Full Title:

Evaluation of the Brain Day Educational Program on the Increase in Safety Knowledge in Canadian Children

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Abstract

Objective: The aim of this investigation was to assess the effectiveness of an educational intervention (Brain Day) on the safety knowledge among Toronto area students.

Design: Cross-Sectional study

Setting: Toronto, Ontario, Canada elementary schools

Subjects: 1285 Canadian elementary school students age 9-12, spanning grades 4-6

Intervention: “Brain Day” educational program administered by the ThinkFirst Foundation of Canada, including written materials and program activities.

Main Outcome Measure: The change in score on a brain injury questionnaire subsequent to the administration of the Brain Day program.

Results: Students showed a significant increase in knowledge after participating in the program. The largest improvements with respect to correct answer selection were exhibited by questions related to helmet durability, brain injury and helmet maintenance; with improvement rates of 44.9%, 67%, and 51.4% apiece. The likelihood of selecting correct questionnaire answers after the Brain Day intervention, was highest for questions 1, 3 and 4; with OR’s of 10.0 (CI 7.41 - 13.36), 26.7 (CI 19.37 - 36.75) and 35.5 (CI 23.9 – 52.7) respectively. Self reported helmet use rates among participants who cycle, skateboard/rollerblade were 49.2% (n=572), 46.6% (n=405).

Conclusion: Students gained an increased awareness of safety specific injury prevention knowledge for brain and spinal cord injury as a result of the Brain Day program. However, reported helmet use rates show room for improvement.

Introduction:

Traumatic brain injury (TBI) and spinal cord trauma represent a significant contributor to paediatric injury. Brain and spinal cord injury is typically the result of a blow or contact which is absorbed by the head or neck [1]. If the impact forces which are sustained are excessive, the results can be devastating. The neurological sequelae resulting from traumatic brain injury (TBI) can include (but are not limited to): loss of consciousness, amnesia, headache, cognitive changes, and seizure [2-4]. Furthermore, mild brain injuries sustained by youths, can over time can result in cumulative neurological deficits, and psychiatric abnormalities [3].

The Canadian Institute for Health Information (CIHI), reports that during 2003-2004 there were 4,966 admissions to hospitals for head injuries among children age 0-19 years [5]. Moreover, this population demonstrated the highest proportion of traumatic head injury admissions; accounting for 30% of recorded hospitalizations [5]. With respect to Ontario alone, in 2006 the reported health care cost of unintentional injury among youth age 0-14 years was 311 million dollars (CAN)[6].

The prevention of paediatric brain and spinal cord injuries is an objective pursued by physicians, health care specialists and educators alike. Educational interventions stressing the fundamentals of safe play, helmet usage and common sense, have been the focus of programs designed towards reducing the rates of paediatric TBI and spinal cord trauma [7-10]. The majority of these injury prevention programs are targeted towards the primary school level (i.e. grades 1–8) [9]. Interventions such as the GET AHEAD program, designed by Morrongiello et. al. (1998), focused on increasing safety knowledge, discouraging unsafe attitudes and promotion of safe behaviours [9].

School based injury prevention programs are an efficient way to reach large numbers of students. This in turn ensures that multiple districts, communities and socioeconomic levels are captured. Current practices regarding the design and implementation of safety and health education programs employ several teaching elements. First and foremost, the program must be engaging to the students. It is crucial that the student's attention be focused so that retention of the subject matter is maximized. This is accomplished through the use of various multimedia tools, as well as interactive activities [9-11].

Evaluations of educational interventions begin with measuring whether participants increase their knowledge as a result of the intervention program. Measurement surveys or questionnaires can be administered to study participants in order to gauge the effectiveness of the intervention on increasing knowledge [10-12]. This pre-test/post-test model serves to determine whether the program increases knowledge.

Objective:

The aim of this investigation was to assess the effectiveness of an educational intervention (Brain Day) on head and brain related safety knowledge among Toronto area students.

Methods:

The ThinkFirst Foundation is a multinational non-profit organization whose goals are the prevention of brain and spinal cord injury, through education aimed at promoting healthy behaviours among children and youth [13]. The Brain Day program implemented by the ThinkFirst Foundation of Canada was designed through expert consensus with neurosurgical specialists, injury prevention epidemiologists, and education professionals.

Brain Day was conducted across Canada, including thirty-four Toronto area elementary schools during the week of March 5-9, 2007. The Brain Day program consisted of a full day educational intervention stressing the fundamentals of neurophysiology, injury prevention, and helmet safety. The program was administered by a staff of trained volunteers to 1285 students, age 9-12 years old, spanning grades 4-6. Permission to conduct the educational intervention was given by school district superintendents and individual school principals. Ethics approval for the program evaluation of the Brain Day Intervention was granted by the York University Human Subjects Review Committee.

Prior to the administration of the Brain Day program, students were given a pre-test questionnaire. All participants were anonymous; only information regarding age, sex and grade level was required for statistical analysis. The questionnaire was comprised of a self reported helmet-use survey, whereby participants were asked a series of open ended queries involving helmet use practices. Response options for each question required the student to indicate whether he or she wore a helmet “always”, “sometimes”, “never”, or “not applicable” (i.e. did not engage in that activity) for that particular scenario. The pretest also included a fourteen item multiple-choice (8 questions), true/false (6 questions) questionnaire. The aim of the pre-test was to assess baseline levels of safety knowledge among participants. Once the pre-test questionnaire was completed, Brain Day commenced. Immediately following the completion of the program, an identical post-test questionnaire was administered to all participants. Through analysis of the pre-test versus post-test responses, it is possible to comment on the effectiveness of the Brain Day program in increasing safety knowledge among its participants.

Data Analysis

Statistical analysis of survey data proceeded through several phases. Data entry was completed via Epi Info, a shareware statistical program published by the United States' Centre for Disease Control (CDC); available at http://www.cdc.gov/epiinfo/. Upon completion of data input, statistical analysis commenced.

Univariate statistics were used to report demographic and frequency variables such as the sex, age, and grade level of participants. Prior to Brain Day, children were asked whether they wore a helmet for various activities. The percentage of helmet use was calculated for children who reported participating in each sport. A chi-square analysis was performed to determine the distribution of correct questionnaire responses between pre-test and post-test. Finally, logistic regression analysis was conducted to ascertain the likelihood of selecting the correct questionnaire responses; controlling for age, sex and grade level. All results were considered significant if the 95% confidence interval did not cross one. Statistical analyses were conducted using SPSS 15.0, SPSS inc. Chicago, IL.

Results:

Participant demographics are detailed in Table 1. Sex distribution of subjects is almost uniform, with 49.2 % of participants being male and 49.0% being female (1.8% n=18 missing). Age and grade level distributions show the majority of participants to be ten years of age; corresponding to a fifth grade level.

The results of the self reported helmet-use survey are presented in Table 2. Helmet use frequencies only included students who participated in the relevant sport. Children participating in high velocity sports such as cycling, and skateboarding/rollerblading, reported that they “always” used a helmet 49.2% (n=572) and 46.6% (n=405) of the time, respectively. Alpine winter sports such as skiing and snowboarding, displayed helmet use rates of 39.8% (n=274). The lowest frequency of helmet usage was seen in tobogganing; with only 7% (n = 70) of participants always using helmets. Behavioral influences of helmet use, such as peer helmet use or self-perceived ability level, were also examined. Participants were asked whether they would wear a helmet “even if no one else does”, or if “they had not fallen off their bike in a while”. Students reported habitual (i.e. “always”) helmet use rates for these scenarios as being 27.8% (n=344) and 36.4% (n=457).

Descriptions of the questions administered to students on the safety knowledge questionnaire are detailed in Figure 1. Questions ranged in type from the consequences of brain injury to proper helmet use. The pre/post-test scores obtained from these questions formed the basis on which this intervention was evaluated.

The results of the chi-square analysis detailing the pre-test/post-test differences in correct answer selection are described in Table 3. Significant improvement can be seen in all but two multiple choice questions. The greatest increases in correct answer selection are exhibited by multiple choice questions 1 (bicycle helmet durability), 3 (neurophysiology) and 4 (helmet maintenance); displaying improvement rates of 44.9%, 67%, and 51.4% respectively.

The results presented in Table 4 describe the findings of the logistic regression analysis. Utilizing the pre-test questionnaire scores as the basis for comparison, the resultant odds ratios (OR) describe the probability of selecting the correct response after the Brain day intervention. Multiple choice questions 1, 3 and 4 exhibited the most pronounced odds of selecting the correct response. As a result of the Brain Day intervention, students were 11.0 (CI 7.41 - 13.36), 26.7 (CI 19.37 - 36.75) and 35.5 (CI 23.96 - 52.72) times more likely to select the correct answer for the above questions. Additionally, significant odds ratios were seen for multiple choice questions 5 (helmet maintenance), 6 (neurophysiology) and 8 (helmet use). With respect to “true or false” question types, regression indicates significant probabilities of selecting correct answer choices after being exposed to the Brain Day intervention.

Discussion:

Participation in Brain Day is associated with a significant increase in brain and brain safety knowledge among students. Results of the chi-square analysis indicate that compared to the pre-test, there are significant increases in the proportion of correct answers among participants in the post-test. These results remain robust after controlling for sex and grade level in multivariate analysis. This suggests that children’s knowledge related to brain safety has increased as a result of participating in Brain Day.

Research by Morrongiello et. al. (1998) suggests that increases in safety knowledge, may result in alterations in behavior, which in turn can reduce injury rates [9]. Similarly, Gresham et. al. (2001) examined safety knowledge among San Diego primary school students, and found there to be specific gaps in knowledge pertaining to bicycle safety, brain and spinal cord knowledge and sports and water safety [11]. As a result of that these deficits in safety knowledge, Gresham submits that children may be at higher risk for injury [11].

This investigation measures the safety knowledge of a population which is particularly at risk for sustaining brain and spinal cord injury [5, 10, 14]. Helmet use practices of participants engaging in high velocity activities such as cycling, skiing/snowboarding and tobogganing, each display helmet use rates less than fifty percent. Results published by Davis-Kirsch and Pullen (2003) reported that 74% of participants age 10-12 reported using a bicycle helmet on their last ride [7]. This compares with the 49.2% habitual (i.e. “always”) bicycle helmet use rate reported by this investigation. This is discouraging considering that Ontario legislation requires helmet use for children when riding their bike [15]. For activities where helmets are strongly recommended (i.e. rollerblading/skateboarding and skiing/snowboarding) helmet use rates are also low. Additionally, the low frequency of helmet use in tobogganing, may substantiate findings identified from CIHI data (2002-2003), which reported tobogganing as being the fifth most injurious winter activity among Ontarians [16]. These results suggest that interventions to increase helmet use are necessary.

To ensure the integrity of survey responses, several safeguards were employed. In order to ensure that students read and understood the question, participants were asked for their helmet use practices in situations where helmet use is not normally warranted (e.g. soccer or jogging). Table 2 describes the self-reported rates of helmet usage in soccer and jogging as being 2.0% (n= 22) and 1.3% (n= 15) respectively. The low proportion of students selecting these answers suggests that most students did understand and answer appropriately.

During the course of Brain Day, several key points were stressed by program instructors (i.e. permanency of brain injury, helmet usage, and helmet maintenance). Prior to the intervention, only 20.5% (n = 263) of participants were able to recognize that injury to the brain and spinal cord is permanent; compared to 87.5% (n = 1124) of participants in the post-test measurement. Similarly, only 9.6% (n = 123) of students in the pre-test assessment were able to correctly identify that bicycle helmets are single-impact helmets and must be discarded after a major fall. This can be contrasted with the 54.5% (n = 700) of students who correctly answered this question in the post-test. One of the most potent safety messages emphasized was that wearing a helmet does not completely protect one from injury. The percent of correct answers to this question (True/False question 1) increases slightly from 53% pre-test, to 59% post-test. Program instructors stressed that making smart, safety conscious decisions was the most effective means of preventing injury.

The results of this study are consistent with the findings of past investigations [7, 11, 12, 17, 18]. However, this study did not examine Brain Day's effect on increasing helmet use rates, nor on frequencies of injuries sustained by students. Other studies which have examined the association between educational interventions and safety behaviour have found improvements in behaviour with increased knowledge. For example, Hotz et. al. (2004) reported an increase in pedestrian safety behaviours (e.g. looking both ways, stopping at curb, etc…) among Miami-Dade county elementary school students as a result of the "WalkSafe" educational program [18]. Research conducted by Mock et. al. (1995) reported that helmet use rates among Seattle area students increased by 57% over six years, as a result of an intensive educational intervention stressing bicycle safety [19]. Mock et. al. demonstrated that educational interventions were effective towards increasing helmet usage, which in turn resulted in observable decreases in head trauma from bicycle collisions [19]. A previous investigation promoting bicycle helmet use to Toronto area students found that voluntary helmet use rates tripled as a result of education intervention [20].

Increased knowledge and improved behaviour have not always been found to improve injury rates. A Cochrane systematic review by Duperrex et. al. (2002), reported that while pedestrian education may improve behaviour there was no evidence of an impact on pedestrian injury rates [21].

This study provided an objective evaluation of an educational injury prevention program. In addition to assessing changes in knowledge as a result of Brain Day, this investigation also reported on helmet use among participants in various activities. Finally, this investigation benefited from a large sample size which ensured adequate statistical power to assess changes in knowledge.

This investigation's main limitation was that it did not assess changes in behaviour or injury rates among participants. Additionally, given that the pre and post evaluation took place on the same day, we were unable to assess the long term impact of Brain Day on children's knowledge. Ongoing assessment of the effectiveness of the Brain Day program in changing behaviour and reducing injuries are important next steps.

Conclusion:

The Brain Day educational program is an effective means of increasing safety knowledge among children aged 9-12 years old. The wide scale introduction of the Brain

Day program into elementary schools can provide teachers with an educational tool to enhance students' knowledge of the consequences of brain injury and promote safety conscious behavior.

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Tables and Figures:

Table 1: Frequency Demographics of Brain Day Participants, Toronto, Canada (n = 1285)

	Frequency (%)
Sex	
Male	632 (49.2)
Female	630 (49.0)
Missing	23 (1.8)
Age (years)	
9	143 (11.1)
10	661 (51.4)
11	428 (33.3)
12	48 (3.7)
Missing	5 (0.4)
Grade	
4	179 (13.9)
5	820 (63.8)
6	282 (22.0)
Missing	4 (0.3)

Figure 1: Administered Brain Day Survey Questions, Toronto, Ontario March 5-9, 2007

Multiple Choice:

1. How many impacts (hits from a fall) can a bicycle helmet suffer before you have to replace it?
   Ans: One
2. How can you prevent injuries to yourself and your friends?
   Ans: By thinking first, by using protective equipment, by sharing knowledge with friends and family (d. all of the above)
3. What happens if you damage the neurons in your brain and spinal chord?
   Ans: They cause permanent damage
4. Why is it bad to decorate your helmet with stickers or paint?
   Ans: It can damage the helmet or hide cracks
5. What should you do if you notice your helmet is damaged?
   Ans: Throw it out and buy a new one
6. What is true about your brain?
   Ans: It is very fragile and easy to damage
7. Why should hats and ponytails NOT be worn under helmets
   Ans: They will not allow the helmet to sit properly on your head
8. If you are riding your bike, scooter or rollerblading, when are you allowed NOT to wear your helmet?
   Ans: Never, you should always wear a helmet

True/False

1. A helmet will always protect you from injury
   Ans: False
2. You can always heal from a head injury, no matter how severe
   Ans: False
3. Pain is important because it tells you when you are hurt
   Ans: True
4. It is okay to wear a hockey helmet when riding your bike
   Ans: False
5. Your skull is fragile
   Ans: True
6. A brain injury can change the way you act, think and feel permanently
   Ans: True

Table 2: Pre-test self-Reported Helmet Behaviours of Toronto Area Students (n = 1285)

	Response Choices (%)				
Query - Do you wear a helmet:	**Always**	**Sometimes**	**Never**	**Not Applicable**	**Not ans**
1. When riding your bike	572 (49.2)	347 (29.9)	243 (20.9)	105	
2. When playing Hockey	253 (54.0)	130 (27.7)	86 (18.3)	772	
3. When playing Soccer	22 (2.0)	45 (4.2)	1017 (93.8)	134	
4. When rollerblading or skateboarding	405 (46.6)	276 (31.8)	188 (21.6)	330	
5. When skiing or snowboarding	274 (39.8)	173 (25.2)	241 (35.0)	565	
6. When you are biking with your family or friends	578 (50.0)	310 (26.8)	267 (23.2)	111	
7. When you go tobogganing	70 (7.0)	156 (15.5)	777 (77.5)	250	
8. While jogging	15 (1.3)	34 (3.0)	1078 (95.7)	138	
9. Even when no one else does	344 (27.8)	465 (37.6)	428 (34.6)	0	
10. If you have not fallen off your bike in a while	457 (36.4)	391 (31.2)	407 (32.4)	0	

Table 3: Pre-test versus Post-test Results Assessing the Effectiveness of the Brain Day Intervention Among Toronto Area Students (n = 1285)

	Number of Correct Responses (%)		
Question:	**Pre-Test**	**Post-Test**	**P Value**
Multiple Choice 1	123 (9.6)	700 (54.5)	.000
Multiple Choice 2	700 (54.5)	726 (56.5)	.341
Multiple Choice 3	263 (20.5)	1124 (87.5)	.000
Multiple Choice 4	41 (3.2)	701 (54.6)	.000
Multiple Choice 5	1077 (83.8)	1179 (91.8)	.000
Multiple Choice 6	977 (76.0)	1123 (87.4)	.000
Multiple Choice 7	909 (70.7)	896 (69.7)	.546
Multiple Choice 8	917 (71.4)	1030 (80.2)	.000
True/False 1	682 (53.1)	769 (59.8)	.001
True/False 2	1159 (90.2)	1193 (92.8)	.024
True/False 3	1146 (89.2)	1209 (94.1)	.000
True/False 4	806 (62.7)	875 (68.1)	.005
True/False 5	895 (69.6)	989 (77.0)	.000
True/False 6	1167 (90.8)	1224 (95.3)	.000

Table 4: Logistic regression analysis for the likelihood of selecting the correct survey repsonse given the Brain Day intervention, Toronto, Canada (n = 1285)

	Odds Ratio (CI)
Question	***Post-Test**
Multiple Choice 1	10.0 (7.41 - 13.36)
Multiple Choice 2	1.0 (0.79 - 1.26)
Multiple Choice 3	26.7 (19.37 - 36.75)
Multiple Choice 4	35.5 (23.96 - 52.72)
Multiple Choice 5	2.0 (1.41 - 2.94)
Multiple Choice 6	2.2 (1.58 - 2.95)
Multiple Choice 7	1.1 (0.88 - 1.47)
Multiple Choice 8	1.9 (1.46 - 2.54)
True/False 1	1.1 (0.84 - 1.35)
True/False 2	1.3 (0.84 - 1.93)
True/False 3	2.5 (1.59 - 3.87)
True/False 4	1.9 (1.50 - 2.47)
True/False 5	1.1 (0.84 - 1.41)
True/False 6	2.1 (1.33 - 3.41)

***Adjusted for sex and grade level**

Work Cited:

1. Prentice WE, *Arnheim's Principles of Athletic Training*. 11 ed. 2003, New York: McGraw-Hill.
2. Goodman, D., M. Gaetz, and D. Meichenbaum, *Concussions in hockey: There is cause for concern.* Medicine and Science in Sports and Exercise, 2001. **33**: p. 2004-9.
3. Marchie, A. and M.D. Cusimano, *Bodychecking and concussions in ice hockey: Should our youth pay the price?* Canadian Medical Association Journal, 2003. **169** (2): p. 124-128.
4. McCrea, M., J.P. Kelly, C. Randolph, R. Cisler, and L. Berger, *Immediate neurocognitive effects of concussion.* Neurosurgery 2002. **50**: p. 1032-40.
5. Emery, C.A. and W.H. Meeuwisse, *Injury Rates, Risk Factors, and Mechanisms of Injury in Minor Hockey.* The American Journal of Sports Medicine, 2006. **34**(12): p. 1960-1969.
6. *The Economic Burden of Injury in Ontario*. 2006, SmartRisk Canada: Toronto.
7. Davis-Kirsch SE and Pullen N, *Evaluation of a School-Based Education Program to Promote Bicycle Safety.* Health Promotion Practice, 2003. **4**: p. 138.
8. DeSimone Eichel J and Goldman L, *Safety Makes Sense: A Program to Prevent Unintentional Injuries in New York City Public Schools.* The Journal of School Health, 2001. **71**(5): p. 180.
9. Morrongiello BA, Miron J, and Reutz R, *Prevention of Paediatric Acquired Brain Injury: An Interactive Elementary School Program.* Canadian Journal of Public Health, 1998. **89**(6): p. 391.
10. Wesner ML, *An Evaluation of Think First Saskatchewan.* Canadian Journal of Public Health, 2003. **94**(2): p. 115.
11. Gresham LS, Zirkle DL, Tolchin S, Jones C, Maroufi A, and Miranda J, *Partnering for Injury Prevention: Evaluation of a Curriculum-Based Intervention Program Among Elementary School Children.* Journal of Pediatric Nursing,, 2001. **16**(2): p. 79-87.
12. Greene A, Barnett P, Crossen J, Sexton G, Ruzicka P, and Neuwelt E, *Prevention Curriculum for Primary Students Evaluation of the THINK FIRST For KIDS Injury*. Injury Prevention, 2002. **8**: p. 257.
13. ThinkFirst Foundation of Canada. *Mission Statement*. [Website] 2007 June 6th, 2007 [cited; Available from: http://www.thinkfirst.ca/default.asp.
14. Gordon KE, Dooley JM, and Wood EP, *Descriptive Epidemiology of Concussion.* Pediatric Neurology, 2006. **34**: p. 376-378.
15. Macpherson AK, Macarthur C, To TM, Chipman ML, Wright JG, and Parkin PC, *Economic disparity in bicycle helmet use by children six years after he introduction of legislation.* Injury Prevention, 2006. **12**: p. 231-235.
16. *Ontario Trauma Registry: Sports and Recreational Injury Hospitalizations in Ontario, 2002-2003*. 2003, Canadian Institute for Health Information (CIHI): Toronto (ON).
17. Cook DJ, Cusimano MD, Tator CH, and Chipman ML, *Evaluation of the ThinkFirst Canada, Smart Hockey, brain and spinal cord injury prevention video.* Injury Prevention, 2003. **9**: p. 361-366.

18. Hotz GA, Cohn SM, Castelblanco A, Colston S, Thomas M, Weiss A, Nelson J, and Duncan R, *WalkSafe: A School-Based Pedestrian Safety Intervention Program.* Traffic Injury Prevention, 2004. **5**: p. 382-389.
19. Mock CN, Maier RV, Boyle E, Pilcher S, and Rivara FP, *Injury Prevention Strategies to Promote Helmet Use Decrease Severe Head Injuries at a Level I Trauma Center.* The Journal of Trauma: Injury, Infection, and Critical Care 1995. **39**(1): p. 29-35.
20. Parkin PC, Spence LJ, Hu X, Kranz KE, Shortt LG, and Wesson DE, *Evaluation of a Promotional Strategy to Increase Bicycle Helmet Use by Children.* Pediatrics, 1993. **91**: p. 772-777.
21. Duperrex O, Roberts I, and Bunn F, *Safety education of pedestrians for injury prevention.* Cochrane Database of Systematic Reviews, 2002(2).