The Reinforcement of ATV Safety Protocols Following Injury Improves Future Adherence

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Abstract

All-terrain vehicles (ATVs) are a leading cause of pediatric trauma. Children may experience a range of injuries from concussion and fractures to severe traumatic brain injury and even death. ATV safety is a priority. Research emphasizes the importance of helmet use while riding an ATV and adhering to manufacturing guidelines for ATVs.

These findings have led to the initiation of an evidence-based project to identify behavioral changes within the pediatric population, specifically children 12-18 years of age who are on the Trauma Service of Phoenix Children's Hospital. Each patient was given a pre-test survey to assess their knowledge regarding ATV safety. After the pre-test survey was completed, an educational component was implemented, the participant used teach-back to the project personnel to demonstrate understanding, and a post-test survey immediately followed. The posttest had several open-ended questions that identified the patient's intention to follow the safety recommendations when riding their ATV in the future.

Keywords: pediatric, injury, ATV, ATV injuries, safety, ATV safety, prevention, law

Pediatric ATV Injuries

All-terrain vehicles (ATVs) are a leading cause of pediatric trauma. Children may experience a range of injuries from concussion and fractures to severe traumatic brain injury and even death. ATV safety is a priority in Arizona. An initiative in underway to decrease ATV injuries in the southwestern United States (U. S.)

Problem Statement

Recent data collected from a large free-standing children's hospital in the southwestern U. S. reports 102 pediatric patients in 2016, 99 pediatric patients in 2017, 105 pediatric patients in 2018, 99 pediatric patients in 2019, that were trauma status and admitted due to an ATV accident (Phoenix Children's Hospital, 2020).

Purpose and Rationale

Nationally, trauma departments have seen a consistent influx of patients from ATV injuries. These patients are transported via helicopter, ambulance, or their parents' vehicles to receive immediate care. All children who ride/drive ATVs, the caregivers of these children, the individuals who transport these children, the health care providers that care for these children, the trauma, plastic surgery, injury prevention, research department, and hospitals are impacted by ATV injuries.

The purpose of this project was two-fold: first, to identify whether a targeted educational intervention increased a participant's knowledge of ATV safety while they were hospitalized for a traumatic injury; second, to identify whether the same educational intervention would impact the participants intention to practice ATV safety in the future.

Background and Significance

The American Academy of Pediatrics (AAP, 2018) provides a list of safety tips regarding ATV use. This list notes that riders should attend and complete a hands-on safety training course, no individual should ride with another individual on an ATV, and riders who do not have a driver's license should not be allowed to operate an ATV (AAP, 2018).

McLean et al. (2017) compared injury risks for children under 16 years of age to individuals over 16 years of age, when using ATVs. They determined that children under the age of 16 years of age are at an increased risk for head injuries and fractures (McLean et al., 2017). Garay et al. (2017) established the mortality rate, incidence, and location of fracture for pediatric patients from an ATV incident. This study was conducted over 11 years and concluded that despite the guidelines established by the AAP (2018), 55.4% of 1912 patients sustained at least one bone fracture at or below the cervical spine. Kennedy et al. (2018) report that children in ATV accidents commonly have multisystem injuries, along with extremity injuries, and head injury.

Shults et al. (2013) analyzed ATV riders under 15 years of age, who were treated in the Emergency Department in the U. S. between the years of 2001-2010. It was unclear whether a state-implemented law is effective in reducing the number of injuries that these patients sustain in an ATV incident (Shults et al., 2013). The authors found that having broad regulations could aid in lowering the number of pediatric ATV injuries (Shults et al., 2013). These general regulations included the rider always wearing a helmet, not riding on paved roads, not allowing anyone under 15 years of age to ride ATVs intended for adults, and not following the model rules for the number of passengers (Shults et al., 2013). Another study by Adil et al. (2017) emphasized the importance of helmet use and concluded that overall, adherence is low.

Further action needs to be taken through state legislation to enforce helmet use by all riders. Strohecker et al. (2017) conducted a study in Pennsylvania to evaluate the cost of care for all ATV-related injuries for passengers under 16 years of age. The study concluded that high medical costs are associated with ATV injuries, and consistent helmet use has the potential to reduce medical costs for patients and shorten their hospital stay (Strohecker et al., 2017). Another study conducted by Hafner et al. (2012) focused on ATV dealers' responsibility to convey safety guidelines and recommendations to their customers. They concluded that injury prevention efforts targeting ATV dealers are not the most effective. Aitken et al. (2004) studied strategies for the prevention of ATV accidents and injuries in children. Yuma et al. (2006) acknowledge that injury prevention for the pediatric population for ATV injuries is difficult because it can only be enforced on public lands, not private.

Jennissen et al. (2014) conducted a study to observe specifically riding behaviors among the adolescents who participate in ATV use. This study led to the realization that prevention efforts, such as anticipatory guidance given to the adolescents and their families, need to be a precedent as it will aid in informing the adolescents who participate in unsafe behaviors while riding ATVs (Jennissen et al., 2014). Doud et al. (2017) came to the conclusion that there is an absence of ATV rider training. This shortfall in anticipatory guidance and training regarding ATV safety has evolved into the pediatric ATV riders not only riding double and after dark, but participating in dangerous and high-risk driving, and even alcohol or substance use while operating the ATVs (Doud, et al., 2017).

Internal Evidence

According to the most recent data collected from PCH (2020), there were 102 pediatric patients in 2016, 99 pediatric patients in 2017, 105 pediatric patients in 2018, 99 pediatric patients in 2019, that were brought into the ED as a trauma status and admitted to the hospital for injuries from an ATV accident. The Arizona Bureau of EMS and Trauma Systems stated that in 2014 there were 351 pediatric ATV injuries, in 2015 there were 362 injuries, in 2016 there were 384 injuries, in 2017 there were 385 injuries, and in 2018 there were 412 injuries statewide (Arizona Department of Health Services, 2020). Over the years there has been a steady increase in pediatric ATV injuries and education needs to be provided to this population regarding safe and proper operation of these vehicles.

PICOT Question

The literature review has led to the PICOT question: For children admitted to the hospital following an ATV-related injury, does education regarding ATV safety impact knowledge and change behavior immediately after education is received within the state of Arizona?

Search Strategy

An exhaustive search was executed in the following electronic databases: PubMed, EBSCOhost, Directory of Open Access Journals (DOAJ), and the ASU Library Database. All four databases provided pertinent and relevant articles. The search process for each database has been described below.

Inclusion Criteria, Exclusion Criteria, and Limitations

The inclusion criteria led to studies that ranged from 2014 to present and studies that were published in English. Criteria for inclusion consisted of pediatric ATV injuries, ATV injuries, pediatric safety, ATV safety, and ATV injury prevention. Inclusion and exclusion criteria remained consistent across all databases. Studies from various countries were included, and not limited to America. Limitations of the search included articles published within the last five years and articles that were published in English.

Keyword Selection for Search

Keywords consisted of *pediatric*, *injury*, *ATV*, *ATV injuries*, *safety*, *ATV safety*, *prevention*, and *law*. All results met the above inclusion criteria and generated numerous articles related to pediatric ATV injuries and prevention. A second search was performed using the following words: *pediatric*, *ATV*, and *injury*. This search assisted in finding a broader spectrum of articles to use because the keywords were not being so specific.

Search Yield

An initial database search of PubMed using the key terms *pediatrics*, *pediatric*, *ATV*, *injuries*, and *prevention* produced seven results, while EBSCOhost yielded seven results. Directory of Open Access Journals yielded one result from the previous key terms, and the ASU Library Database yielded one result. A second database search of PubMed using the key terms *pediatric*, *ATV*, and *injury* yielded 86 results. Eleven studies were chosen, after a thorough critical appraisal of each one, due to their competence in addressing the PICO question and the content requires regarding pediatric ATV injuries and prevention (see Appendix A, Table A1).

Critical Appraisal and Synthesis

Ten studies were collected and evaluated, using Melnyk and Fineout-Overholt's (2011) rapid critical appraisal, for the literature review. The majority of the studies were high-level evidence, with five of them having a deductive theory framework, and the other five a retrospective study framework. All included studies with a pediatric population and only one study compared results of pediatrics to adults (see Appendix A, Table A1). A common theme throughout the studies was the bias from the trauma databases used to gather information from the studies. The studies exhibited demographic information with participants within the age range of pediatrics, less than 18 years old (see Appendix A, Table A1). Eight of the studies were conducted in the United States, one in Canada and one in the United Kingdom.

Measurement tools varied between studies, but most used the trauma database registry as a resource for gathering data and surveys. Data was most commonly analyzed by chi-squared testing and the logistic regression to assess odds ratio and 95% confidence intervals among nearly all the studies, and most studies reported confidence intervals, means, standard deviations, and level of significance. Outcomes focused on trends of pediatric ATV injuries, and common injuries related to the severity of the ATV crash and the type of crash. Helmet usage was acknowledged in nearly every study's conclusion, along with the need for further safety measurements to be implemented (see Appendix A, Table A1).

Conclusions from Evidence

ATV's are a leading cause of pediatric trauma. Children may experience a range of injuries from concussion and fractures to severe traumatic brain injury and even death. Pediatric ATV safety is a national priority, that needs attention. This literature review demonstrates the range of pediatric injuries from ATV accidents, along with the lack of safety education being implemented. Current evidence suggests that structured education on ATV safety needs to be communicated to the pediatric population, particularly regarding helmet usage and proper ATV riding guidelines. The studies in this literature provided evidence that ATV injuries are a leading cause of pediatric trauma, and the numbers are not decreasing with time.

Frameworks

The Health Belief Model was chosen as the conceptual framework for this project. The Health Belief Model focuses on positive behavioral change, specifically by targeting barriers that would assist with the change (Rosenstock, 1974). The overall goal of this model is to lead by health promotion, and to further understand health behaviors. This model was applicable to this project because a behavioral change was being evaluated. The behavioral change was whether the pediatric population would improve their adherence after receiving education on ATV safety. The change was evaluated by asking them open ended questions, in the posttest, regarding why they would change their safety behavior when riding an ATV. The hope was that this education would have a positive impact on the population and assist with decreasing the number of pediatric ATV injuries seen within the trauma departments.

The Rosswurm and Larabee's Model was chosen as the evidence-based practice model for this project (Rosswurm & Larabee, 1999). This model includes assessing the need for change, researching and collecting data to support the need for change, analyzing the data collected, and finally creating and implementing an intervention to assist with the issue that needed to change. Eventually, the implementation was evaluated. Step 1 included assessing the need for change with ATV use in pediatrics. Step 2 included researching the trauma database of Arizona and PCH to collect the data and statistics to support the project and a need for change, and step three analyzed all of this information. This step allowed for the data to be reviewed and identify whether there were any trends. After the information was gathered, step four was implemented to create an intervention to assist with decreasing the number of pediatric ATV injuries. This intervention was done by rounding with the Trauma Team at PCH and asking their patients between the age range of 12 to 17 to take a presurvey, then watch a video on ATV safety education, teach back the information learned to the investigator, and then complete a posttest. These steps allowed us to understand their baseline level of knowledge for ATV safety and see if there was an intended behavior change moving forward after the education was provided to them. Then step five implemented the intervention and evaluated the behavioral changes based upon the responses to the surveys. Step six reinforced the change and continued education, based upon the results. This model fits this project appropriately because it used clinical expertise, contextual evidence, quantitative data, and overall adheres to the objectives of this project.

Methods

IRB approval was obtained from Phoenix Children's Hospital and Arizona State University prior to the initiation of this project. The budget for this project did not require any funding, all materials that were needed for the project were in-kind expenses at PCH.

An educational intervention and behavior change initiative was needed to reduce pediatric injuries from ATV accidents in Arizona. All patients were 12-18 years of age. Their legal guardians consented, and they assented to participate in the project. All patients were admitted to the Trauma service at PCH. Inclusion criteria included individuals 12 to 18 years of age, legal guardian at bedside, patient at baseline mental status, consented to participation (by completing the pretest), and admitted for ATV injury. The exclusion criteria included the patient having COVID19, admitted to the Pediatric Intensive Care Unit (PICU), non-English speaking, mentally or physically incapable of participating, and if any of the clinical team requested not to participate. Once a patient met all inclusion criteria, trained project personal would schedule a time to visit them to explain the project and enroll them within the project. There was a pretest (see Appendix E), a safety education video that was played along with reinforcement by trained project personnel, and then the subject was able to teach-back to the investigator the knowledge that they had just obtained. Finally, there was a posttest (see Appendix F) that evaluated the knowledge retention and safety behavior intentions. The posttest was conducted after the pretest and interventions were completed. The posttest had several open-ended questions that identified the patient's intention to follow the safety recommendations for ATV's.

The data was collected by trained project personnel and stored in a password-protected file on a secure network drive, and only project personnel had access; this network drive was locked in a cabinet, in a locked room. Trained project personnel accessed the data for analysis.

Results

The demographic information, primary, and secondary endpoints were intended to be summarized using standard descriptive statistics. The project team intended to analyze the pre- and posttest results using paired t-tests, means, and proportions analysis. Unfortunately, the small sample size did not allow for this analysis. The positive outcome from the project is that both participants improved their scores from the pretest to posttest after receiving education on ATV safety and teaching back the knowledge they obtained from the educational video. Both participants scored six out of eight on the pretest. On the posttest they scored eight out of eight. Both participants acknowledged within the open-ended questions, that moving forward they would adhere to safety protocols when operating an ATV.

The focus of this project was to assess the feasibility of reproducing this education of pediatric ATV safety on a larger scale and ultimately to reduce ATV injuries. This project had a sample size of two participants. Results show improvement between the pretest and posttest scores, and the answers to the open-ended questions implied that both participants would have a behavior change moving forward. They planned to adhere to ATV safety protocols and guidelines that they learned through the education that was provided to them.

Discussion

The small scope of this project did not have a goal of evaluating a reduction in ATV injuries. Limitations for this project included the COVID-19 pandemic leading to delays in IRB approval. This delay limited the enrollment time for the project. This created a smaller sample size than anticipated. Restrictions and adjustments were made to the project to meet the COVID-19 criteria required to achieve IRB approval. One of these adjustments was to only consider project participants if they were admitted for ATV injuries.

Emergency department visits for traumatic injuries provide a “teachable moment” for safety and prevention education (Zonfrillo et al., 2014). No study to date has determined whether inpatient hospital admission for a traumatic injury of any cause provides an effective opportunity for targeted ATV safety education for pediatric patients and their families.

This project was part of the process of identifying effective and accessible means of ATV safety education delivery, which was achieved by this project. Future work is likely to evolve from here, and recommendations include a lengthened implementation timeline that would allow for a larger sample size.

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Appendix A
Evaluation and Synthesis Tables

Table 1
Evaluation Table

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Strohecker, et al. (2017). Pediatric all-terrain vehicle (ATV) injuries: An epidemic of cost and grief. Funding: Unknown Bias: None recognized Country: USA	Deductive Theory	Design: Population-based retrospective cohort design - reviewing **COC** of 78 **PTs ATH** for injuries **r/t ATV** accident Purpose: Evaluate **COC** of all **ATV** related injuries sustained by riders 16 yo and younger in Pennsylvania	**n**:78 **PTs** (16 years, or younger) Setting: Admission to institution in Pennsylvania (01/01/2007-12/31/2009) Demographics: 78% male Mean age 12.2 years	IV: **LOS**; acuity of patient DV1: age DV2: **WH** DV3: type of **CR** DV4: cost	Cost ratios for potential cost determinants (p=0.69); Requiring a stay of ≥ 1 day for potential risk factors (p=0.07); Year by year comparison of **COC** and **LOS** (p > 0.07); Age (p=0.70); Rollover (p=0.71); Ejection (p=0.65); Crash with Stationary Object (p=0.01); helmet (p=0.24); driver (p=0.69)	Generalized Linear Regression w/ log-link function; Logistic Regression; ANOVA, chi-square. SAS statically software, with p-value of <0.05 considered **SS**.	**COC** varied \$322-\$310,435; **AVG** cost **ICR** with **ICR** age. **PTs WH** had lower mean costs. **CR** w/ stationary objects not involving **ROE** had **SL** mean costs (p=0.01) **PTs** involved with **ROE** more likely to require an **OHA** (OR=3.45, p=0.07) **PTs WH** were marginally less likely to require **OHA** (OR = 3.45, p=0.07).	**LOE**: IV Strengths: multiple year study, specific to pediatrics, included a variety of significant variables Weaknesses: Limited to only **PTs** admitted to Pennsylvania institute; limited to **PTs** underage of 16 (not include all pediatric population) Conclusions: **ATV CR** involving non- **WH** riders result in increased **COC**. Interventions to increase **WH** and measure to improve stability are likely to reduce **COC** and **LOS**; relevant to PICO

Key: **ANOVA** – analysis of variance; **AAP** – American Academy of Pediatrics; **ATH** – admitted to hospital; **ATV** – all-terrain vehicle; **AVG** – average; **CHIRPP** – Canadian Hospitals Injury Reporting and Prevention Program; **CI** – chest injury; **CoAU**- characteristics of ATV users; **COC** – cost of care; **CR** – crashes; **CSS** – cross sectional study; **d/t** – due to; **DV**-dependent variable; **ED** – emergency department; **HI** – head injury; **ICR** – increased; **INJ** – injury; **IS** – injury severity; **IV**- independent variable; **LOE** – level of evidence; **LOS** – length of stay; **N**-number of studies; **n**- number of participants; **OHA** – overnight hospital admission; **OR** – odds ratio; **POS** – point of sale; **PTs** – patients; **r/t** – related to; **ROE** –rollover or ejection; **SL** – significantly lower; **SS** – statistically significant; **WH** – wearing helmets; **yo** – years old

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McLean, et al. (2017). Age and the risk of all-terrain vehicle-related injuries in children and adolescents: a cross-sectional study. Funding: Children's Hospital Research Institute of Manitoba; Public Health Agency of Canada Bias: None recognized Country: Canada	Deductive Theory	Design: **CSS** of children and adults presenting to pediatric & adult **ED**s, 1990-2009 in Canada	Inclusion Criteria: **CHIRPP** survey; verbal consent Setting: 17 participating centers in Canada **n**: 5002	IV: Risk of **ATV** related **INJ** DV1: **WH**? DV2: driver status DV3: sex DV4: region of country where patient was seen DV5: era DV6: type of **INJ**	Demographic characteristics of 5002 younger and older injured **ATV** users Description of the 7018 **INJ** sustained by 5002 **ATV** users **CoAU** by **IS** **CoAU** w/ **HI** by **IS** Risk factors for most common isolated moderate to serious **ATV**-related **INJ** Alpha < 0.05 = statistically significant	Demographic and INJ characteristics described as proportions and tested for statistical significance using chi-squared testing. Odds ratio and 95% confidence interval calculated. Logistic regression analyses used to determine moderate to severe INJ. Logistic regression used to determine risk factors. and logistic regression	58% were <16 **yo** and 35% were **ATH**. The odds of a moderate to serious **INJ** vs. minor **INJ** among **ATV** users <16 **yo** was not different compared with those greater than 16 **yo** (OR; 0.94, 95% Cl: 0.84, 1.06). After adjusting for era, **WH**, sex and driver status, youth < 16 **yo** were more likely to present with **HI** (aOR:1.45; 95% Cl: 1.19-1.77) compared to those greater than 16 **yo** Male participants (OR: 1.21; 95% Cl: 1.06-1.38) and drivers (OR: 1.30, 95% Cl:	**LOE**: IV Strength: **CHIRPP** data represent over 20 years surveillance of Canada's tertiary pediatric care facilities; included **INJ** that did not require admission Limitations: risk misclassification bias **d/t** self-report; several missing variables to predict moderate to serious **INJ** not included; acute traumas did not complete **CHIRPP** survey, therefore not included Conclusion: Youth under 16 **yo** are at increased risk of **HI** and fractures. Identified a common INJ among ATV injuries in pediatrics, and the specific age range who is

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							1.12-1.51) were more likely to experience moderate or serious **INJ** than females and passengers. **WH** was associated with significant protection from **HI** (OR: 0.59; 95% Cl: 0.44-0.78)	vulnerable to fractures; relevant to PICO
Hagedorn, et al. (2019). Characterization of all-terrain vehicle–related chest injury patterns in children. Funding: Unknown Bias: None recognized	Inferred Retrospective Study	Purpose: evaluate **CI** patterns in pediatric **PTs** involved in **ATV** accidents Method: Retrospective review of **PTs** 0-18 **yo** admitted to a level I trauma institute following an **ATV**-related incident from	**n**: 455 **PTs** Setting: level 1 trauma institute	DV1: **CI** type DV2: accident mechanism DV3: driver/passenger status DV4: demographic data DV5: clinical data	**CI**: pulmonary contusion, pneumothorax, rib fracture Cardiac, esophageal, or tracheobronchial injuries. **PTs** w/ **CI** had longer median hospital stays.	Chi-square testing.	**CI** present in 102 (22%) of total 455 **PTs** Most common pulmonary contusion (61%), pneumothorax (45%), and rib fracture (34%). **PTs** w/ **CI** had longer median hospital stay (p=0.0054). 8 **PTs** w/ **CI** died compared to 2	LOE: III Strengths: CHIRP databases provided information on pediatric INJ trends, regarding ATV incidents; 20 years of surveillance Limitations: self-reported instrument; risk of bias; data missing for driver status and WH

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Table 1

Evaluation Table

Citation	**Theory/ Conceptual Framework**	**Design/ Method**	**Sample/ Setting**	**Major Variables & Definitions**	**Measurement/ Instrumentation**	**Data Analysis**	**Findings/ Results**	**Level/Quality of Evidence; Decision for practice/ application to practice**
Country: United States		2004-2013 was performed.			Death comparison between **PTs** w/ **CI** and without.		**PTs** w/out **CI** (p=0.0002)	Conclusion: **CI** are common in pediatric **ATV** accidents; increase public awareness of these injuries and safety education are needed; relevant to PICO
Adil, M. T., et al. (2017). All-Terrain Vehicle (ATV) Injuries - An Institutional Review Over 6 Years. Funding: Unknown Bias: None recognized Country: United Kingdom	Deductive Theory	Design: Cohort analysis Purpose: describe single center experience w/ ATV INJ over 6-year period, 2010-2015	n: 65 PTS Setting: South West Acute Hospital, UK Demographics: children between 0-17 yo	IV: ATV INJ DV1: WH DV2: Type of collision DV3: mechanism of INJ	88% of PTs were ejected from ATV 6 PTs got trapped underneath ATV 2 PTs had collisions	Chi-squared testing; cohort analysis	Ejection was most common INJ (p<0.0001) Compliance w/ WH was at 16% (n=10) Extremity (48%) and head and face trauma (43%) were most common INJ	**LOE: III** Strength: identify common ING after ATV accident; common INJ for admission Limitations: data collected between 2010 to 2015; bias compliance of WH Conclusions: Extremity and head trauma are most common r/t ATV INJ; relevant to PICO

Key: **ANOVA** – analysis of variance; **AAP** – American Academy of Pediatrics; **ATH** – admitted to hospital; **ATV** – all-terrain vehicle; **AVG** – average; **CHIRPP** – Canadian Hospitals Injury Reporting and Prevention Program; **CI** – chest injury; **CoAU**- characteristics of ATV users; **COC** – cost of care; **CR** – crashes; **CSS** – cross sectional study; **d/t** – due to; **DV**-dependent variable; **ED** – emergency department; **HI** – head injury; **ICR** – increased; **INJ** – injury; **IS** – injury severity; **IV**- independent variable; **LOE** – level of evidence; **LOS** – length of stay; **N**-number of studies; **n**- number of participants; **OHA** – overnight hospital admission; **OR** – odds ratio; **POS** – point of sale; **PTs** – patients; **r/t** – related to; **ROE** –rollover or ejection; **SL** – significantly lower; **SS** – statistically significant; **WH** – wearing helmets; **yo** – years old

Table 1

Evaluation Table

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
								WH compliance is low.
Garay, M., et al. (2017). Pediatric ATV Injuries in a Statewide Sample: 2004 to 2014. Funding: Unknown Bias: None recognized Country: United States	Retrospective Study	Design: Purpose: incidence, mortality rate, fracture location of PED PTs while using ATV over 11-year period	**n**: 1912 PTs Median age: 14 yo Setting: PED + Adult Trauma Centers w/in the state; evaluated 1/1/2004 – 12/31/2014 Demographics: PED population < 18 yo	IV: ATV INJ DV1: type of INJ DV2: age DV3: severity DV4: LOS in hospital DV5: COC	6.2 PTs per 100,000 children in Ped population Decrease 13.4% in 1st 5 yrs of study vs. last 6 yrs of study Median hospital LOS: 3 -9 days 28 fatalities (1.5%)	Chi-squared testing; logistic regression used to assess odds ratio and 95% confidence intervals	Majority of PTs sustained at least 1 bone fracture at or below cervical spine (55.4%). Femur and tibia were commonly fractured (21.6% and 17.7%)	**LOE**: IV Conclusion: Despite AAP guidelines, children < 16 yo remain victims of ATV injuries; Preventative guidelines are still needed; relevant to PICO Strengths: it was identified that primary health care providers need to be the forefront of prevention efforts Limitations: selection bias; mortality numbers higher than estimated ones; coding

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Table 1

Evaluation Table

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
								errors from database; limited to the state of Pennsylvania
Hafner, J. W., et al. (2012). All-Terrain Vehicle Dealership Point-of-Sale Child Safety Compliance in Illinois. Funding: Unknown Bias: None recognized Country: USA	Deductive Theory	Design: telephone survey Purpose: identify safety guidelines and recommendations dealers convey to consumers at POS	**n**: 127 calls Setting: Illinois	IV: survey DV1: individual answering phone	108/127 dealers recommend WH 3/127 labeled ATV as 'safe' 83.5% dealers recommend training	Chi- square	Telephone interview by male longer than female; p = 0.001 108/127 dealers recommend WH 3/127 labeled ATV as 'safe' 83.5% dealers recommend training	**LOE**: III Strength: miscellaneous survey Limitations: Unknown who will answer phone call. Conclusion: Illinois recommends child-size vehicles, safety training, and WH; relevant to PICO
Hagaopian, M., et al. (2014). ATV injury experience at a pediatric trauma center: A 5-year review.	Retrospective Study Inferred	Design: comparison model Purpose: to see if there has been ATV safety improvement	**n**: 197 ATV admissions Setting: Trauma Registry 2007-2011 and 2006-2008	IV: trauma admit DV1: ATV admit DV2: transfer DV3: outside hospital	51% of children under 10 yo were drivers 18% WH	Chi-square	Mortality 0.5% for ATV and 1.3% for all trauma injuries	**LOE**: III Strength: identification that further safety efforts need to be implemented. Limitations: length of time data was

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Table 1

Evaluation Table

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Funding: Unknown Bias: None recognized Country: USA			Demographics: Trauma admissions	DV4: severity score DV5: need for operation				collected in; trauma database Conclusion: ATV safety has not improved; efforts need improved; efforts need to improve it; relevant to PICO
Jordan, R. W., et al. (2020). Characterization of all-terrain vehicle-related thoracolumbar spine injury patterns in children using the AOSpine classification system. Funding: Unknown Bias: None recognized Country: USA	Retrospective Review	Purpose: to evaluate PED PTs r/t thoracolumbar spine injury patterns and clinical characteristics	**n**:456 PTs Setting: level 1 trauma center Demographics: 0-17 yo admits	IV: DV1: thoracolumbar spine injury pattern DV2: accident mechanism DV3: driver/passenger status DV4: demographic data DV5: clinical data	36 PTs sustained 1 or more thoracolumbar spine injuries (7.9%); Commonly older, taller, heavier, and high BMI. ATV rollover 61% cause of spine fractures	Chi-square; Wilcoxon rank sum test; Fisher's exact test	PTs w/ spine injuries, 2X length hospital stay, compared to those with not; p= 0.003 Nonstructural spine injuries 49.1% Wedge-compression fractures 41.1%	**LOE**: IV Conclusion: distinct spine fracture for PTs 8 yo and younger, d/t mature osseous-ligamentous complex; relevant to PICO Strengths: trends of spine fractures identified with ATV INJ Limitations: trauma registry, exclusion of PTs; selection bias; not every PT received CT scan

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Table 1

Evaluation Table

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Kennedy, A. P., et al. (2018). Assessment of the pediatric trauma patient: Differences in approach. Funding: Unknown Bias: None recognized Country: USA	Deductive Theory	Purpose: traumatic injury most frequent case of death for child in US	**n**: Trauma Centers Demographics: Trauma PTs	IV: pediatric PTs DV1: trauma center DV2: INJ DV3: institution protocols	Differences in treatment for PED PTs vs. adult PTs; specifically, trauma centers	None indicated	Over 10,000 children die d/t unintentional and non-accidental INJ PEDs PTs solid organ INJ, do not require operative intervention	**LOE**: III Conclusion: must have protocols for pediatric vs. adult traumas ; not all pediatric PTS need operative treatment vs. adults for blunt abdominal INJ; relevant to PICO Strengths: protocols for pediatric PTs with blunt abdominal trauma r/t ATV INJ Limitations: no identification on what prophylactic measures should be used; unclear on risk factors that carry most significance
Shults, R. A., et al. (2013). All-terrain vehicle-related nonfatal injuries among young riders in the United States.	Retrospective Study	Method: National Electronic Injury Surveillance System-All Injury Program Data Purpose: < or equal to 15 yo	**n**: 361,161 Setting: United States Demographics: ATV rider treated in ATV,	IV: DV1: age DV2: gender DV3: primary body part injured DV4: diagnosis DV5: hospital admission	INJ rate at 67 per 100,000 children in 2004 INJ rate decline to 42 per 100,000 children in 2010	Chi-Square testing; logistic regression used to assess odds ratio and 95% confidence intervals	INJ rate for boys doubled girls; 73 vs. 37 per 100,000 PED PTs age 11-15 yo accounted 2/3 of ED visits	**LOE**: IV Limitations: economy Conclusion: Unknown why the decline of injuries in 2010; unclear how to reduce injuries; effective safety measures

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Table 1

Evaluation Table

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Funding: Unknown Bias: None recognized Country: USA		treated in ED w/in US during 2001-2010	15 yo or younger				and hospitalizations Fractures 28% of ED visits Fractures 45% of hospitalizations	include WH; relevant to PICO Strengths: identification of importance of WH Limitations: National estimates only, not region, state, or local jurisdiction; inaccuracy in hospitals; sample underestimated the problem due to limited inclusion criteria

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Appendix B

	Adil	Garay	Hafner	Hagaopian	Hagedorn	Jordan	Kennedy	McLean	Shults	Strohecker
Year	2017	2017	2012	2014	2019	202	2019	2017	2013	2017
LOE/Design	III/ CA	IV/ RS	III/ RCT	III/ RS,CA	III/ RS,CA	IV/ RS,CA	III/ RCT	IV/ RCT	III/ RS,CA	IV/ CA
Independent Variables										
ATV INJ	X	X			X	X	X	X	X	X
Survey			X							
Trauma Admit				X						
Dependent Variables										
Type of INJ	X	X		X		X	X	X	X	X
WH	X							X		X
Type of Collision	X									X
Mechanism of INJ	X				X	X			X	
Age		X			X	X		X	X	X
Severity of INJ		X		X			X	X	X	
LOS in Hospital		X		X					X	
Cost of Care		X							X	X
Answering Call			X							
Thoracolumbar Spine INJ Pattern						X				
Driver/Passenger Status					X	X		X	X	
Need for Operation				X						
Clinical Data					X	X				
Trauma Center							X			
Conclusion										
Effective Safety measures include WH	X	X	X	X	X				X	X
Protocols for Ped ATV INJ Traumas		X					X			
Increased risk under 16 yo		X						X		
Vulnerable to fractures	X					X		X		
Need for Safety Measure Improvement	X		X	X	X	X		X		X
HI Common	X	X								

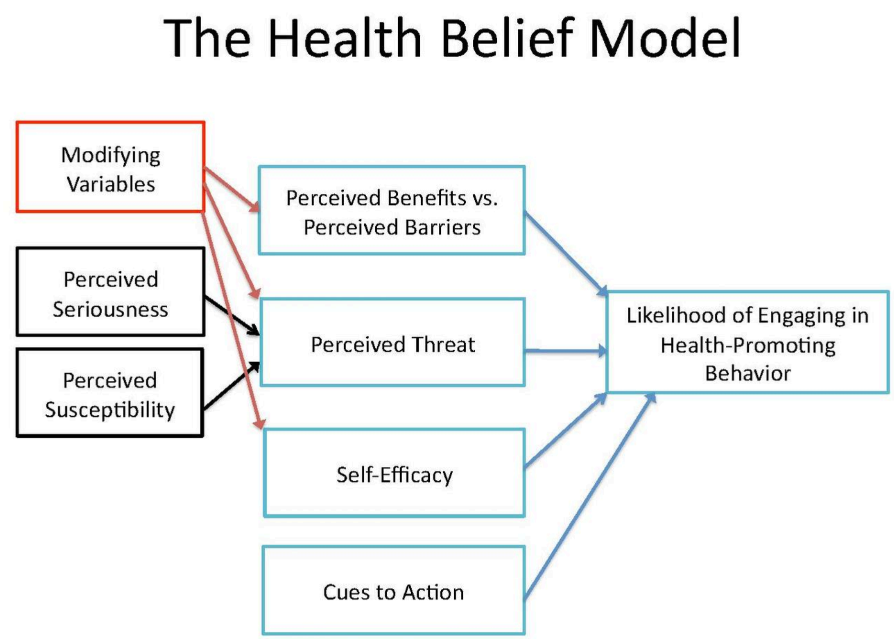
Key: **ATV** – all-terrain vehicle; **INJ** – injury; **HI** – head injuries; **LOE** – level of evidence; **LOS** – length of stay; **Ped** – pediatric; **WH-** wearing helmet;

APPENDIX C

Models and Frameworks

Figure 1

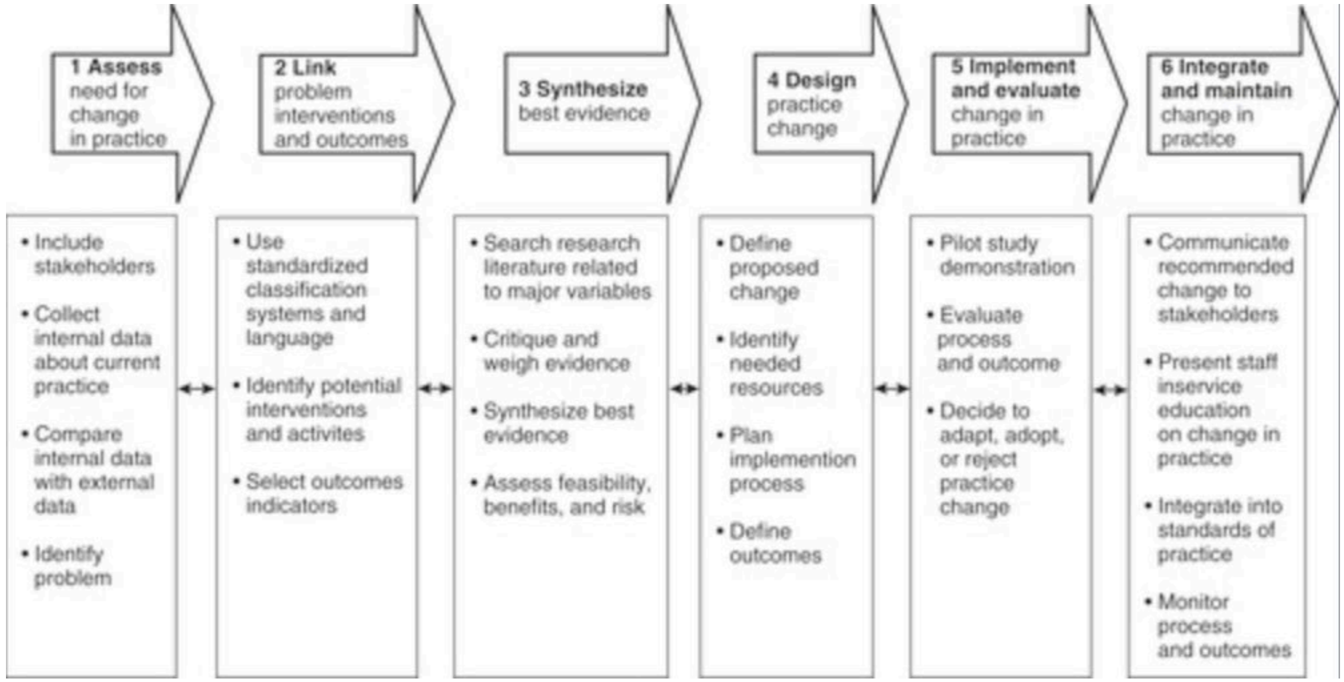
Health Belief Model



Key: **ANOVA** – analysis of variance; **AAP** – American Academy of Pediatrics; **ATH** – admitted to hospital; **ATV** – all-terrain vehicle; **AVG** – average; **CHIRPP** – Canadian Hospitals Injury Reporting and Prevention Program; **CI** – chest injury; **CoAU**- characteristics of ATV users; **COC** – cost of care; **CR** – crashes; **CSS** – cross sectional study; **d/t** – due to; **DV**-dependent variable; **ED** – emergency department; **HI** – head injury; **ICR** – increased; **INJ** – injury; **IS** – injury severity; **IV**- independent variable; **LOE** – level of evidence; **LOS** – length of stay; **N**-number of studies; **n**- number of participants; **OHA** – overnight hospital admission; **OR** – odds ratio; **POS** – point of sale; **PTs** – patients; **r/t** – related to; **ROE** –rollover or ejection; **SL** – significantly lower; **SS** – statistically significant; **WH** – wearing helmets; **yo** – years old

Figure 2

Rosswurm and Larabee's Model



Key: **ANOVA** – analysis of variance; **AAP** – American Academy of Pediatrics; **ATH** – admitted to hospital; **ATV** – all-terrain vehicle; **AVG** – average; **CHIRPP** – Canadian Hospitals Injury Reporting and Prevention Program; **CI** – chest injury; **CoAU**- characteristics of ATV users; **COC** – cost of care; **CR** – crashes; **CSS** – cross sectional study; **d/t** – due to; **DV**-dependent variable; **ED** – emergency department; **HI** – head injury; **ICR** – increased; **INJ** – injury; **IS** – injury severity; **IV**- independent variable; **LOE** – level of evidence; **LOS** – length of stay; **N**-number of studies; **n**- number of participants; **OHA** – overnight hospital admission; **OR** – odds ratio; **POS** – point of sale; **PTs** – patients; **r/t** – related to; **ROE** –rollover or ejection; **SL** – significantly lower; **SS** – statistically significant; **WH** – wearing helmets; **yo** – years old

APPENDIX D

Budget

Figure 1

Pediatric ATV Injury Project Budget

Budget for DNP Project: Pediatric ATV Injuries at Phoenix Children's Hospital		
Direct Costs: Personnel	**Expenses**	**Donated**
DNP Student		(volunteered time)
Project Director $50/hr x 4hr/week x 12weeks		$2400.00 (volunteered time)
Project Researcher $30/hr x 2hr/week x 12weeks		$720.00 (volunteered time)
Manager of Trauma Program $50/hr x 1hr/week x12weeks		$600.00 (volunteered time)
Injury Prevention Specialist for Bike + ATV Safety $45/hr x 1 hr/week x 12 weeks		$540.00 (volunteered time)
Translator $25/hr x 4 hr/week x 8 weeks		$768.00 (provided by organization)
Direct Costs: Materials	**Expenses**	**Donated**
Color Printing Services $0.30/page x 100		$30.00 (provided by organization)
Pen, Writing Utensil $5/12-pack x 4		$20.00 (provided by organization)
Paper $0.05/page x 100		$5.00 (provided by organization)

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10.2 inch I-pad (Apple) $329 x 2		$658.00 (provided by organization)
Indirect Costs: Operations	**Expenses**	**Donated**
Phoenix Children's Hospital (air conditioning/electricity) $250/month x 2 months		$500.00 (provided by organization)
Internet Connection: Wi-Fi $120/month x 2 months		$240.00 (provided by organization)
ZOOM business membership $19.99/month x 2 months		$40.00 (provided by organization)
TOTAL	**Expenses**	**Donations**
$6521	$0	$6521

Key: **ANOVA** – analysis of variance; **AAP** – American Academy of Pediatrics; **ATH** – admitted to hospital; **ATV** – all-terrain vehicle; **AVG** – average; **CHIRPP** – Canadian Hospitals Injury Reporting and Prevention Program; **CI** – chest injury; **CoAU**- characteristics of ATV users; **COC** – cost of care; **CR** – crashes; **CSS** – cross sectional study; **d/t** – due to; **DV**-dependent variable; **ED** – emergency department; **HI** – head injury; **ICR** – increased; **INJ** – injury; **IS** – injury severity; **IV**- independent variable; **LOE** – level of evidence; **LOS** – length of stay; **N**-number of studies; **n**- number of participants; **OHA** – overnight hospital admission; **OR** – odds ratio; **POS** – point of sale; **PTs** – patients; **r/t** – related to; **ROE** –rollover or ejection; **SL** – significantly lower; **SS** – statistically significant; **WH** – wearing helmets; **yo** – years old

APPENDIX E

Pre-Test for Pediatric ATV Safety

1. How much does the average adult size ATV weigh?
   a. 100 pounds
   b. 20 pounds
   c. 600 pounds
   d. 450 pounds

2. What is the benefit of wearing a helmet when riding an ATV?
   a. Reduces head and neck injuries
   b. Gives you a headache
   c. Reduces arm and leg injuries

3. How many riders should be on an ATV at a time?
   a. 5 riders
   b. 1 rider
   c. 2 riders
   d. 3 riders

4. True or **False**? Individuals under the age of 16 years old should ride the size/age-appropriate ATV.

5. Should you ride ATVs on paved roads or dirt roads? **Dirt roads only.**

6. Are ATV's toys or motorized vehicles? **Motorized vehicles.**

7. Other than a helmet, what should you wear when riding an ATV?
   a. Gloves, eye protection, and reflective clothing
   b. Gloves and long sleeve shirt
   c. Eye protection
   d. Eye protection, and reflective clothing

8. Do you want your helmet to be loose or snug when riding an ATV? **Snug.**

If you choose to participate in this research project, we will not collect any of your protected health data. All of the information you have been given by the hospital about your health information applies to this research project as well.

By completing this 'Pre-Test Survey', I consent to participating in this project .

Age: ____________

Gender: ____________

Reason for admission: ____________

Ever ride an ATV? ____________

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APPENDIX F

Post-Test for Pediatric ATV Safety

1. How much does the average adult size ATV weigh?
   a. 100 pounds
   b. 20 pounds
   c. 600 pounds
   d. 450 pounds

2. What is the benefit of wearing a helmet when riding an ATV?
   a. Reduces head and neck injuries
   b. Gives you a headache
   c. Reduces arm and leg injuries

3. How many riders should be on an ATV at a time?
   a. 5 riders
   b. 1 rider
   c. 2 riders
   d. 3 riders

4. True or **False**? Individuals under the age of 16 years old should ride the size/age-appropriate ATV.

5. Should you ride ATVs on paved roads or dirt roads? **Dirt roads only.**

6. Are ATV's toys or motorized vehicles? **Motorized vehicles.**

7. Other than a helmet, what should you wear when riding an ATV?
   a. Gloves, eye protection, and reflective clothing
   b. Gloves and long sleeve shirt
   c. Eye protection
   d. Eye protection, and reflective clothing

8. Do you want your helmet to be loose or snug when riding an ATV? **Snug.**

9. If you ride an ATV, will you be sure to wear a helmet? Why or why not?

10. If you ride an ATV, will you be sure to ride alone, without passengers? Why or why not?

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