Child Injuries and Deaths from Road Traffic Incidents in Ghana: Informing Policy and Practice

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ABSTRACT

Child injuries and deaths from road traffic incidents in Ghana: informing policy and practice

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Background: Road traffic crashes are a major public health concern globally; low middle-income countries bear the greatest burden. The Sub-Saharan region accounts for 35.2% child deaths globally due to RTI. The burden of road traffic injuries in Ghana among children is alarming and impacts the lives of Ghanaian children. The world health organization announced a second Decade of Action to achieve their target of reducing RTCs by the year 2030. However, in Ghana, the decade of action is yet to yield any results. The study aimed to report on the annual fatal rates of road traffic injuries (RTI) and to describe the fatal and non-fatal patterns of road traffic crash characteristics among children under 15 years in Ghana from 2005-2020.

Methods: We employ Ghana's Building and Roads Research Institute (BRRI) database which includes detailed information on each police reported Road Traffic Crashes (RTC), Road Traffic Injury (RTI), and Road Traffic Fatality (RTF) from 2005 to 2020 in Ghana as of 2022. Descriptive analysis of variables such as sex, vehicle type, gender, age, road conditions were analyzed. Crashes stratified as either injury or death and Chi square test used to determine the relationship between dependent and independent variables.

Results: Pedestrian RTCs were the leading cause of injuries and deaths among these age groups over the last 16 years. It is coming down but remains the leading cause. The overall average road crash fatality was 3.35 per 100,000 population with children aged 10-14 group being the most affected. The number of males involved in road traffic crashes were more than females (p=0.001). The Highest proportion of childhood road traffic injuries and deaths were caused by cars including both children riding in cars that crashed, and children struck by cars. Good tar road conditions contributed to many road traffic crashes involving children (73.5%).

Conclusion: This study showed overwhelming evidence of road traffic crashes on pedestrians, primarily males aged 10-14 years old. Targeted interventions aimed at improving the road environment, construction of speed bumps, sidewalks, overheard crossings, provision of safe playing and walking space for children and adolescents will help reduce the avoidable deaths on our roads.

ACRONYMS

RTA……. Road Traffic Accidents

RTI……Road Traffic Injury

RTC……..Road Traffic Crash

RTF……..Road Traffic Fatality

BRRI……Building and Road Research Institute

WHO……World Health Organization

LMICs…….Low-Middle-Income Countries

SSA……..Sub-Saharan Africa

UN……United Nations

NRSC……..National Road Safety Commission

NRSA……..National Road Safety Authority

UNICEF……..United Nations International Children Emergency Fund

DHS……Demographic and Health Survey

IHME……..Institute of Health Metrics and Evaluation

MTTD…….Motor Traffic and Transport Department

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I would like to thank my thesis committee members, Caryl Feldacker, Charles N Mock, and Barclay T Stewart for their guidance and support throughout this work. I also give sincere thanks and appreciation to Aldina Mesic who gave me a lot of help and support. I would like to thank BRRI Ghana for giving me the opportunity to use their data set. My family, friends, staff, and faculty of global health departments I am forever grateful.

DEDICATION

I dedicate this work to my mum and dad for their unending love and prayers right from the very beginning. My wife, and kids; Amina, Barkis, Ziyaada, and Mukeem your love is beautiful. I also dedicate this work to all the children in Ghana who are dealing with road traffic crashes in their everyday lives. We will continue to work and ensure no avoidable deaths on our roads.

BACKGROUND AND SIGNIFICANCE

Road Traffic Crashes (RTC) are a leading cause of death worldwide, with a current estimate 1.3 million deaths occur around the world due to road traffic crashes according to the World Health Organization (WHO)(1). In the last two decades, the number of road traffic injuries and deaths has decreased in high-income countries however the same cannot be said of developing countries(1,2). An estimated 93% of Road Traffic Crash (RTC) fatalities are from low- and middle-income countries(1). Low and Middle Income Countries (LMICs) constitute 85% of deaths due to Road Traffic Injuries (RTIs) globally(3). Road traffic injury among children is within the top five causes of death for all children above age 5(4). RTIs are the second leading cause of death among this age group(3,5). It is reported that RTIs claim about 180,000 children under 15 years of age lives, with males being affected 1.5 times more than females(2).

The road traffic mortality rate in Africa in 2019 was 27 per 100,000 population, the highest in the world(1,6,7). Sub-Saharan Africa accounts for 35.2% of global child deaths caused by Road Traffic Injuries (RTI)(8,9). In Ghana road traffic fatalities involving occupants of vehicles accounted for 53% while pedestrians, motorists, and cyclists takes the remaining 47%(10,11). However, injury prevention among children has received less global attention from government agencies, nongovernmental organizations, and donor partners compared to other public health issues(12). Children share a high proportion of road traffic fatalities in the country and are disproportionately harmed compared to adults(13,14). Children have unique developmental characteristics which expose them to RTI (2,9), due to their body size and the disproportionate body-to-head size makes them susceptible to injuries. They are not often visible or seen by on-coming vehicles(17). Most children and young people afflicted by injuries come from poor family backgrounds(3,18), and RTIs in these age groups have far-reaching consequences(19).

A low-middle-income country like Ghana has recognized the burden of road traffic injuries among children but after decades of the recognition, the problem persists, and as a result road traffic morbidity and mortality are still high(20). To holistically tackle this burden, appropriate targeted interventions and strategies are needed to describe the changing trends of child road traffic injuries over time. These types of studies when carried out will not only provide the impetus needed for policymakers to act but will also provide the needed evidence for injury prevention measures that affect children. Child RTIs are not the same in terms of gender, age, geographical location, socio-economic status, and exposure (living in a densely trafficked zone).

The United Nations Decade of Action for road safety 2011-2020 was formed by the UN to open the conversation and actions on keeping our children safe on the roads. The world health organization announced a second Decade of Action to achieve their target of reducing RTCs by the year 2030(4). However, in Ghana, the decade of action is yet to yield any results(21). The Ghana National road safety commission (NRSC) together with the Ministry of Transport put up an ambitious road safety target to reduce fatalities by 50% from 2011-2020(10) but a pediatric road traffic injury study, one of the few studies ever conducted in Ghana in 2011 in urban Ghana found 43 RTI/1000 person-years in 5-14 year age group with child pedestrians affected the most(20). Road traffic injury prevention measures are yielding good results in high-income countries like US and Europe(6). However, the government of Ghana has placed much emphasis and priority on childhood diseases such as malaria, pneumonia, diarrhea, HIV/AIDS, neonatal disorders, and other health burdens to the neglect of this increasing problem of RTI's(20).

The burden of road traffic injuries in Ghana is alarming and often neglected by child health advocates and public health practitioners(13,22). Injury prevention among children has received less global attention from government agencies, nongovernmental organizations, and donor partners compared to other public health issues(12). Despite the substantial burden, descriptive reports and temporal trends for road injuries and deaths among children have been a neglected research area. To the best of our knowledge, there have not been nationally representative studies on road traffic injuries among children. We aim to fill this gap by describing the rates of injuries, deaths, and temporal trends and characteristics associated with child road injuries in Ghana.

Ghana's Building and Roads Research Institute (BRRI) together with the police is among the few LMICs collecting data on RTCs, RTIs, and Road Traffic Fatalities (RTFs) using a standardized definition which places it in a good position in leading efforts on data-informed road safety decision-making in LMICs. Since 2005, the National Road Safety Authority (NRSA) and its affiliate BRRI have collected data with detailed information on the location, conditions, and outcomes for each RTC, RTI, and RTF in the country. With the use of this data, there is potential to identify high-risk areas, RTI, and RTF to define high-risk factors and identify targets for intervention. The government of Ghana is committed to improving road safety and has collaborated with the BRRI and its partners alike in their quest to improve road safety. Ghana can position itself in the African sub-continent as a leader in the efforts to improve road safety issues and an example for other LMICs to follow.

The overall objective of this study is to report on the human, vehicle, and environmental level factors and temporal trends that cause road traffic injuries and deaths among children in Ghana to inform policymakers and, stakeholders who can take action to decrease the morbidity and mortality of RTIs in children nationally. Thus, morbidity and mortality among children and their drivers may differ across the human, vehicle, and environmental levels, and factors contributing to injuries and deaths may also vary between locations.

STUDY OBJECTIVES AND SPECIFIC AIMS

To inform policy and practice that may reduce road traffic injuries and deaths among children in Ghana.

Aim 1: To describe injuries, and deaths in Ghana among children overall and compare factors between key age categories. We will report the rates of injuries and deaths for children in key age categories of interest in global health, we will report descriptive factors on the human, vehicle, and environmental level for each age category. We will run a chi-square test to determine if these variables significantly differ by age category, sex/gender, and vehicle type. This will inform age-specific interventions for reducing deaths and injuries on our roads. Detailed information on each variable is presented in Appendix - Table A

- Children from 0 years of age under and equal to 59 months (0-4 years)
- Children from 5 years and under or equal to 9 years (5-9 years)
- Children from 10 and under or equal to 14 years (10-14 years)

Aim 2: To assess temporal trends in injuries and deaths among children from 2005 to 2020 nationally in Ghana. We will assess trends overtime (2005-202) for injuries, and deaths among this group of road users using national population census data among ages (0-4), (5-9), and (10-14), and this will inform age and road user-specific interventions.

Research Questions

We seek to answer the following questions.

1. What is the rate of child road traffic injury, and deaths in Ghana overall, and do they differ by key age categories?
2. Which factors (Human vehicle and environment) are associated with child road traffic injuries and deaths, and do they vary by age category?
3. What is the temporal graphical presentation of child road traffic injury and deaths in Ghana overall and among key age categories?

METHODS

Participants and Settings

In this study, we employ Ghana's Building and Roads Research Institute (BRRI) database which includes detailed information on each police reported Road Traffic Crashes (RTC), Road Traffic Injury (RTI), and Road Traffic Fatality (RTF) from 2005 to 2020 in Ghana as of 2022. The dataset included more than 150,000 crashes with detailed information on the human factors and vehicle factors conditions outcome. The data analyzed included children's gender, road condition, casualty type, and child pedestrian and occupant of a vehicle as injury or deaths for each pedestrian, and passenger involved in an RTC.

Use of these data for this study was approved by the Building and Roads Research Institute. The University of Washington IRB determined that use of these data for this study did not constitute human subject's research. The data were anonymous and did not contain any names or other identifying information.

Variable outcomes

Dependent Variables:

For each detailed case of RTC, we extracted a variable on the human, vehicle, and environment levels as described below in Appendix Table 1. We finally looked at vehicle crash outcomes (i.e., injury, and death). Crashes were stratified as either injury or death.

Independent Variables:

Age category: Our work is centered on these key age categories, first we used age category 0-4, (0-59 months old) as UNICEF uses this key age category for all childhood survival, and mortality reports, among children under 5(23), again, we also used age category (5-9), and (10-14), as these are the age categories used by the Demographic and Health Survey (DHS), and Ghana Population and Housing Census(24,25).

Data Collection:

Ghana's Building and Roads Research Institute (BRRI) together with the police is among the few LMICs collecting data on RTCs, RTIs, and RTFs using standardized definitions which places it in a good position in leading efforts on data-informed road safety decision-making in LMICs. Since 2005, the National Road Safety Authority (NRSA) and its affiliate the Building and Road Research Institute (BRRI) have collected data with detailed information on the location, conditions, and outcomes for each RTC, RTI, and RTF in the country. The population data for each age category was obtained from the Ghana Population and Housing Census, the Ghana Statistical Service, and the Demographic and Health Survey (DHS).

Missing Data

We analyzed the missing data, data 127 were excluded from the analysis, vehicle type (n= 111), and sex (n=16), and we concluded that the proportion of missing variables was less than 1%, which indicates no further action on any variable. We decided to remove all the missing data from the dataset for consistency in our analysis across all the variables.

DATA ANALYSIS

Statistical analysis was performed with R-studio, Crashes were stratified as either injury or death. A descriptive analysis of categorical variables was conducted for characteristics such as sex, vehicle type, road condition, and casualty type. To analyze injuries and mortality rates we use logistic regression. We analyze the data to evaluate child road traffic injuries and deaths from 2005 – 2020 in Ghana among children from 0-14 years. Pearson's Chi-square test was used for the variables to understand the factors which influence injuries and mortalities in Ghana. The chi-square test of p-value < 0.05 is regarded as statistically significant. We then presented the results in a table and figures. Age-specific data was obtained from the Ghana Population and Housing Census and the Ghana Statistical Service age 0-14 years from 2005-2020. We calculated the rate and standardized it per 100, 000 population. We looked at trends of deaths for pedestrians, cyclists, and occupants of all other types of vehicles. We also looked at pedestrians vs. motorcyclists, bicyclists, and occupants of all other vehicle types.

RESULTS

Vehicle type Characteristics

The predominant vehicles were Cars (n= 7011, 38.24%), minibus (n=4,422, 24.12%), bus (n= 2491, 13.59%). Motorcycles were the fourth dominant vehicle involving 1,454 children (7.93%). Others include HGV (7.07%), pick-up (5.31%), and bicycle (2.28%) seen in **Table 1**. The vehicle crashes impacted the various age groups with the 10–14-year age group accounting for 42.16%, followed by ages 5-9 years and 0-4 years representing 36.6% and 35.5% respectively.

Table 1. Characteristics of Road Traffic Injuries and Deaths Experienced by Children and Adolescents in Ghana from 2005-2020.

	Total		Age group 0-4		Age group 5-9		Age group 10-14		
Category	N	%	N	%	N	%	N	%	P-value
Vehicle type									
Car	7,011	38.24%	1612	35.59%	2304	35.64%	3095	42.16%	<0.001*
HGV	1,297	7.07%	387	8.54%	452	6.99%	458	6.24%	
Tractor	61	0.33%	17	0.38%	30	0.46%	14	0.19%	
Bus	2,491	13.59%	695	15.35%	910	14.08%	886	12.07%	
Minibus	4,422	24.12%	1177	25.99%	1527	23.62%	1718	23.40%	
Motorcycle	1,454	7.93%	304	6.71%	536	8.29%	614	8.36%	
Pick-up	974	5.31%	239	5.28%	323	5.00%	412	5.61%	
Bicycle	418	2.28%	38	0.84%	284	4.39%	96	1.31%	
Other	57	0.31%	16	0.35%	24	0.37%	17	0.23%	
Tricycle	38	0.21%	9	0.20%	19	0.29%	10	0.14%	
Rickshaw	111	0.61%	35	0.77%	55	0.85%	21	0.29%	
Road condition									
Tar good	13,562	73.55%	3210	70.35%	4862	74.81%	5490	74.43%	<0.001*
Tar few potholes	3,005	16.30%	734	16.09%	1037	15.96%	1234	16.73%	
Tar many potholes	628	3.41%	190	4.16%	179	2.75%	259	3.51%	
Gravel	582	3.16%	178	3.90%	236	3.63%	168	2.28%	
Earth few potholes	503	2.73%	195	4.27%	136	2.09%	172	2.33%	
Earth many potholes	158	0.86%	56	1.23%	49	0.75%	53	0.72%	
Sex									
Male	10,005	54.28%	2669	58.62%	3352	51.57%	3984	53.99%	<0.001*
Female	8,427	45.72%	1884	41.38%	3148	48.43%	3395	46.01%	
Casualty type									
Passenger	6,143	34.04%	2140	47.94%	2318	37.15%	1685	22.95%	<0.001*
Pedestrian	11,903	65.96%	2324	52.06%	3922	62.85%	5657	77.05%	
Injury type									
Injured	14,340	77.73%	3236	70.86%	5367	82.57%	5737	77.73%	<0.001*
Fatal	4,108	22.27%	1331	29.14%	1133	17.43%	1644	22.27%	

Table 2. Reported Counts of Road Traffic Injuries and Deaths Experienced by Children and Adolescents in Ghana from 2005-2020.

This Table represents the total population in each year and the fatal and non-fatal injuries recorded for the various age groups. There is a downward trend in both the number of injuries and fatalities recorded from 2005 to 2020.

	0-4 age group			5-9 age group			10-14 age group		
Year	Total pop	Injured	Fatalities	Total pop	Injured	Fatalities	Total pop	Injured	Fatalities
2005	3199185	234	100	2822554	374	89	2610748	459	111
2006	3288109	227	98	2875140	406	79	2634707	427	124
2007	3383244	202	87	2929367	545	88	2664826	483	132
2008	3482798	298	99	2984518	477	99	2701828	515	131
2009	3585512	292	113	3047701	547	97	2750257	563	155
2010	3690256	282	115	3124883	442	80	2803019	529	137
2011	3797828	217	96	3214320	400	91	2854984	421	133
2012	3905963	226	96	3309999	349	86	2909760	383	103
2013	4015095	155	93	3412994	258	65	2965903	271	79
2014	4124311	190	77	3519769	290	58	3031889	345	90
2015	4218557	153	77	3626969	211	35	3108459	255	87
2016	4285538	125	62	3735688	143	58	3197579	151	65
2017	4333231	152	47	3846648	175	42	3293504	179	66
2018	4368180	176	54	3958486	258	50	3397147	285	73
2019	4390734	135	49	4068800	236	71	3503371	247	75
2020	4412746	172	68	4164750	256	45	3610397	224	83

This table represents the type of vehicle involved in road crashes leading to fatalities and non-fatalities, and the various aged groups involved.

Table 3. Mechanism of Vehicle of Road Traffic Injuries and Deaths Experienced by Children and Adolescents in Ghana from 2005-2020.

	0-4 age group		5-9 age group		10-14 age group		
Vehicle type	Injured	Fatalities	Injured	Fatalities	Injured	Fatalities	Totals
Car	1153	459	1899	405	2414	681	7011
HGV	196	191	308	144	268	190	1297
Tractor	8	9	19	11	8	6	61
Bus	531	164	786	124	703	183	2491
Minibus	864	313	1314	213	1363	355	4422
Motorcycle	260	44	473	63	524	90	1454
Pick-up	133	106	239	84	306	106	974
Bicycle	26	12	230	54	82	14	418
Other	6	10	18	6	13	4	57
Tricycle	3	6	14	5	7	3	38
Rickshaw	27	8	39	16	18	3	111

Road condition characteristics

The highway with good tar road conditions recorded 13,562 collisions (73.5%), followed by a tar few potholes with 3,005 collisions (16.3%). Tar many potholes and gravel earth few potholes represented 3.41% and 3.1% respectively seen in **Table 1.** Concerning age groups, the highest cases are reported in the age group 10-14 years in this category with 42.2% of children affected and a statistically significant p-value of 0.001. The number of fatalities included 1,222 in children aged 10-14 years, followed by age 0-4 years in the database. See **Table 4**

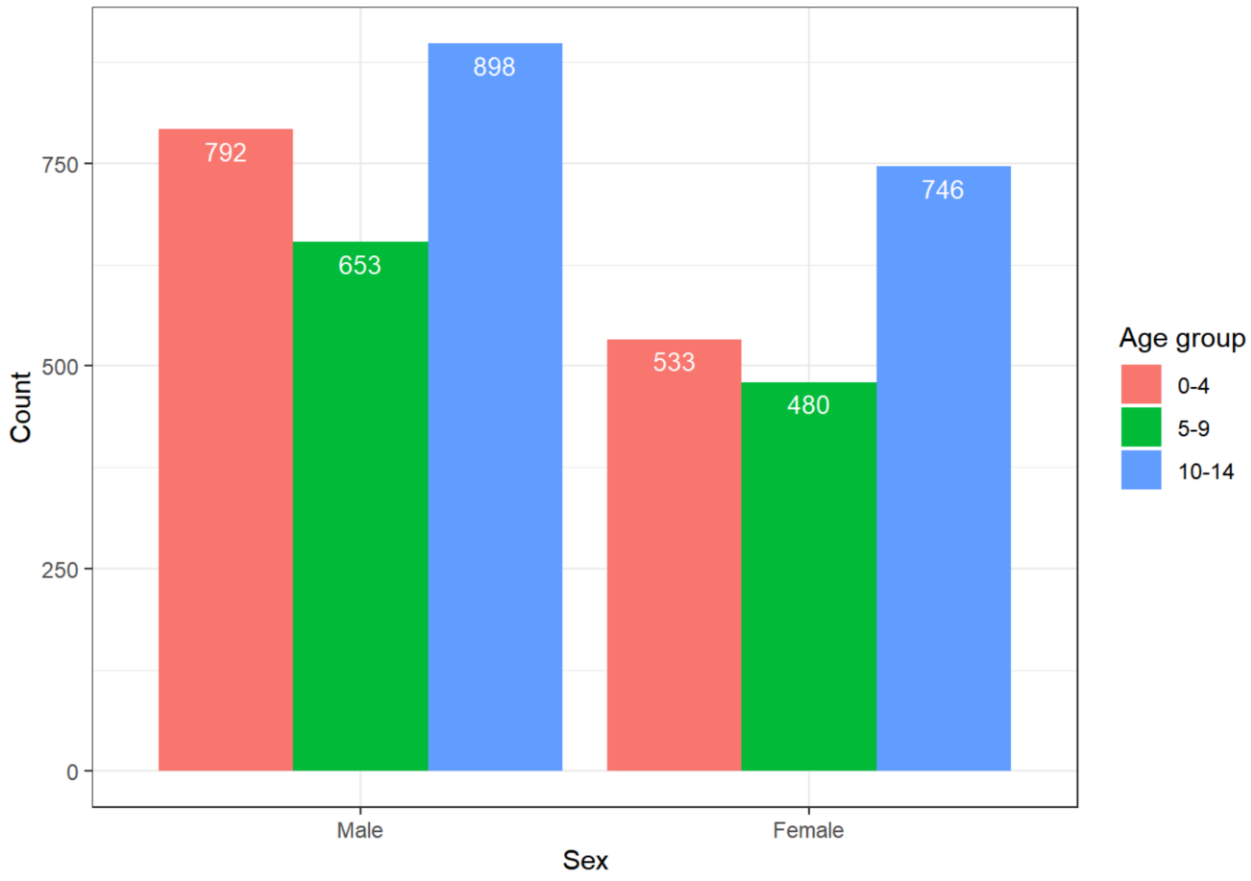
Table 4. Road Condition Type of Road Traffic Injuries and Deaths Experienced by Children and Adolescents in Ghana from 2005-2020.

	0-4 age group		5-9 age group		10-14 age group	
Road type	Injured	Fatalities	Injured	Fatalities	Injured	Fatalities
Tar good	2328	882	4019	843	4268	1222
Tar few potholes	524	210	850	187	975	259
Tar many potholes	136	54	144	35	205	54
Gravel	107	71	199	37	120	48
Earth few potholes	108	87	113	23	129	43
Earth many potholes	32	24	41	8	36	17

Gender Characteristics

There were 18,432 child road traffic injuries and deaths out of which 10,005 were boys (54.2%) and girls representing the remaining 45.7%. When explored further to age groups, in age group 0-4 boys were the dominant group (58.6%), followed by age 10-14 (53.9%). The fatality among ages is shown in **Figure 1** with the 10-14 age group recording 1644 fatalities, age 0-4 followed with 1,325 child deaths in the same period.

Figure 1. Gender Distribution of Road Traffic Deaths Experienced by Children and Adolescents in Ghana from 2005-2020.



Pedestrians and Passenger Characteristics

More than half of all the children involved in fatal and non-fatal collisions were child pedestrians (n=11,903, 65.9%). Children passengers were the second most affected (n= 6143, 34.0%), see **Table 1**. When explored further, the number of fatalities among children pedestrians was 3,220 child fatalities overall. The number of passenger non-fatalities over the period was (n=6143, 34.0%) and 764 passenger fatalities, see **Table 5**. With regards to age groups, most of the crashes were children from 0-4 years (47.9%), followed by 5-9 (37.1%) and 22.9% in children aged 10-14 years, Seen in **Table 1**

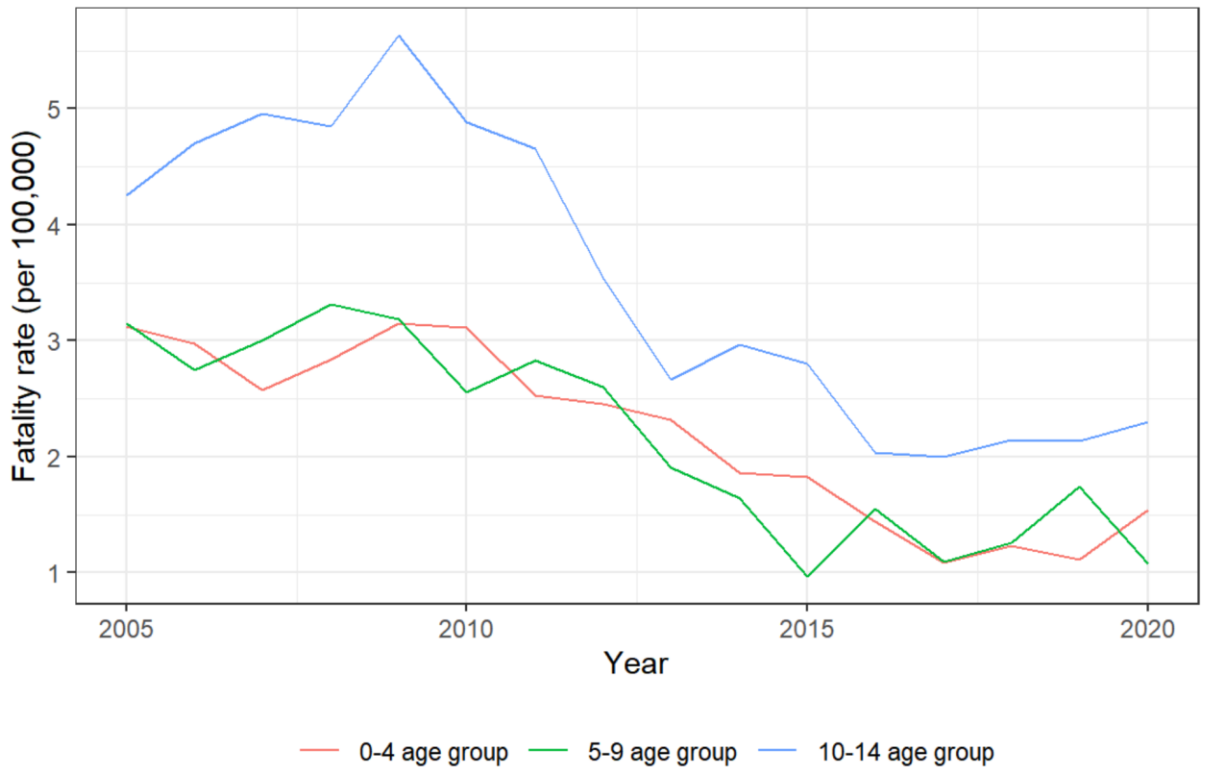
Table 5. Type of Casualty of Road Traffic Injuries and Deaths Experienced by Children and Adolescents in Ghana from 2005-2020.

	0-4 age group		5-9 age group		10-14 age group	
Casualty type	Injured	Fatalities	Injured	Fatalities	Injured	Fatalities
Passenger	1744	396	2124	194	1511	174
Pedestrian	1442	882	3043	879	4198	1459

Annual fatality trends per 100,000 population

The overall average road crash fatality was 3.35 per 100,000 population, children aged 10-14 age group had the highest fatality per 100,000 population overall. The year 2005 up to 2009 was the deadliest road fatality period then it reduced in the subsequent years, the highest fatality year was 2009 with RTC fatality of 5.6 per 100,000 population occurring in 10–14-year group. The age group 0-4 and 5-9 fatality rate was relatively the same and there was no significant difference between these age groups over the last decade and a half period. There was a decline in the fatality rate for all age groups starting from the year 2009. **Seen in Figure 2**.

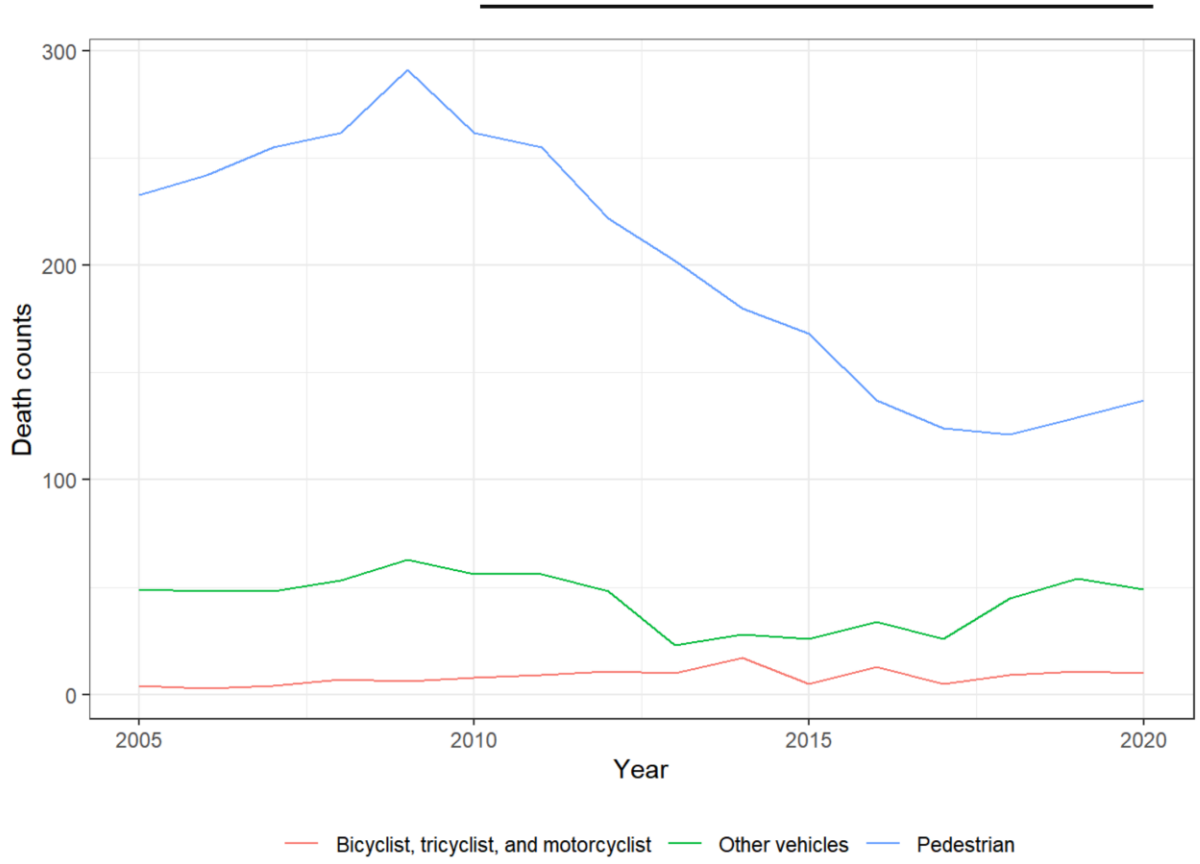
Figure 1. Fatality by Age Group (Per 100,000 Population) of Road Traffic Deaths Experienced by Children and Adolescents in Ghana from 2005-2020.



Pedestrians, Motorcyclists, and Bicyclist Characteristics

Concerning fatalities among child pedestrians, child motorcyclists, and child bicyclists, often referred to as vulnerable road users, there was a significantly higher proportion of fatalities in children pedestrians (n=3061), Tricyclists (motorcyclist, bicyclists, and tricyclists combined) had (n=291) and occupants of all other vehicles put together (n=754) within the period. **As seen in Figure 3**. Additional information on the results regarding national population figures, yearly injury and deaths, fatality rates, and vulnerable and non-vulnerable road user tables are presented in the appendix B, C, and D.

Figure 3. Pedestrian, Motorcyclist, and Bicyclist Trends of Road Traffic Deaths Experienced by Children and Adolescents in Ghana from 2005-2020.



DISCUSSION

The purpose of this study was to describe the RTI injuries and deaths among children from 2005 -2020 while looking at characteristics associated with RTIs in the Country and comparing between age categories. The second aim was to assess the temporal trends of RTC injuries and deaths from 2005-2020 nationally to inform age and road user-specific interventions. Ghana is one of the few SSA that has data on RTCs, the data used in this study can contribute to decision-making on road accident prevention methods, and road safety decisions for children.

In our study, we found that pedestrian RTCs were overwhelmingly the leading cause of injuries and deaths among these vulnerable road users over the last 16 years with the age 10-14 group being the most impacted. These findings are consistent with a study done in South Africa that found three-quarters of those who got injured were pedestrians(16). Another study found that 68% of all crashes were pedestrian crashes(2). In Ghana, pedestrian fatalities constitute 40% of all road traffic deaths(10). A recent study conducted in South Africa also saw 72.5% of all deaths as child pedestrians deaths(26).

In the study, a high proportion of children involved in road traffic injuries and deaths were caused by cars (38.2%) minibus (24.1%, and bus (13.5%) as a mechanism of road traffic injury seen in Table 1. Cars, minibuses, buses, and motorcycles were the major contributing vehicles to child pedestrian and passenger fatalities and non-fatal injuries. Age group 10-14 years was the most impacted age group, these findings are also consistent with a WHO study that indicated that RTIs are the top cause of death among this age group(27). These age groups are said to be active age group and are more likely to engage in risky behaviors(27,28), which further exposed them to the unconducive road environment in developing countries such as Ghana.

Furthermore, we also observed that children in this age group accounted for 74.4% of good tar road incidents indicating that at this age they were likely to be school-age children traveling to and from school. Most of these children often encounter the main busy highways, especially if they use this road to walk to school, the bus stations, or the farms. This paper also corroborated this(29), children at this age are experiencing a developmental process and reduced cognitive abilities and hence had a low sense of good judgment when often on the road. These findings are also in line with a previous study done in Ghana in which 43 RTI /1000 person-years were found in 5-14 year age groups(20).

In terms of gender, males recorded 54.2% of all road traffic crash incidents which was statistically significant. The 10–14-year group was in the lead seen in **Table 1**, this is also consistent with other studies done in the subregion(5). Male children were dominant in all the age groups and had the highest number of fatal and non-fatal crashes recorded, the same is reported in this study(30). The male child is often attributed to being involved in risky taking behaviors(31), according to WHO, boys in low and middle-income settings from poor backgrounds are more likely to play on the streets(31,32) which exposed them to road traffic crashes. Therefore addressing road safety for children is social justice and should form part of global efforts to reduce poverty(1,27).

Fatality by sex, in our study, we had male's children dominated with 5.29 per 100,000 population compared to their female counterparts with 4.27 per 100,000 population. Similarly, this study had male pedestrians also being the highest risk(30). The global trends for RTC fatalities in 2019 according to IHME data had male children 5-14 years age group showing higher mortality compared to females in the same age group(7). These findings also agreed with similar studies in the subregion, South Africa where 65% of RTI's fatalities were boys which is

consistent with various pediatric studies(33). The overall fatality rate of children's road traffic injuries was 5.6 per 100,000 population and 2009 was the highest recorded year.

Figure 3 represents the death counts for child pedestrians, child bicyclists, tricyclists and motorcyclists, and all other types of vehicles. Pedestrians and bicyclists are the most impacted among road users. With the increase in motorization and urbanization in developing countries, the situation is expected to worsen if effective intervention methods fail to be implemented. Most of the RTIs in this study were caused by cars (38.2%), minibuses (24.1%), buses (13.5%), and pick-up (5.3%). According to a World Bank report on global road safety, there were 7,328 registered vehicles per 100,000 population in Ghana in 2016 alone(10). This should be a concern for everyone. The need to implement road safety measures and reduce the deaths on our roads is needed more than ever. In most developed countries, the use of helmets and pediatric car seats, and child restraints has yielded positive results(17), and the citizens in these countries are required by law to use them while traveling. No wonder the rate of RTC fatalities has reduced in those countries(31). Child seat restraints used in Ghana is only 32.2% and law enforcement agencies lacked the willpower to enforce those laws(17,34)

Table 1 reveals 14340 (77.7%) non-fatal crashes and 4,108 (22.2%) fatal crashes in children from 0-14 years. According to the data, most children with non-fatal crashes are in the 10-14 group (66.7%). The fatal crashes also occurred among the same age group 10-14 (66.7%) these findings are not consistent with this paper(16) which had a mean age of 6.3 and more crashes occurring in ages 5-9 years.

In Sub-Saharan Africa Road traffic crashes among children are a major concern, with the increase in urbanization and motorization, the problem is expected to increase(9,35). There is still unreliable data on RTCs and injuries in developing countries like Ghana(4,9). Data on RTCs involving children on fatal and non-fatal is even more scarce, having reliable data on the specific cause of injury will provide specific solutions to policymakers and partners to tackle this creeping problem more holistically.

This study showed overwhelming evidence of pedestrian fatalities and non-fatalities among children in Ghana over the last 16 years, most of these children affected were either crossing the road, having to use the road to and from school, walking along pavements, or standing by the bus stops. In Ghana like most countries in SSA, there are limited traffic resources(36), inadequate pedestrian walkways, and as shown in this study children under the age of 15 cognitive processes are still developing(37), low impulse control which is often exacerbated by socioeconomic conditions and financial constraints(9). These children often sell on the roadside to support their families(2), with the limited sidewalks, and crosswalks, it is more dangerous for these groups of people to use the road. It is estimated that 21% of children aged 5-17 years are involved in child labor in Ghana(38) and about 90,000 children are found on the streets in 2019 dwellings in big cities like Accra, Kumasi, and Tamale(39). According to WHO child stree-tism (the act of children roaming in the streets aimlessly) has been a major contributing factor to child pedestrians 'RTCs and deaths(27,35)

It is obvious and based on our study pedestrian children and young adolescents are not safe from crossing the roads, walking to school, and from school. It is imperative to design good and child-friendly crosswalks with pavements, separating pedestrians and vehicular traffic, provision of pedestrian crossings, in the cities and busy roads, and erection of speed bumps to slow down moving vehicles(40). Studies also revealed that when road-injured victims received prompt and quick emergency services it reduces disability and deaths by half(31,41,42). So, the need to improve the emergency medical services, retooling the National Ambulance Services, the police who are always the first point of contact, and the emergency units of the Tertiary hospitals, by no means prevent avoidable deaths.

It is also clear from our studies that the condition of the road does matter, drivers are more likely to over speed on good highways, so training these drivers on road safety, enforcing road-worthy vehicles, and testing drivers for alcohol will help improve the situation. It is worth noting that road traffic deaths for child pedestrians are going down consistently over the last decade, whereas occupants of other vehicles and child bicyclists, tricyclists, and motorcyclists remain stable for a period, went down in 2013, and peaked again in 2018.

STRENGTHS AND LIMITATIONS

The limitation of this study is that this dataset requires the police to collect data on traffic crashes on a large scale which may put a strain on the police and hence might miss reporting some cases. Furthermore, there was some missing data on vehicle and casualty variables of less than 1% even though this number was insignificant but could have resulted in bias. Also, Ghana's population is ever-increasing as a result the population figures we used will not be the same if we visit the same age groups again. The police report is not sacrosanct and is subjected to bias as the police may be concentrated on urban and accessible settings to neglect rural and remote areas.

Despite these limitations, several strengths overcome these limitations, the BRRI dataset provided an insight into the RTC morbidity and mortality burden in children under the age of 15 years, we also used population estimates figures by the Ghana Statistical Services and Population and Housing Census (2020) which are accurate and reliable. Ghana is one of the few countries in SSA where the police gather such data on road crashes on a large scale, it is important to use this data to understand the characteristics of RTIs among children and adolescents this would inform policy interventions for road safety development.

RECOMMENDATIONS AND POLICY IMPLICATIONS

The study showed male children are dominant in fatal and non-fatal road crashes, this is also observed in other studies, a well-tailored education campaign is needed at this time, targeted towards parents, school children, drivers, and law enforcement agencies which is crucial to reduce children RTI's and deaths, especially children pedestrians.

A significant number of RTCs involving children were caused by cars, minibusses, buses, pick-ups, and tractors, LMICs have the least child restraints use(17) including Ghana with a child restraints use of 13.2%(17). Enactment of the Road traffic act 2004 (act 683) and Road Regulation 2180 in 2013 makes it mandatory to use child restraints by all vehicle occupants, but the enforcement of such law is still a mirage by the Ghana Police Service MTTD department leading to low observance of this law by road users and vehicle occupants as compared to well-advanced countries like the US and Europe(9). There is therefore the need to enforce such laws and punish offenders to serve as deterrence to other road users.

A child health initiative, Amend is a nongovernmental organization with support from the Child Health Initiative Ghana, works to reduce RTIs among children, especially school children, they have worked with local partners and government agencies to improve safe infrastructure around schools area, sidewalks, road bumps(43), etc. Child health is a human rights issue(31) and needs a multifaceted approach thus everyone getting involved including civil society organizations, the media, cooperating institutions, etc. for proactive measures to be put in place, workable legislative laws passed and implemented to prevent and reduce the increasing road morbidity and mortality.

Pedestrian children constitute a large proportion of road traffic injuries and deaths, targeted interventions aimed at improving the road environment, construction of speed bumps, sidewalks, overheard crossings, provision of safe playing and walking space for school children,

use of security personnel to guide school children to and from school, and educational campaigns targeting school children understanding of traffic signs and symbols and how to behave appropriately on the street will help improve the situation.

CONCLUSION

RTAs are a leading cause of injuries and deaths among children globally, especially in low-income countries such as Ghana. The study aimed to describe trends of children under 15 injuries and deaths and compared between age groups from 2005-2020. This study has illustrated a decreasing trend in the number of injuries and deaths in Ghana from 2005-2020. We can assume that the National Road Safety Commission, the Ministry of Transport, and government policies aimed at reducing road crashes and deaths are working positively. This study also indicates that gender, age, location, and type of vehicle all influence the outcome of injury and death among children, and these injuries and deaths are preventable.

Further research is needed to assess the regional distribution of RTIs, among children and adolescents to provide an effective and specific causal factor for policymakers and stakeholders to act to reduce the avoidable deaths on our roads.

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APPENDIX

These appendices show the Haddon's Matrix on Human, vehicle, and Environmental level factors affecting road crash injury, severe injury, and death. Additional information on yearly number of injuries and fatalities, the fatality rates per year, and table showing the vulnerable road users and all other users, plus pedestrian death are presented in table A, B, C, and D

Table A: Factors affecting crash, injury, severe injury, and death frequency among children in Ghana (Building and Roads Research Institute Crash Database)

Haddon's Matrix	Factor	Categories
Environment	Light conditions	Night- no lights; Night- lights off, Night-lights on
	Road description	Straight and flat; curve only; incline only; curve and incline; bridge
	Road surface type	Tar good; Tar few potholes; tar many potholes; gravel; earth, few potholes
	Shoulder type	Tarred; untarred; no shoulder
	Shoulder condition	Good; poor; overgrown; no shoulder
	Road separation	Median; no median
	Surface condition	Dry; wet; muddy
	Surface repair condition	Good; potholes; rough
	Road type	Motorway; highway; urban road; feeder road; other roads
	Type of junction	Traffic circle; T-junction; Y-junction
	Traffic control	None; pedestrian crossing; signals; stop sign; give way; other
	Roadworks	At roadworks; not at road works
Vehicle	Type of vehicle	Car; HGV; tractor; bus; minibus; motorcycle; pick up; bicycle; tricycle; rickshaw
	Maneuver	Right turn; left turn; U-turn; cross traffic; merging; diverging; overtaking; going ahead; reversing; sudden start; sudden stop; parked off road; stopped on road
	Vehicle damage	None; minor; extensive
	Defects	None; brakes, steering; tires; suspension; lights; multiple; other
Human	Sex	Male; female
	License status	Full; provisional; learner; unlicensed
	Drink/drug	Not suspected; suspected; tested and positive; tested and negative
	Driver error	None; inexperienced; inattentive; too fast; too close; no signal; improper overtaking; improper turning; fatigued/asleep; other
	Passenger position	Front seat; rear seat; motorcycle passenger; bus passenger; inside; outside sitting; outside standing
	Passenger action	Boarding; jumping; falling from vehicle; other
	Pedestrian action	No action; crossing road; walking along road; walking along edge; playing on road; on footpath; other

Table: B Reported counts of yearly injuries and fatalities among children in Ghana from 2005-2020

	0-4 age group		5-9 age group		10-14 age group		
Year	Injured	Fatalities	Injured	Fatalities	Injured	Fatalities	Totals
2005	234	100	374	89	459	111	1367
2006	227	98	406	79	427	124	1361
2007	202	87	545	88	483	132	1537
2008	298	99	477	99	515	131	1619
2009	292	113	547	97	563	155	1767
2010	282	115	442	80	529	137	1585
2011	217	96	400	91	421	133	1358
2012	226	96	349	86	383	103	1243
2013	155	93	258	65	271	79	921
2014	190	77	290	58	345	90	1050
2015	153	77	211	35	255	87	818
2016	125	62	143	58	151	65	604
2017	152	47	175	42	179	66	661
2018	176	54	258	50	285	73	896
2019	135	49	236	71	247	75	813
2020	172	68	256	45	224	83	848

Table: C Fatality rates of child road traffic injuries in Ghana from 2005-2020.

	Fatality rate		
Year	0-4 age group	5-9 age group	10-14 age group
2005	3.125796	3.1531726	4.251655
2006	2.980437	2.7476923	4.706406
2007	2.571496	3.0040620	4.953419
2008	2.842542	3.3171185	4.848569
2009	3.151572	3.1827269	5.635837
2010	3.116315	2.5600958	4.887587
2011	2.527761	2.8310809	4.658520
2012	2.457781	2.5981881	3.539811
2013	2.316259	1.9044862	2.663607
2014	1.866979	1.6478354	2.968446
2015	1.825269	0.9649931	2.798815
2016	1.446726	1.5525922	2.032788
2017	1.084641	1.0918597	2.003945
2018	1.236213	1.2631092	2.148862
2019	1.115986	1.7449862	2.140795
2020	1.540991	1.0804970	2.298916

Table: D Vulnerable Road users, Pedestrians and all other types of vehicle reported counts of fatalities among children in Ghana from 2005-2020.

year	Other vehicles	Pedestrian	Bicycles, tricycles, and motorcycles
2005	49	233	4
2006	48	242	3
2007	48	255	4
2008	53	262	7
2009	63	291	6
2010	56	262	8
2011	56	255	9
2012	48	222	11
2013	23	202	10
2014	28	180	17
2015	26	168	5
2016	34	137	13
2017	26	124	5
2018	45	121	9
2019	54	129	11
2020	49	137	10