent Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>20</td>
</tr>
<tr>
<td>I don't know</td>
<td>24</td>
</tr>
<tr>
<td>Yes</td>
<td>55</td>
</tr>
</tbody>
</table>
Knowledge sum between students who had and had not taken BBB was not significant (p=0.086). Behavior risk sum was also not significant between the two groups (p=0.177)(Figure 7).
Figure 7: Graph showing knowledge sum and behavior sum were not significant between students who had and had not participated in BBB. In this analysis, attitude sum was significant.

**BBB v Non-BBB participants in knowledge, attitude, and behavior risk sum scores**

Note that higher score indicates incorrect or riskier response
Students who participated in BBB demonstrated higher risk sum scores regarding attitudes about concussion over those who had not participated in BBB (p=0.033). However, two-way ANOVA test evaluating concussion and BBB participation as independent variables demonstrated that more of the variability in the increased attitude risk sum score was due to sustaining a concussion (p<0.01) rather than BBB participation (p=0.399)(Figure 8).
Figure 8: ANOVA testing evaluating concussion and BBB participation as independent variables showing that variability in the increased attitude risk sum score was due to sustaining a concussion rather than BBB participation.

Note that higher score indicates riskier response
There was no statistically significant linear relationship between knowledge sum and years since taking BBB ($R^2 = 0.007$). A greater mean number of concussions was found for athletes who played football over those who did not play football ($p<0.05$) and for athletes who played at the varsity level ($p<0.05$)(Figure 9).
Figure 9: Graph demonstrating a higher mean number of concussions for student athletes who played football and for student athletes who played at a varsity level.

**Mean number of concussions by level of play and sport**

- Football (n=167)
- Sport other than football (n=196)
- Varsity (n=203)
- Level of play other than varsity (n=160)
DISCUSSION

With a new focus on sports related concussions, many educational interventions have been implemented to prevent injuries and promote appropriate concussion management. However, few studies have investigated concussion related attitudes and behaviors following an educational intervention. In addition, this study directly looks at students who have sustained a concussion after taking part in an educational intervention.

First, only a small majority (62%) of students had participated in the mandatory BBB program. Some of the students that had not participated were eighth grade students entering high school and would take it before beginning high school sports. However, eighth grade students only accounted for 4% of all study participants. Other students were starting high school sports for the first time and were planning on taking BBB as part of their requirement. However, some students responded that they had already participated in high school sports and had not yet taken the BBB, which suggests that compliance could be improved.

The purpose of an educational intervention is to promote a positive change in behavior. One part of this study was directed at students that sustained a concussion after taking BBB to evaluate if they engaged in appropriate concussion management. The majority of students reported their concussion to a coach, athletic trainer, or parent. However, 13% did not report a suspected concussion to anyone. In addition, 17% of students were not evaluated by any health professional after their injury. Only 59% of student athletes that sustained a concussion were not able to return to play until they were asymptomatic. 11% had no treatment, and a surprising 20% of students were allowed to return to play in the same game when they reported that their symptoms were better. This is concerning given that repeat injury in close proximity to a previous injury puts the athlete at risk of more severe symptoms and prolonged recovery.

Return to play should be individualized and gradual program and be supervised by a licensed healthcare provider to prevent increased susceptibility to recurrent or more severe concussion. In our study, only half of students participated in a return to play program after their concussion, while the rest either responded that they did not know or did not participate.
In addition, almost a fourth of students were not cleared to return to play by anyone. The importance of return to play is an area that needs improvement in educational programs.

In comparing concussion knowledge, attitudes, and behaviors between students that had taken BBB and students who had not, there was no significant difference. In addition, there was no relationship between concussion knowledge and years since taking BBB. Furthermore, students who played football and participated at a varsity level were significantly more likely to get a concussion. Sustaining a concussion was associated with riskier attitudes regarding concussion management, although it is unclear whether students with riskier attitudes are more likely to engage in practices leading to head injury or whether having a concussion leads to riskier behaviors in the future.

These findings are reflective of similar studies showing that educational interventions are not as effective as hoped in changing attitudes and behaviors. Although providing information on how to prevent, recognize, and manage concussions is important, this study did not demonstrate that the Barrow Brainbook educational program increases knowledge regarding concussion identification and management. There was also no significant difference between participants and non-participants in changing attitudes or behaviors of athletes regarding sport related concussion.

Education is likely only a small, but necessary piece of modifying behavior in student athletes. The unfortunate reality is that athletes are not changing their behavior. Other factors that likely contribute are teammates’ and coaches’ perceptions of concussions and coaches’ expectations of their players. A new direction of concussion education should be focused on changing the culture in sports.

**Limitations**

Several limitations of this study are related to recall bias, inherent in survey based studies. Students that did not remember taking BBB likely reported that they did not participate. This study was a de-identified study without a clear way to verify athletes who did not participate in BBB. We suspect that BBB participation was underreported by student athletes as this educational program has been required for participation in AIA sponsored high
school sports since 2012. The large number of non-participants was not expected and underreporting could have a significant impact on the results of this study. Additionally, student athletes and parents commonly confuse computerized baseline concussion testing with BBB, which could lead to misclassification of participants. Another bias could have occurred if a student was unsure if they did or did not sustain a concussion. These students responded ‘maybe’ and were placed into the concussion group.

Another limitation of this study is the lack of concussion management questions for non-BBB participants who sustained a concussion. Questions regarding evaluation and treatment of concussion were directed only to students that had taken BBB. Due to the mandatory participation requirement, it was not expected in the initial study design to have a large number of student athletes in the non-BBB group. Including questions regarding the management of concussions to all participants would have allowed a comparison of BBB participants to non-participants, which would have been a valuable analysis.

An additional limitation is with the population of students. Although the sample of students that participated was demographically representative of Arizona state high schools in terms of ethnicity, this was not a randomized sample. High schools were chosen based on availability of sports physical days, agreement with athletic administrators, and sports schedules.
FUTURE DIRECTIONS

As mentioned previously, students who had not taken BBB did not answer questions regarding behaviors and management after sustaining a concussion. Comparing behaviors and evaluation after concussion between students who have and have not taken BBB would be an important analysis to consider in the future. Additionally, our research shows that years since taking BBB was not a good predictor of concussion knowledge. A future focus could be on short and long term retention of material. Even if an educational intervention is effective in teaching students, students need to remember material in order to apply it. Future study could determine if administering the program more frequently would help to instill knowledge and ultimately change behavior. Another area of future research would be to look further into socioeconomic status to determine if a student’s economic background has a role in concussion attitudes, behaviors, and management.

Educational interventions are an important part of promoting health in sports medicine. However, it’s possible that interventions are not as effective when targeting student athletes themselves with concussion knowledge. Future work is needed to evaluate coaches, parents, and school administrators’ attitudes and behaviors, as these figures are crucial in setting parameters for how student athletes participate in sports and recover from injuries.
CONCLUSIONS

In this study, there was no evidence to show that participating in the Barrow Brainbook program improved concussion knowledge, attitudes, or behaviors. Additional study is needed to identify specific strengths and weaknesses of educational interventions in order to improve the effectiveness of concussion education.
REFERENCES


