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Introducing an Innovative Brain and Spinal Cord Injury Prevention Curriculum to Adolescents: Evaluation Results

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ABSTRACT

SANDY TEMPLETON

Introducing an Innovative Brain and Spinal Cord Injury Prevention Curriculum to Adolescents: Evaluation Results

(Under the direction of Sheryl Strasser, Ph.D.)

Introduction

In the U.S., injuries account for over half of all deaths among persons age 1-44 which is more deaths than non-communicable and infectious diseases combined. Adolescents and males are disproportionately affected.

Objective

The aim of this study was to evaluate the effectiveness of an injury prevention curriculum for adolescents.

Methods

A curriculum employing indirect instructional strategies was implemented with 7th graders in four local middle schools in Cobb County, Georgia. A 45-item test assessing 6 injury-related theoretical domains: awareness of *severity*, *preventability*, *risk* and *susceptibility*; intention to *behave protectively* and to *advocate* for safety, was administered at baseline, and 4 weeks later, following curriculum completion. Dependent t-tests were run to evaluate differences in average pre- and post-test responses. Independent t-tests were conducted to investigate gender differences.

Results

A total of 678 matched pre- and post-tests were included in analysis, 44% male/56% female. Dependent t-test results revealed that respondents' awareness of *severity*, *preventability*, *risk* and *susceptibility*, as well as intention to *behave protectively* and *advocate* for safety, increased significantly. Significant post-test gender differences were only observed in the intention to *behave protectively* domain; where female gains were greater than male gains.

Discussion

Results demonstrate the effectiveness of indirect instructional strategies which make positive use of adolescent egocentrism, an important characteristic that puts adolescents at greater risk for brain and spinal cord injury. This curriculum demonstrates promise in influencing adolescents' beliefs in invincibility. Future studies should evaluate effectiveness in other communities and amongst students with diverse socio-demographic backgrounds.

INDEX WORDS: traumatic brain injury, spinal cord injury, adolescent, curriculum, injury prevention, evaluation

**Introducing an Innovative Brain and Spinal Cord Injury Prevention Curriculum
to Adolescents: Evaluation Results**

By

Sandy Templeton

B.S Tennessee Technological University
M.S., University of Tennessee at Chattanooga

A Thesis Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment
of the
Requirements for the Degree

MASTER OF PUBLIC HEALTH

ATLANTA, GEORGIA
30303

**Introducing an Innovative Brain and Spinal Cord Injury Prevention Curriculum
to Adolescents: Evaluation Results**

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CHAPTER I

Introduction

In 2010, injuries accounted for over half of all deaths among Americans aged 1-44, which is more deaths than non-communicable and infectious diseases combined (U.S. Centers for Disease Control and Prevention [CDC], 2007b). Injuries are also the leading cause of disability for all ages (CDC, 2007b). For persons aged 10-24, the percentage of deaths from injuries reached nearly three-quarters in 2010 (CDC, 2010b). Motor vehicle accidents accounted for 30% of these deaths; various other unintentional incidents accounted for 15%. Homicide accounted for 15% and suicide 12% (CDC, 2010a). Almost a third (30.5%) of all injury-related deaths are associated with traumatic brain injury (TBI) (Faul, Xu, Wald, & Coronado, 2010). Of all injuries sustained through the various mechanisms of injury, brain and spinal cord injury (SCI) are the most devastating, resulting in death or permanent paralysis and brain disorders for which there are currently no known cures. During the ten year period from 1997 to 2007 in the U.S., at least three TBIs occurred every minute, with more than 50,000 people per year dying from their injuries (CDC, 2011a). The National SCI Statistical Center (NSCISC) estimated that every hour, at least one person in America injured their spinal cord and each day, three to four people died from their injury (2013). The economic burden is enormous for society and overwhelming for families. The CDC estimates that the annual cost of TBI for 2010 was 76.5 billion (CDC, 2011a). The NSCISC (2013) estimates that lifetime costs for a person who injured their spinal cord at age 25 ranged from 1.5 to 4.5

million per injured individual. The human cost is incalculable. Life expectancy for injury survivors is significantly decreased and quality of life for them and their loved ones is greatly diminished (NSCISC, 2013).

Adolescents and males are disproportionately affected. Over half of incident cases of TBI and SCI occur in persons aged 15 to 35. Statistics from National Vital Statistics System-Mortality (NVSS-M) (CDC, 2007a) show that TBI and SCI fatalities begin to rise in the 12 to 17 and 18 to 24 age groups and that males are affected 3 times more than females. Adolescents are physically more vulnerable because of their developmental life stage. They are growing larger, stronger and faster while increasing interaction with the world around them. Their brains have not fully developed which may be why they recover from concussion more slowly than adults (CDC, 2011b) and also why they may not make the best decisions. Males tend to participate in greater numbers in inherently more dangerous sports (CDC, 2011b), are socialized to take more risks, and are granted more autonomy by parents than girls (Santrock, 2009).

The health belief model (HBM) one of the most frequently used models of individual behavior change, assists with designing appropriate interventions (McKenzie, Neiger & Thackeray, 2013). The HBM posits that behavior change depends upon an individual's belief that he/she is susceptible to a health problem deemed serious; belief that treatment or prevention activities are effective and not too expensive in money, effort, or discomfort; and confidence in one's ability, or *self-efficacy*, to engage in a desired behavior or change an undesired behavior (Bandura, 1977; Hochbaum, 1956, 1958; Rosenstock, 1966; Rosenstock, Strecher & Becker, 1997). However, *adolescent egocentrism*, a human development concept developed Jean Piaget and expanded by

David Elkind in the 1960's, is a tendency of teens to think that somehow they are exceptional and therefore, invincible (Elkind, 1967; Santrock, 2009). In order to apply HBM, strategies must somehow convince adolescents that not only are they not invincible but are actually at great risk of injury and traumatic outcome.

Over the past three decades, many caring adults from virtually all walks of life have created partnerships and interventions passionately trying to get the message of injury prevention across to young people in hopes of breaking through adolescents' belief in invincibility with varying success. Past interventions have used formats ranging from single elements to various combinations of elements including whole school assemblies, videos, lectures, classroom lessons, field trips to detention centers and trauma facilities, and meetings with injured youth. Partnerships have been forged between schools, colleges, law enforcement, trauma facilities, businesses, charitable groups, and other community organizations like Mothers Against Drunk Driving, and Students Against Destructive Decisions, to develop, support and deliver these interventions. Evaluations along the way have highlighted that, in terms of content: more is better when it comes to length and repetition (Vassilyadi, Duquette, Shamji, Orders, & Dagenais, 2009; Azeredo & Stephens-Stidman, 2003); messaging must arouse emotions to increase retention (Monneuse et al., 2008); and positive use of the most important relationship to teens--peers--, maximize the reach of risk-taking prevention interventions (Gardner & Steinberg, 2005; Buckley, Sheehan, & Shochet, 2010).

Research Questions

The Brain and Spinal Cord Injury: Anatomy, Careers, Injury Prevention curriculum employs student-centered indirect instructional strategies that shift the role of

traditional teacher/lecturer to that of facilitator and resource person. This strategy makes positive use of adolescent egocentrism by asking students to make their own observations and inferences to generate problem-solving ideas. Students are asked to take on the role of health professionals in caring for a just-injured friend to determine the friend's injury, review their friend's rehabilitation plan of care, and to generate the injury prevention messages that might have prevented their friend's injury. This study aimed to determine to what extent this student-centered curriculum increased middle school student:

- 1) awareness of the severity of brain and spinal cord injury
- 2) perception of risks
- 3) awareness of personal susceptibility to brain and spinal cord injury
- 4) awareness of preventability of brain and spinal cord injury
- 5) intention to engage in protective behavior
- 6) intention to advocate for safety of self and others

Additionally, the researcher wanted to know if there were differential effects of the curriculum based on gender.

CHAPTER II REVIEW OF THE LITERATURE

Epidemiology of TBI/SCI

Injuries are a major health problem in the U.S. In 2010 injuries accounted for over half of all deaths among Americans age 1-44 which is more deaths than non-communicable and infectious diseases combined. In addition to being the leading cause of death for this age group, injuries are also the leading cause of disability for all ages (CDC, 2007b). Healthy People 2020 prioritized injuries as one of ten leading health indicators for the nation which includes both intentional and unintentional injuries (Federal Interagency Workgroup, [FIW], 2013).

Approximately 72% of all deaths among persons aged 10-24 are attributed to injuries from four causes; motor vehicle accidents (MVA) account for 30%; all other unintentional such as falls, non-MVA transport, sports and recreation account for 15%; homicide accounts for 15% and suicide 12% (CDC, 2010a). Almost a third (30.5%) of these injury-related deaths are associated with TBI (Faul, Xu, Wald, & Coronado, 2010). Of all injuries sustained through the various mechanisms of injury, TBI and SCI are perhaps the most devastating. For injury survivors, damage to nerve tissue in the central nervous system frequently results in paralysis and brain disorders, both of which currently have no known cures.

In the U.S., during the ten year period from 1997 to 2007, at least three TBIs occurred every minute or 1.7 million people each year. In that same period, approximately 580,000 Americans died from TBI, or more than 50,000 each year.

Estimates of prevalence suggest that 5.3 million people are currently living with permanent impacts from TBI (CDC, 2011a). Recent U.S. estimates of annual SCI incidence ranged from 12,000 to 20,000 equating to more than 1 every hour. U.S. annual SCI fatalities are estimated at 1300-1400 or 3-4 each day. Prevalence estimates suggest that about 200,000 people are currently living with the permanent impacts of SCI (National Spinal Cord Injury Statistical Center [NSCISC], 2013). These catastrophic injuries impose a huge burden on not just the injured individual but also their families and society. The CDC estimates that the economic cost of TBI for the year 2010 was 76.5 billion (CDC, 2011a). The NSCISC (2013) estimates that individual lifetime costs for a person injured at age 25 range from 1.5 to 4.5 million depending upon the level of injury. There are other economic costs to society than the cost of medical care such as lost productivity and lost wages. However, it is the human costs that are most devastating. The life expectancy for a person injured at age 20 is 72 for the mildest of injury, 55 to 65 for various levels of injury and only 39 for any level injury that is ventilator dependent (NSCISC, 2013). Compared to the U.S. average life expectancy of 78.7, this is an enormous loss (Hoyert & Xu, 2012). The many facets of lost quality of life for injured individuals and their families are hard to comprehend and defy measurement.

Risk Factors

The FIW (2013) organized risk factors associated with injury into three categories; individual behaviors such as risk-taking and absence of protective behavior; the physical environment inside our homes and in our streets; and the social environment including cultural beliefs, relationships, and laws. Also, having access to services such as

emergency response, trauma care and rehabilitation is a factor in injury outcomes.

Effects of individual risk taking behavior and the social environment are seen in the groups who are disproportionately affected, adolescents and males. Over half of incident cases of TBI and SCI occurred in persons aged 15 to 35. Statistics from NVSS-M show that TBI and SCI fatalities rise in the 12 to 17 and 18 to 24 age groups and that males are affected 3-4 times more than females (CDC, 2007a).

Adolescents are particularly vulnerable because of their developmental life stage. Physically, adolescent bodies are experiencing rapid maturation, resulting in increasing speed and strength. This period of life involves increasing participation in sports and interaction with the community and built environment. In addition to their bodies, adolescent brains are undergoing notable developmental changes as well. According to research with newer scanning technology, scientists have discovered structural processes that indicate the adolescent brain is undergoing growth/development patterns (Santrock, 2009). This may explain why adolescents recover more slowly from concussions than adults (CDC, 2011b) and why they behave the way they do. Three structures in particular are noteworthy. The corpus callosum, the bridge between the right and left hemispheres, begins to thicken which improves the ability to process information. The prefrontal cortex which is responsible for reasoning, decision-making and self-control, begins developing but does not reach full maturity until sometime between ages 18 and 25. Thirdly, the amygdala, or the seat of emotions, develops sooner than the prefrontal cortex leaving adolescents with strong emotions and motivations while lacking the full cognitive capacity to help guide and modulate them (Santrock, 2009).

Adolescent development is also unique from a social perspective, as teens seek autonomy while parents negotiate levels of diminishing supervision. Santrock (2009), informed by Harry Stack Sullivan's pivotal 1953 text, *The Interpersonal Theory of Psychiatry*, emphasized the important role peers play as teens turn more to friends than family to meet their social needs for companionship, reassurance of worth and emotional intimacy. The increasing prominence of friends and their influence on an adolescent, which has the potential to be positive or negative, is contingent upon characteristics and tendencies of each individual. Some factors that influence adolescent friendships include risk-taking and styles of socialization.

While males of any age are three times more vulnerable to TBI and SCI than females, adolescent males have four times the risk as females. Male teenagers are growing even larger and stronger than their female counterparts and exhibit higher rates of participation in inherently more dangerous sports (CDC, 2011b). Societal norms surrounding males perpetuate risk-taking behavior. Societal norms for males support aggression, bravery, adventure and conquering of the world around them. Females are encouraged to be more reserved, gentle and affectionate. In negotiating supervision, parents tend to be more protective of girls while males are granted more autonomy (Santrock, 2009).

Prevention Strategies

“The ability of medical care to reverse the consequences of these injuries is limited; consequently, the major strategy to decrease the impact of TBI and SCI must be through primary prevention,” (Wright, Rivera & Ferse, 1995, p. 81). Injury prevention has historically focused more on strategies that were passive or structural such as

modifying environment, improving product safety and the use of technology and engineering. These strategies were assumed to result in safer environments for everyone because they required little or no action or change by people. Active or behavioral strategies that require individuals and/or groups to make changes in their behavior such as policy enactment and enforcement, or education and behavior change, were seen as too narrowly focused on an individual (hence, leading to solely blaming a victim ultimately for his/her negative outcomes) or as less likely to succeed. More recently, the value of promoting an ecological prevention agenda, supporting both passive and active strategies, has been recognized because it has become evident over time that even passive strategies require people to change their behavior in some way. Use of protective equipment, development of and adherence to safety rules and regulations, as well as engaging in other protective behaviors can reduce injuries, but they require individuals and groups to adapt their behavior in order to be effective (Gielen & Sleet, 2003).

Behavior change theories offer guidance when developing prevention programs because they can help us understand causes, identify mechanisms of change, and determine why an intervention achieves its intended outcomes or not (Gielen & Sleet, 2003). The HBM is one of the most frequently used models for developing individual behavior change interventions (McKenzie, Neiger & Thackeray, 2013). Developed by psychologists in the 1950's, the model posits that behavior change depends upon an individual's belief that they are susceptible to a health problem that they believe is serious; belief that treatment or prevention activities are effective and not too expensive in money, effort or discomfort; and belief in their ability, or *self-efficacy*, to engage in a desired behavior or change an undesired behavior (Bandura, 1977; Hochbaum, 1956,

1958; Rosenstock, 1966; Rosenstock, Strecher & Becker, 1997). This model provided the basis for the development of the curriculum and its intended mechanism for behavior change.

Educational interventions to prevent TBI/SCI

A review of the literature yields several studies of school-based educational curriculum interventions addressing prevention of TBI and SCI. The American Association of Neurological Surgeons and the Congress of Neurological Surgeons directed two neurosurgeons, E. Fletcher Eyster, MD, of Pensacola, Florida and Clark Watts, MD, JD, of Columbia, Missouri to develop a national TBI/SCI prevention program based on their previous prevention efforts in their respective communities. The Think First National Injury Prevention Foundation was created in 1986 to disseminate this program which includes *Think First for Kids* for elementary and middle schools and *Think First for Teens* for middle and high schools.

***Think First for Teens* Assembly Program**

ThinkFirst for Teens (TFFT) assembly program was developed in 1986 and has been continually implemented and studied since. It is a one hour assembly type program comprised of a 10 minute video, a 15 minute presentation by an injury prevention specialist, followed by a 25 minute personal testimony and question and answer session hosted by a young person who sustained a B/SCI. Research results on the effectiveness of *TFFT* vary. Rosenburg, Zirkle and Neuwelt (2005) summarized several early studies from the 1980's and 1990's evaluating the effect of *TFFT* and reported significant increases in knowledge among student participants. Wright, Rivera and Ferse (1995) evaluated a *TFFT* implementation in three middle schools and three high schools in

Washington utilizing a 2 group pretest/repeated post-test design with one each of the middle and high schools serving as control groups. They reported slight change in knowledge; however, undesired changes were noted in attitude and self-reported behaviors measures.

Wesner studied the *TFFT* assembly program in sixth and seventh graders using a two group pretest/post-test design. Significant increases in knowledge and in three out of four self-reported protective behaviors were observed (2003). Self-reported wearing of protective equipment for biking, rollerblading and skateboarding increased. Students reporting they did not wear a seatbelt significantly decreased for females but not for males in the treatment group. In the control group, both males and females self-report of not wearing seatbelts increased. Gehardstein (2007) implemented *TFFT* assembly program in 3 suburban Chicago high schools and conducted a one group pretest/posttest study with 525 students taking the pretest and 486 taking the post-test. Desired percentage changes in intended helmet use, intended safety belt use, and belief in preventability were reported. Students were asked reasons they do not always wear a helmet or always wear a safety belt. Some indicated it was because they did not believe they would crash, be hurt if they did crash, or because they were not going far. Although student gender and ethnicity were reported, no analysis by demographic groups was reported. Koestner (2012) evaluated *TFFT* during the 2008-2009 academic year in Michigan using a 30 question web pretest and web post-test 3 months after implementation. While significant changes in relation to knowledge were found, no significant changes in self-reported behaviors of seat belt and helmet use were detected. Average self-reported risk-taking behaviors, drowsy driving and distracted driving,

actually increased on the post-test. When asked about agreement with the statement, “There are times when having fun with friends is more important to me than the risk of being hurt,” the average female response decreased, while the average male response increased, which is indicative of an undesired result although it was not found to be statistically significant. Although Koestner (2012) reported collecting ethnicity information, no analyses examining ethnicity in relationship to learning outcomes were reported.

Think First for Kids Curriculum

The ThinkFirst National Injury Prevention Foundation created another curriculum ten years later, in 1996, called *ThinkFirst for Kids, TFFK*. It was initially designed for grades 1 through 3 and consists of separate curricula, one for each grade, each comprised of six interactive safety behavior didactic lessons to be delivered one per week over a 6 week period. It was later adapted for grades 4-8. Hall-Long, Schell, and Corrigan (2001) evaluated *TFFK* curriculum in 140 second graders in an urban mid-Atlantic elementary school using a 10-item pretest and post-test. The percentage of students who agreed that everyone in a vehicle should wear a seatbelt, they always wear a helmet when riding a bike, and they always check water with their feet before swimming, increased by 35%, 30%, and 35%, respectively. Green et al. (2002) evaluated *TFFK* curriculum in first, second, and third graders comparing three schools who received the curriculum with two control schools using pretests and post-tests designed to measure knowledge and self-reported behavior. Results indicate increases in knowledge but no change in self-reported behaviors. No studies were found evaluating implementation in grades 4 through 6. ThinkFirst of Canada adapted this curriculum for grades 7 and 8 which they termed

“*Navigators*”. Vassilyadi et al. (2009) evaluated this curriculum in four middle schools using a 30 question self-report questionnaire administered before, immediately after, and again six weeks after to 204, 176, and 111 students, respectively. This intervention achieved retention of knowledge to the later post-test. The researchers suggest the length and scope of content within this six week, six lesson curriculum may have positively affected retention. Additionally, on the later post-test, 70% reported improvement in self-reported behaviors of safer decision-making and protective behavior. The researchers suggested that responses to several questions were at or near maximum creating ceiling effects which may have led to underestimation of the intervention effect.

Other Interventions

Other educational interventions besides *ThinkFirst* have been reported in the literature. Bhide, Edmonds and Tator (2000) evaluated the use and awareness of a 20 minute diving safety video, *Sudden Impact*, produced by SportSmart Canada. This evaluation was a process evaluation designed to determine distribution and use of the video as opposed to an outcome or behavior change evaluation. Researchers surveyed 92 Toronto public high schools with 59 responding. Of those responding, 80% had heard of the video, 76% reported receiving the video. Of schools who received the video, 91% reported using it. However, even in schools that used it, very few students were exposed because it was generally shown in non-compulsory physical and health education classes. The researchers recommended changes in distribution and follow up with schools to encourage greater use and for schools to use in a compulsory injury prevention curriculum to reach more students.

Monneuse et al. (2008) evaluated a full day intervention with students of eight Toronto high schools. The intervention consisted of a 40 minute, nurse-delivered didactic session on TBI and SCI and its linkage with impaired driving, an interactive session with a Mothers Against Drunk Drivers representative on the lasting impacts of TBI and SCI, a session with local police officer(s) who share their experiences as first responders at alcohol-related motor vehicle crashes, and as officers responsible for informing parents about the injury or death of their child. The day ends with a tour of the trauma hospital where students come face-to-face with the realities of injuries and an interactive discussion with a young person who has experienced a TBI or SCI. These researchers employed a critical incident study technique using a vignette describing typical activities of 4 fictional high school students celebrating various achievements with their friends. The vignette ends with one of the characters killed and two more injured. Questionnaires designed to assess ability to identify situational risk and discern safer options were administered. After completing questionnaires, students read an alternative vignette where the characters make different choices and arrive home safely. A qualitative study was conducted four months later with a third of the original participants to gather rich information on views and attitudes on injury. Four groups were compared on questionnaire results; a control group, a group who completed the survey eight days after the intervention, a group who completed thirty days after and a group of experts comprised of physicians, surgeons and nurses. For intervention recipients, the researchers report that the increased risk perception scores on questions related to the poignant vignette were more durable over time than those related to didactic-acquired knowledge. Qualitative results indicated that students felt strongly that “bad” things should not

happen to friends or family. The researchers suggest that because attitudes are more likely to change with emotional versus intellectual stimuli, future interventions should use this theme to achieve stronger, more durable changes.

Azeredo and Stephens-Stidman (2003) report on the development and evaluation of an elementary school injury prevention program that included 18 and 27 lesson curricula for grades one through five used throughout the school year. This two-group quasi-experimental time series study was implemented in 12 schools; 6 program schools and 6 control schools. Chi square analysis of aggregate data from 6300 pre-tests and post-tests revealed significant between test and between group differences for knowledge, attitudes and self-reported behaviors. The direction of these differences is not reported or ascertainable but implied to be positive from discussion.

Australian researchers, Buckley, Sheehan and Shochet (2010) evaluated the *Skills for Preventing Injury in Youth* program, *SPIY*, in 1,961 ninth grade students from 10 schools in Southeast Queensland. *SPIY* consists of eight weekly 50 minute lessons delivered by classroom teachers designed to decrease risk-taking behavior, increase protective behavior toward risk-taking friends and to increase first aid skills. Each lesson presented a risk-taking injury scenario, first aid instruction related to the injury in the scenario and cognitive-behavioral activities addressing ways to reduce risk and protect friends. Data from previous adolescent focus groups on risk-taking situations informed the scenarios which were designed specifically to provide opportunity to apply injury prevention in the context of friendship situations. Positive change on the risk-taking measure was significantly greater for the intervention group than control. Along with more typical targets of reducing individual attitudes, self-efficacy and behaviors, this

intervention represented a novel approach of promoting direct peer protection and intervention on a peer's behalf.

Research Questions

Although TBI and SCI are statistically rare events, they are nonetheless devastating; therefore, any such injury is one too many. To see a significant impact on actual injury rates in an intervention population would require a prohibitively large sample size. Alternatively, researchers have assessed changes in self-reported, intended and actual behavior, knowledge and attitudes among students who participate in various curriculum-based TBI/SCI programs. While these may not directly translate into prevented injuries, they are a necessary first step in addressing the active or human behavioral factors which must be part of any comprehensive injury prevention strategy (Gielen & Sleet, 2003). This study aimed to determine to what extent this student-centered curriculum increased middle school student:

- 1) awareness of the severity of brain and spinal cord injury
- 2) perception of risks
- 3) awareness of personal susceptibility to brain and spinal cord injury
- 4) awareness of preventability of brain and spinal cord injury
- 5) intention to engage in protective behavior
- 6) intention to advocate for safety of self and others

Additionally, the researcher examined differential effects of the curriculum based on gender.

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CHAPTER III MANUSCRIPT

Abstract

Introduction

In the U.S., injuries account for over half of all deaths among persons age 1-44 which is more deaths than non-communicable and infectious diseases combined. Adolescents and males are disproportionately affected.

Objective

The aim of this study was to evaluate the effectiveness of an injury prevention curriculum for adolescents.

Methods

A curriculum employing indirect instructional strategies was implemented with 7th graders in four local middle schools in Cobb County, Georgia. A 45 item test assessing 6 injury-related theoretical domains: awareness of *severity*, *preventability*, *risk* and *susceptibility*; intention to *behave protectively*, and *advocate for safety*, was administered at baseline, and 4 weeks later, following curriculum completion. Dependent t-tests were run to evaluate differences in average pre- and post-test responses. Independent t-tests were conducted to investigate gender differences.

Results

A total of 678 matched pre- and post-tests were included in analysis, 44% male/56% female. Dependent t-test results revealed that respondents' awareness of *severity*, *preventability*, *risk* and *susceptibility*, as well as intention to *behave protectively* and to *advocate for safety*, increased significantly. Significant gender differences were only observed in the intention to *behave protectively* domain; where female gains were greater than male gains.

Discussion

Results demonstrate the effectiveness of indirect instructional strategies which make positive use of adolescent egocentrism, an important characteristic that puts adolescents at greater risk for brain and spinal cord injury. This curriculum demonstrates promise in influencing adolescents' beliefs in invincibility. Future studies should evaluate effectiveness in other communities and amongst students with diverse socio-demographic backgrounds.

INDEX WORDS: traumatic brain injury, spinal cord injury, adolescent, curriculum, injury prevention, middle school, evaluation

Introduction

In 2010, injuries accounted for over half of all deaths among Americans aged 1-44, which is more deaths than non-communicable and infectious diseases combined. Injuries are also the leading cause of disability for all ages.¹ Healthy People 2020 prioritized injuries as one of ten leading health indicators for the nation.² For persons aged 10-24, the percentage of deaths from injuries reached nearly three quarters in 2010.³ Motor vehicle accidents accounted for 30% of these deaths, various other unintentional incidents accounted for 15%, homicide accounted for 15% and suicide 12%.⁴ Almost a third (30.5%) of these injury-related deaths are associated with traumatic brain injury, TBI.⁵ Of the types of injuries sustained through these mechanisms of injury, brain and spinal cord injury, SCI, are the most devastating, resulting in death or permanent paralysis and brain disorders for which there are currently no known cures. During the ten year period from 1997 to 2007 in the U.S., at least three TBIs occurred every minute with more than 50,000 people per year dying from their injuries.⁶ The National SCI Statistical Center (NSCISC) estimated that every hour, at least one person in America injured their spinal cord and each day, three to four people died from their injury.⁷ The economic burden is enormous for society and overwhelming for families. The CDC estimates that the annual cost of TBI for 2010 was 76.5 billion.⁶ The NSCISC estimates that lifetime costs for a person with a SCI at age 25 ranged from 1.5 to 4.5 million per injured individual.⁷ The human cost is incalculable. Life expectancy for injury survivors is significantly decreased and quality of life for individuals and their loved ones is greatly diminished.⁷

Adolescents and males are disproportionately affected by TBI/SCI. Over half of incident cases occur in persons aged 15 to 35. Statistics from National Vital Statistics System-Mortality (NVSS-M) show that TBI and SCI fatalities begin to rise in the 12 to 17 and 18 to 24 age groups and that males are affected 3 times more than females.⁸ Adolescents are particularly vulnerable because of their developmental life stage. Physically, adolescent bodies are experiencing rapid maturation, resulting in increased speed and strength. This period of life involves increasing participation in sports and interaction with the community and built environment. In addition to their bodies, adolescent brains are undergoing notable developmental changes as well which may be why they recover from concussion more slowly than adults⁹ and also why they may not make the best decisions. Male teenagers are growing even larger and stronger than their female counterparts, exhibit higher rates of participation in inherently more dangerous sports⁹, are socialized to take more risks and are granted more autonomy by their parents than girls.¹⁰

Behavioral factors are a necessary component of a comprehensive injury prevention strategy.¹¹ The health belief model, HBM, one of the most frequently used models of individual behavior change, assists with designing appropriate interventions.¹² HBM posits that behavior change depends upon an individual's belief that they are susceptible to a health problem that they believe is serious; belief that treatment or prevention activities are effective and not too expensive in money, effort or discomfort; and belief in their ability, or *self-efficacy*, to engage in a desired behavior or change an undesired behavior.^{13,14,15} However, adolescent egocentrism, a human development concept developed by Jean Piaget and expanded by David Elkind in the 1960's, is a

tendency of teens to think that somehow they are exceptional and therefore, invincible.¹⁰

¹⁸ In order to apply HBM, strategies must somehow convince adolescents that not only are they not invincible but are actually at greater risk.

Over the past three decades, many caring adults from virtually all walks of life have created partnerships and interventions all passionately trying to get the message of injury prevention across to young people in hopes of breaking through adolescent belief in their invincibility with varying success. Past interventions have used formats ranging from single elements to various combinations of elements including whole school assemblies, videos, lectures, lessons, field trips to detention centers and trauma facilities, and meetings with injured youth.¹⁹⁻³¹ Partnerships have been forged between schools, colleges, law enforcement, trauma facilities, businesses, charitable groups and other community organizations like Mothers Against Drunk Driving and Students Against Destructive Decisions to develop, support and deliver these interventions. Evaluations along the way have highlighted that more is better when it comes to length and repetition^{19,29}, that we must arouse emotions to increase retention²⁷, and that positive use of the most important relationship to teens, the peer relationship, can add power to our interventions.^{21,22}

Research Questions

The Brain and Spinal Cord Injury: Anatomy, Careers, Injury Prevention curriculum employs student-centered indirect instructional strategies that shift the role of the teacher from lecturer to that of facilitator and resource person. This strategy makes positive use of adolescent egocentrism by asking students to make their own observations and inferences to generate problem solving ideas. Students are asked to take on the role

of health professionals in caring for a just-injured friend to determine the friend's injury, review their friend's rehabilitation plan of care and to generate the injury prevention messages that might have prevented their friend's injury. This study aimed to determine to what extent this student-centered curriculum increased middle school student

1. awareness of the severity of brain and spinal cord injury
2. perception of risks
3. awareness of personal susceptibility to brain and spinal cord injury
4. awareness of preventability of brain and spinal cord injury
5. intention to engage in protective behavior
6. intention to advocate for safety of self and others

Additionally, the researcher wanted to know if there were differential effects of the curriculum based on gender.

Methods

A student-centered curriculum was developed for middle school students from the experiential evidence of multiple stakeholders including young persons living with brain and spinal cord injuries, middle school teachers, an instructional curriculum specialist, and clinical and research staff of Shepherd Center, a private, not-for-profit specialty rehabilitation hospital in Atlanta, GA, serving people with SCI and disease, acquired and TBI, multiple sclerosis and other neuromuscular problems. The curriculum consisted of ten lessons to be conducted over three weeks. Shepherd Center has made this curriculum available on their website and has, through donors, provided teacher manuals, student workbooks, and teacher training, as well as coordination and financial support of the Team Visits to schools ³²

The *Brain and Spinal Cord Injury Prevention Curriculum* was designed to be taught by the student's regular school teacher. It incorporated lessons learned and findings from published studies, and utilizes a combination of formats, including: a group assembly, featured young injured speakers, and instructor-facilitated sessions.^{19, 29} Lessons were interactive, as opposed to didactic, and relational in that they involve the student in the fictional but realistic injuries of a friend. Students were asked to work in groups where they learn what has happened to their friend. Working in groups, they assumed simulated roles of various healthcare professionals to create and present case studies addressing the extent of injury, treatment and rehabilitation that their injured friend will need. The program concludes with students developing injury prevention messages tailored to the scenarios leading to their friend's injury.

The curriculum utilized a variety of strategies that have been found to enhance positive student outcomes. First, instructional programs that arouse emotions of peers have been found to be more effective for long-term knowledge retention and attitude change. The curriculum refers to injured persons in its scenarios as "friends" as opposed to unfamiliar/fictional characters.^{21,22,27} Additionally, the use of case studies and role playing are examples of indirect instructional strategies that make positive use of adolescent egocentrism. The curriculum also includes foundational brain and spinal cord anatomy lessons, disability etiquette, and information about careers in healthcare which integrates into the local school district's educational objectives for 7th grade to enhance adoption. Implementation by the student's regular teacher affords a longer treatment of the subject than a one day visit by outsiders such as health professionals. Implementing daily over a 3 week period provides a more in-depth exploration of the subject compared

to once weekly lessons or embedding safety messages throughout the school year, which may be more appropriate for younger students. Similar to previous interventions, there is also a school visit by young former patients as well as a team of various healthcare professionals who are involved in the treatment of persons with TBI/SCI.

This curriculum was implemented by 7th grade science and reading teachers in four middle schools within the same county school district in Georgia in April/May of 2013. Approvals from Shepherd Center IRB and Georgia State University IRB were obtained to ensure the protection of human subjects. A one group pretest/post-test study was conducted, utilizing a 45-item pretest that was administered by teachers prior to instruction or access to materials. The test was comprised of seven point Likert-type scale items measuring agreement, frequency, and amount (with 1=lowest and 7=highest) related to the short term outcomes for the curriculum; *severity, preventability, perception of risk, susceptibility, protective behaviors* and *advocacy*. The same test, plus six additional items, three Likert-type and three open-ended questions requesting student reflection on the curriculum and its impact, was administered by teachers at the end of the curriculum. Students were asked to rate their level of agreement with each of the questions listed by domain in Table 3.1.

Table 3.1 Survey Questions with Agreement Responses

<p>Awareness of <u>Severity</u> of Brain and Spinal Cord Injury</p> <p><i>I believe a brain or spinal cord injury could be easily fixed by a doctor</i></p> <p><i>A brain or spinal cord injury could affect my life long term</i></p> <p><i>People with brain & spinal cord injuries get better & get their normal daily life back</i></p> <p>Awareness of <u>Preventability</u> of Brain and Spinal Cord Injury</p> <p><i>Following safety rules and regulations can lower my chances of being injured</i></p> <p><i>A lot of injuries are the result of choices people make</i></p> <p><i>Most injuries are NOT preventable</i></p> <p><i>It is important to think about risks before participating in physical activities</i></p> <p><i>I consider the possibility of being injured before I do something risky</i></p> <p>Awareness of Personal <u>Susceptibility</u> to Injury</p> <p><i>A brain or spinal cord injury would seriously affect my health</i></p> <p><i>Brain and spinal cord injuries are a serious problem for people my age</i></p> <p><i>I am NOT at risk of getting a brain or spinal cord injury</i></p> <p>Intention to <u>Advocate</u> for Safety</p> <p><i>Important to speak up if I see someone doing something that might lead to injury</i></p> <p><i>I speak up if I see someone doing something that might lead to an injury</i></p> <p><i>Easy for me to speak up if I see someone doing something that might lead to injury</i></p> <p><i>With friends, I can speak up if I see someone doing something that could lead to injury</i></p>
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Table 3.2 displays questions related to the domains *risk* and *behave*. Students were asked to rate the amount of risk associated with selected behaviors and the frequency they would engage in selected protective behaviors. Responses on questions associated with each outcome were combined and averaged to create an overall pretest score and overall post-test score. Questions phrased for a desired decrease in response were reverse coded before combining with questions phrased for a desired increase in response. Dependent t-tests were performed for each summary outcome measure to determine differences from pre to post for each gender and overall. Independent t tests were performed to investigate gender differences on each test.

Table 3.2 Survey Questions with Frequency or Amount Responses

<p>Perception of Risk</p> <p><i>Driving while texting</i></p> <p><i>Driving while talking on the phone</i></p> <p><i>Riding in a moving car without a seat belt</i></p> <p><i>Jumping on a trampoline without a safety net</i></p> <p><i>Riding my bike without a helmet</i></p> <p><i>Playing sports when a doctor or the coach has told me not to play</i></p> <p><i>Participating in gymnastics or cheer-leading</i></p> <p><i>Diving into a body of water (pool, lake, creek or ocean)</i></p> <p><i>Sliding head first down a water slide</i></p> <p><i>Riding in the back of a pickup truck</i></p> <p><i>Riding on an all-terrain vehicle (ATV, a 3 or 4 wheeler)</i></p> <p><i>Playing sports like hockey or football without proper equipment</i></p> <p><i>Riding a motorcycle</i></p> <p>Intention to Behave Protectively</p> <p><i>Ride on an all-terrain vehicle (ATV, a 3 or 4 wheeler)</i></p> <p><i>Ride on a motorcycle</i></p> <p><i>Dive into a body of water (pool, lake, creek or ocean)</i></p> <p><i>Wear a helmet when I ride my bike</i></p> <p><i>Follow safety rules and suggestions</i></p> <p><i>Ride in the back of pickup truck</i></p> <p><i>Jump on a trampoline without a safety net</i></p> <p><i>Wear a seat belt in a moving car</i></p>

Results

A total of 678 matched pre- and post-tests, from 297 males and 381 females, were collected and analyzed. Table 3.3 presents the number of tests collected at the 4 study sites. Overall, 92.6% of the post-tests collected were matched. However, only 53.9% of the pre-tests were matched. Students from one of the four schools were unable to complete a post-test due to scheduling constraints at the end of the school year. Some students may have completed only one test due to absence.

Table 3.3 Completed Surveys by School

School	Pre	Post	Pairs
A	437	338	304
B	377	335	318
C	94	59	56
D	349	0	0
Totals	1257	732	678

Statistical tests were run to answer each of the original research questions, as well as to compare differences between genders on each test. Summary measure means by gender are presented in Table 3.4. All changes in means were positive. The largest changes were observed in the *risk* and *susceptibility* domains.

Table 3.4 Summary Measure Means by Gender

	Pre	Post	Chg		Pre	Post	Chg
Awareness of Severity				Awareness of Susceptibility			
M	5.41	5.64	.23	M	5.29	5.96	.67
F	5.13	5.61	.48	F	5.33	5.89	.56
Total	5.25	5.62	.37	Total	5.31	5.92	.59
Awareness of Preventability				Intention to Behave Protectively			
M	5.02	5.41	.39	M	4.49	4.83	.34
F	5.22	5.52	.30	F	4.72	5.07	.35
Total	5.14	5.47	.33	Total	4.62	4.96	.34
Perception of Risk				Intention to Advocate for Safety			
M	4.55	5.25	.70	M	5.13	5.49	.36
F	4.78	5.41	.63	F	5.41	5.61	.20
Total	4.68	5.34	.66	Total	5.29	5.56	.27

Results of independent t-tests between genders can be found in Table 3.5. Male pretest means were significantly higher than female means on the *severity* measure but significantly lower on *preventability*, *risk*, *behave* and *advocate*. On the post-test, greater gains by males on *preventability*, *risk*, and *advocate* and greater gains by females on *severity* reduced these differences. No gender differences were observed in *susceptibility* on either test.

On the post-test, female scores were significantly higher than males on *behave*, the only significant post-test difference.

Table 3.5 Independent t-tests comparing Gender

Summary Measures	Gender			
	Pretest		Post-test	
	t	p	t	p
Severity	3.426	.001	.304	.761
Preventability	-2.951	.001	-1.892	.059
Risk	-2.944	.003	-1.754	.080
Susceptibility	-.441	.660	1.042	.298
Behave	-2.190	.029	-2.709	.007
Advocate	-2.804	.005	-1.168	.243

Dependent t-test results on the matched pairs which measured the change from before the curriculum to after are displayed in Table 3.6. Results show highly significant increases in mean responses of both males and females on all six summary measures.

Table 3.6 Dependent t-tests comparing Pre to Post

Summary Measures	Pre to Post					
	Male		Female		Total	
	t	p	t	p	t	p
Severity	-3.718	<.000	-8.500	<.000	-8.820	<.000
Preventability	-6.598	<.000	-6.316	<.000	-9.122	<.000
Risk	-10.076	<.000	-12.387	<.000	-15.844	<.000
Susceptibility	-10.902	<.000	-9.310	<.000	-14.081	<.000
Behave	-6.370	<.000	-8.001	<.000	-10.210	<.000
Advocate	-4.767	<.000	-3.263	.001	-5.632	<.000

Discussion

Strengths and Limitations

The number of significant results found in this study was surprising. This may be related to the strengths of this study which include the sample size and the extensive formative evaluation that was undertaken to develop the curriculum and measurement

instruments. The sample size was large enough to allow for issues that decreased participation inevitable in a school setting, such as school schedule problems and student absences, while maintaining the ability to capture effects. Curriculum developers utilized focus groups of injured youth, experts in curriculum development, as well as TBI/SCI specialists in the creation of this curriculum. This wave of curriculum implementation builds upon two previous years of pilot implementation and program refinement. The survey instrument development was guided by a logic model depicting the theory of change and intended outcomes of the intervention. Questions were developed from a review of other published surveys, the pilot survey and interviews of curriculum developers who reviewed the completed instrument to provide a measure of face validity. However, no formal content validation procedures were undertaken. Due to the self-reported administration of study instruments, the researcher acknowledges one threat of response bias exists that may have impacted results.

Further, controversy surrounding interval-level measurement/inferences with Likert response type items ensues. Intervalists assert that Likert items may behave more like interval-level measurement when the ordered responses are presented as a continuum with 2 to 7 anchors.^{33,34} Carifio and Perla suggest that individual likert response type items may be analyzed at the interval-level when a composite/scale is being developed to guide understanding of the resulting summary measure.³³ Summation of multiple Likert items into a composite score does create interval-level data which may be analyzed parametrically.³⁴

Finally, it is important to note that comparisons between schools, ethnic groups or socioeconomic status (SES) were not conducted in this wave of curriculum

implementation. Of the 3 schools who contributed to the 678 matched pairs, the 2 schools with the greatest number of matches differed greatly in terms of school-level ethnicity and SES estimates.³⁵ However, between schools comparisons were not examined due to varying teacher experience with the curriculum. Of the two schools, one had piloted the curriculum during the previous 2 years resulting in teachers who were more experienced with the curriculum. A third school utilized its reading teachers versus other schools utilized science teachers. This school also contributed less than ten percent of the matched pairs.

Recommendations

No previous studies were found addressing ethnicity or SES perhaps because this is very sensitive information to ask and collect from young students. Although between school comparisons were not made with this implementation, future studies might consider specifically selecting schools based on their ethnic and socioeconomic profiles to be used as proxies as opposed to collecting this sensitive information individually from students. However, individual level data on ethnicity and SES would be most useful to determine if the curriculum is equally effective across these personal factors.

In this study, we do not know if the students received all 10 lessons or if the teacher presented all activities within each lesson. Future implementations plan to include fidelity measures which can help quantify equality of curriculum presentation and receipt by students.

Injury prevention programs might consider using external evaluators with specialized expertise in research design and statistical analysis. Internal evaluators, authors who are associated with development and/or implementation of the intervention

may introduce bias and certainly create opportunity costs within the program. It would also be beneficial to conduct future waves of curriculum implementation/evaluation utilizing an enhanced study design. Employing control or comparison groups and some level of randomization would allow more definitive conclusions about the curriculum effects versus the possibility of other unknown influences.

Conclusions

Results of this study demonstrate that these middle school students exposed to a student-centered curriculum increased awareness of *severity* of TB/SC injury, personal *susceptibility* to TB/SC injury, *preventability* of TB/SC injury; perception of *risk*, intention to engage in *preventive behavior* and intention to *advocate* for safety.

Combining previous lessons learned with indirect instructional strategies that make positive use of adolescent egocentrism, an important characteristic that puts adolescents at greater risk, was found to be effective in these schools. Allowing students to discover and generate the injury prevention messages for themselves demonstrates promise in influencing adolescent perceived invincibility.

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