ARTICLE DETAILS

TITLE (PROVISIONAL)
Comparative analysis of all-terrain vehicles, motorcycle, and automobile-related trauma in a rural border community of the United States.

AUTHORS
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VERSION 1 – REVIEW

REVIEWER
Jarman, Molly
Brigham and Women's Hospital Biomedical Research Institute, Department of Surgery

REVIEW RETURNED
19-Aug-2021

GENERAL COMMENTS
Thank you for the opportunity to review this manuscript. The authors present descriptive results related to the epidemiology of injury from all terrain vehicles use in the Rio Grande region to Texas (USA), as compared to injuries from motor vehicles and motorcycles. The manuscript is well written; however, there are several areas where additional details would improve clarity.

The dissemination plan specifically mentions promotion at orthopedic and rehabilitation clinics to increase safety awareness. Why not also promote/disseminate via primary care, and in particular pediatric clinics?

Is it possible to obtain data on pre-hospital deaths and patients treated at other (non-trauma center) hospitals in the region? If not, this should be addressed in the limitations. If the primary objective of this manuscript is establishing the incidence and population impact of ATV-related injury, lack of data on pre-hospital deaths and early deaths at community hospitals (i.e. before transfer to trauma center) might bias estimates, particularly as EMS are more likely to experience delays in reaching and extracting patients from ATV crashes on remote/private land compared to motorcycle/motor vehicle crashes on public roadways.

Please provide additional information for specification of the models used to estimate odds ratios. Were these derived from (multivariable?) regression models, or calculated as crude/unadjusted odds ratios? It is also not clear in the methods section that the dependent variables of interest are age, open fracture, insurance type, and protective equipment.

Injury severity score is not truly a continuous variable. As a result, it is difficult to interpret mean ISS. ISS is calculated as the sum of the squared abbreviated injury scale scores for up to three body regions with the most severe injuries. Based on this formula, some
values in the ISS range are not possible and the relative "distance" between values is not constant. ISS is typically categorized as <=9, 10-15, 16-24, and >= 25. It can also be used as an ordinal variable.

Lines 32-41 on page 11 are confusing - I think there is a word/phrase missing.

The conclusions highlight differences in motor vehicle insurance requirements as a likely factor causing the elevated use of Medicaid for ATV injuries compared to other mechanisms. Might another cause be the tendency for ATV users to be younger (and specific to Rio Grande region, more likely to be US citizens?), and therefore more likely to qualify for Medicaid.

Olivier, Jake
University of New South Wales, School of Mathematics and Statistics

ATV, or quad bike, injuries are on the rise in many places across the world. It is good to have additional information from a region of the US on injuries resulting from this mode of transport and often work vehicle.

I would suggest the authors spend some time putting an international context into their submission. For example, many places outside the US call these vehicles quad bikes. Presumably, this is the type of vehicle as referred by the authors as opposed to, say, side-by-sides which are also meant for many kinds of terrain and have four wheels. Also, many places worldwide have banned three-wheelers, I believe. Is the annual cost of ATV injuries at $6.5B for the US only? Australia now requires an operator protection device be fitted onto an ATV/quad bike.

ATVs/quad bikes are inherently unstable. Severly research articles over the years has made this clear.

https://doi.org/10.1016/j.ssci.2018.02.018
https://doi.org/10.1080/15389588.2015.1091073
https://doi.org/10.4271/2014-01-0095

I am confused by the wording of the manuscript in several parts. The authors mention their hospital has a Level 2 Trauma Center, but then say it is operating as a Level 1 Center. There should be some clarification as to why this is the case here. Also, trauma registries often collect data from multiple hospitals/EDs/trauma centers. Is that not the case here?

Abstract: The last sentence of the Methods section starts with "Results revealed" should probably be in the Results section.

The highlights state "there is no use of protective equipment while using ATVs", yet there were some who presented with ATV-related injuries who were wearing a helmet at the time. Is there a US helmet standard for ATVs? Or is it the same as a motorcycle helmet?

Intro: by 4M vehicles and 10.7M in 2012, is that per year or total? I also assume "vehicles" are ATVs. Correct? I'm also not sure an
injury rate can be considered "dramatic" but a sharp increase in the injury rate can.

Please provide a citation for 76% of injured children are males. Is this the US?

The Rio Grande Valley Region is in the southern part of the US, but not the southernmost region. Parts of southern Florida are further south, Key West, FL has the "southernmost" point in the mainland US, and Hawaii is even further south.

Data sources: It is true that not excluding patients/patients' records can minimize selection bias, but this measure alone cannot avoid or eliminate it. The data available come from reported injurious ATV crashes and not all ATV crashes or ATV-related injuries. Many of these go unreported, I suspect.

Testing for normality is not usually a good idea. It would be better to check modelling assumptions through QQ plots or other diagnostic measures.

Why not conduct linear modelling and logistic regression for the analyses? As the analysis stands, it is not clear how ORs were computed across the three groups. Were these two separate 2x2 tables? This is not an efficient use of the data and logistic regression is a much better option. Also, since types of vehicle and age groups (<16 years of age) were included in the model and there is an association between age and use of these vehicles, did the authors include interaction terms for them? Otherwise, I think the reported statistical results can be misleading.

For reporting statistical results, I think the mean difference between groups (or standardized mean difference) with confidence intervals are a better effect size measure than the F statistic (also OR better than reporting chi-square stat).

Tables: I do not think the column "Differences" provides much info. Inequalities can readily be inferred from the mean or proportion estimates.

Mortality data in a trauma registry is often misleading. Only those with reportable injuries present to an ED or trauma center. Those with mortal injuries at the scene are never counted in such registries. It would be better to supplement the trauma registry mortality data with coronial data.

How was the injury severity score computed? Was it the abbreviated injury scale method of sum of squares of 3 most serious injuries?

I am not sure I agree with the interpretation of Figure 1D as risky behaviors. Behavioral data does not appear available in this data set except for the use/non-use of a helmet. Is that correct?

VERSION 1 – AUTHOR RESPONSE

Reviewer: 1
Comments to the Author:
Thank you for the opportunity to review this manuscript. The authors present descriptive results related to the epidemiology of injury from all-terrain vehicles use in the Rio Grande region to Texas (USA), as compared to injuries from motor vehicles and motorcycles. The manuscript is well written; however, there are several areas where additional details would improve clarity.

1. The dissemination plan specifically mentions promotion at orthopedic and rehabilitation clinics to increase safety awareness. Why not also promote/disseminate via primary care, and in particular pediatric clinics?

Response: The authors agree that the dissemination plan should include the population as a whole, but especially for the pediatric population. The conclusion has been modified to include these sentiments.

2. Is it possible to obtain data on pre-hospital deaths and patients treated at other (non-trauma center) hospitals in the region? If not, this should be addressed in the limitations. If the primary objective of this manuscript is establishing the incidence and population impact of ATV-related injury, lack of data on pre-hospital deaths and early deaths at community hospitals (i.e. before transfer to trauma center) might bias estimates, particularly as EMS are more likely to experience delays in reaching and extracting patients from ATV crashes on remote/private land compared to motorcycle/motor vehicle crashes on public roadways.

Response: We were not able to obtain pre-hospital deaths or data on patients at other hospitals as it was outside the scope of the IRB approval for this study. This has been included as one of the limitations of the study. The primary objectives were to determine the difference in Injury Severity Scores (ISS), Glasgow coma scale scores (GCS), and hospital length of stay (LOS) between ATV-related injuries and injuries sustained from motorcycles (MOTO) and motor vehicle cars (MVC). This statement has been included in the introduction.

3. Please provide additional information for specification of the models used to estimate odds ratios. Were these derived from (multivariable?) regression models, or calculated as crude/unadjusted odds ratios? It is also not clear in the methods section that the dependent variables of interest are age, open fracture, insurance type, and protective equipment.

Response: The methods section now includes specific details about the models used to determine odds ratios. All variables including whether they were independent/dependent have also been clearly defined.

4. Injury severity score is not truly a continuous variable. As a result, it is difficult to interpret mean ISS. ISS is calculated as the sum of the squared abbreviated injury scale scores for up to three body regions with the most severe injuries. Based on this formula, some values in the ISS range are not possible and the relative “distance” between values is not constant. ISS is typically categorized as <=9, 10-15, 16-24, and >= 25. It can also be used as an ordinal variable.

Response: Based on previous literature, the ISS has been categorized as the reviewer has suggested. This has been detailed in the methods section and is categorized in the analyses and results.

5. Lines 32-41 on page 11 are confusing - I think there is a word/phrase missing.

Response: The section has been modified.
6. The conclusions highlight differences in motor vehicle insurance requirements as a likely factor causing the elevated use of Medicaid for ATV injuries compared to other mechanisms. Might another cause be the tendency for ATV users to be younger (and specific to Rio Grande region, more likely to be US citizens?), and therefore more likely to qualify for Medicaid.

Response: Financial data has been removed from the data included in this study. The Rio Grande Valley is made up of 4 counties including Starr, Hidalgo, Cameron, and Willacy. Data from the U.S. Census Bureau indicates that these are among the poorest counties in Texas with a per capita income of approximately $14,000 and at least 25% percent of residents living in poverty. It is reasonable to understand that many of the children that get admitted to this hospital would qualify for Medicaid funding. For adults, the law strictly limits who can qualify for Medicaid, and most adults who can work are ineligible to receive any benefits. Most adults who receive Medicaid beneficiaries are doing so under a disability benefits plan. Upon further discussion, the authors do not believe that financial data or insurance type is a factor in determining differences in the mechanism of injury if only pediatric patients qualify for Medicaid benefits.

(https://www.census.gov/quickfacts/fact/dashboard/willacycountytexas,hidalgocountytexas/INC910219#INC910219)

Reviewer: 2

Comments to the Author:

ATV, or quad bike, injuries are on the rise in many places across the world. It is good to have additional information from a region of the US on injuries resulting from this mode of transport and often work vehicle.

1. I would suggest the authors spend some time putting an international context into their submission. For example, many places outside the US call these vehicles quad bikes. Presumably, this is the type of vehicle as referred by the authors as opposed to, say, side-by-sides which are also meant for many kinds of terrain and have four wheels. Also, many places worldwide have banned three-wheelers, I believe.

Response: We have included “quad bikes” in the opening sentence of the first paragraph.

2. Is the annual cost of ATV injuries at $6.5B for the US only?

Response: Yes, this estimate for the US only. The sentence has been modified.

3. Australia now requires an operator protection device be fitted onto an ATV/quad bike. ATVs/quad bikes are inherently unstable. Severy research articles over the years has made this clear.

https://doi.org/10.1016/j.ssci.2018.02.018
https://doi.org/10.1080/15389588.2015.1091073
https://doi.org/10.4271/2014-01-0095

Response: The introduction now includes this sentiment and one of the suggested references has been included.

4. I am confused by the wording of the manuscript in several parts. The authors mention their hospital has a Level 2 Trauma Center, but then say it is operating as a Level 1 Center. There should be some clarification as to why this is the case here. Also, trauma registries often collect data from multiple hospitals/EDs/trauma centers. Is that not the case here?
Response: The hospital was a certified Level 2 Trauma Center during the years in which data was analyzed. The hospital has since been certified as a Level 1 Trauma Center but this should not be mentioned in the manuscript as it is not relevant to the study. The Methods section has been modified to only include Level 2 Trauma Center.

There are national trauma registries; however, this data was extracted from the hospital specific trauma registry that must be maintained as a requirement for Trauma Center certification by the American College of Surgeons.

5. Abstract: The last sentence of the Methods section starts with "Results revealed" should probably be in the Results section.
Response: The abstract has been corrected.

6. The highlights state "there is no use of protective equipment while using ATV's", yet there were some who presented with ATV-related injuries who were wearing a helmet at the time. Is there a US helmet standard for ATVs? Or is it the same as a motorcycle helmet?
Response: The new tables indicate the differences in use of protective equipment between the different mechanisms of injury (e.g., ATV vs MOTO vs MVC).

7. Intro: by 4M vehicles and 10.7M in 2012, is that per year or total? I also assume "vehicles" are ATVs. Correct? I'm also not sure an injury rate can be considered "dramatic" but a sharp increase in the injury rate can.
Response: This sentence has been modified to read:
"By the year 2000, nearly four million ATVs were sold in the U.S.A and just two years later, the U.S. Consumer Product Safety Commission (CPSC) estimated that 10.7 million four-wheeled ATVs were in operation by 2012."

8. Please provide a citation for 76% of injured children are males. Is this the US?
Response: Yes, this is the US. The citation has been provided.

9. The Rio Grande Valley Region is in the southern part of the US, but not the southernmost region. Parts of southern Florida are further south, Key West, FL has the "southernmost" point in the mainland US, and Hawaii is even further south.
Response: The Rio Grande Valley is the most southern part of Texas and is located along the Texas/Mexico border. The manuscript has been edited to reflect this statement.

10. Data sources: It is true that not excluding patients/patients' records can minimize selection bias, but this measure alone cannot avoid or eliminate it. The data available come from reported injurious ATV crashes and not all ATV crashes or ATV-related injuries. Many of these go unreported, I suspect.
Response: The authors agree with this comment. This statement has been removed from the manuscript.

11. Testing for normality is not usually a good idea. It would be better to check modelling assumptions through QQ plots or other diagnostic measures.
Response: The authors acknowledge the reviewers’ critique on the analytical methods used in this study. As a result, and after careful consideration, the authors used proportional odds regression as well as logistic regression models in the analyses. The statistical methods as well as the reported results have been clearly defined.

12. Why not conduct linear modelling and logistic regression for the analyses? As the analysis stands, it is not clear how ORs were computed across the three groups. Were these two separate 2x2 tables? This is not an efficient use of the data and logistic regression is a much better option. Also, since types of vehicle and age groups (<16 years of age) were included in the model and there is an association between age and use of these vehicles, did the authors include interaction terms for them? Otherwise, I think the reported statistical results can be misleading.

Response: The authors acknowledge the reviewers’ critique on the analytical methods used in this study. As a result, and after careful consideration, the authors used proportional odds regression as well as logistic regression models in the analyses. The statistical methods as well as the reported results have been clearly defined.

13. For reporting statistical results, I think the mean difference between groups (or standardized mean difference) with confidence intervals are a better effect size measure than the F statistic (also OR better than reporting chi-square stat).

Response: The authors acknowledge the reviewers’ critique on the analytical methods used in this study. As a result, and after careful consideration, the authors used proportional odds regression as well as logistic regression models in the analyses. The statistical methods as well as the reported results have been clearly defined.

14. Tables: I do not think the column “Differences” provides much info. Inequalities can readily be inferred from the mean or proportion estimates.

Response: The table has been replaced by a new table based on chi-square test for non-zero regression coefficients in univariable logistic regression analysis.

15. Mortality data in a trauma registry is often misleading. Only those with reportable injuries present to an ED or trauma center. Those with mortal injuries at the scene are never counted in such registries. It would be better to supplement the trauma registry mortality data with coronial data.

Response: We were not able to maintain pre-hospital deaths or data on patients at other hospitals as it was outside the scope of the IRB approval for this study. This has been included as one of the limitations of the study.

16. How was the injury severity score computed? Was it the abbreviated injury scale method of sum of squares of 3 most serious injuries?

Response: Yes, the ISS was calculated by taking the sum of the squares of the highest abbreviated injury scale from each of the three most severely injured body regions.

17. I am not sure I agree with the interpretation of Figure 1D as risky behaviors. Behavioral data does not appear available in this data set except for the use/non-use of a helmet. Is that correct?

Response: The new tables indicate the differences in use of protective equipment between the different mechanisms of injury (e.g., ATV vs MOTO vs MVC). References to risky behavior have been removed.
**GENERAL COMMENTS**

Thank you for providing a thoughtful response to reviewers and thorough revisions. I believe the manuscript is significantly improved. In particular, the methods are more robust now and easier to understand. I do believe the manuscript would benefit from additional revisions.

This introduction is very long and ventures into editorialized discussion in several spots - I suggest paring down the intro to establish the public problem, knowledge gaps and objectives, and moving some of the content to the discussion.

The last sentence in the first paragraph of the introduction (page 5, lines 24-29) is confusing - it states there were an estimate 4 million ATVs sold in 2000, and two years later 10.7 were in operation in 2012. Please clarify if the 10.7 million estimate is from 2002 or 2012.

The abbreviation MVC is typically used for motor vehicle collision, not motor vehicle car (and in that context, MVC as a standard abbreviation technically includes motorcycle and ATV collisions). I suggest using automobile as an alternative, to improve clarity of the distinction between ATV crashes, motorcycle crashes, and car crashes.

There is a disconnect between the stated objectives and the organization of results presented in tables. If the objective is to describe the epidemiology and ATV-related injuries and draw comparisons between ATV, motorcycle, and automobile injuries, I would expect to see tables (or figures) comparing the outcomes of interest for those three mechanisms.

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**GENERAL COMMENTS**

Thanks for addressing my concerns. Much better now.

I do have a concern about a new sentence that explored modelling these distributions and comparing them using information criterion:

"Poisson, scaled Poisson, negative binomial, generalized Poisson, Conway-Maxwell Poisson model"

Note that these approaches require the models be nested and they are not. Perhaps a better and simpler approach would be to just fit a Poisson model and then use a quasi-Poisson or NB approach if there is overdispersion.
Reviewer: 1
Thank you for providing a thoughtful response to reviewers and thorough revisions. I believe the manuscript is significantly improved. In particular, the methods are more robust now and easier to understand. I do believe the manuscript would benefit from additional revisions.

1. This introduction is very long and ventures into editorialized discussion in several spots - I suggest paring down the intro to establish the public problem, knowledge gaps and objectives, and moving some of the content to the discussion.

Response: We agree with reviewer’s suggestions and have modified the introduction and discussion to address the concerns.

2. The last sentence in the first paragraph of the introduction (page 5, lines 24-29) is confusing - it states there were an estimate 4 million ATVs sold in 2000, and two years later 10.7 were in operation in 2012. Please clarify if the 10.7 million estimate is from 2002 or 2012.

Response: This was an error by the authors during the previous revision, the 10.7 million estimate is from 2012. The manuscript has been modified.

3. The abbreviation MVC is typically used for motor vehicle collision, not motor vehicle car (and in that context, MVC as a standard abbreviation technically includes motorcycle and ATV collisions). I suggest using automobile as an alternative, to improve clarity of the distinction between ATV crashes, motorcycle crashes, and car crashes.

Response: The abbreviation MVC has been modified to AUTO (automobile) throughout the manuscript.

4. There is a disconnect between the stated objectives and the organization of results presented in tables. If the objective is to describe the epidemiology and ATV-related injuries and draw comparisons between ATV, motorcycle, and automobile injuries, I would expect to see tables (or figures) comparing the outcomes of interest for those three mechanisms.

Response: The objectives have been further clarified in the introduction. We have verified that the tables include the 3 mechanisms of injury.

Reviewer: 2
Thanks for addressing my concerns. Much better now.

1. I do have a concern about a new sentence that explored modelling these distributions and comparing them using information criterion:

"Poisson, scaled Poisson, negative binomial, generalized Poisson, Conway-Maxwell Poisson model"

Note that these approaches require the models be nested and they are not. Perhaps a better and simpler approach would be to just fit a Poisson model and then use a quasi-Poisson or NB approach if there is overdispersion.

Response: We started the modeling with Poisson regression and since the assumptions were not satisfied and data were overdispersed, we fitted quasi-Poisson and negative binomial models. The models were compared using the Akaike’s information criteria (AIC) and the Bayesian information criteria (BIC). As a result, quasi-Poisson regression was used to model the outcome variable hospital LOS.
The sentence has been modified as follows: “To model the highly right-skewed variable hospital LOS, measured in number of hours, as well as considering the presence of overdispersion in the data, quasi-Poisson regression was used.”

| REVIEWER          | Jarman, Molly  
|-------------------|----------------|
|                   | Brigham and Women’s Hospital Biomedical Research Institute, 
|                   | Department of Surgery |
| REVIEW RETURNED   | 03-May-2022 |

| GENERAL COMMENTS  | The authors have appropriately an adequately responded to reviewer comments. I have no additional questions or suggestions. |