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Injuries Associated with Auto-Tricycle Crashes in an African City: Incidence and Pattern

Augustus Nii Kwame Okleme[1], David Anyitey-Kokor[1], Dominic Konadu-Yeboah[1,2*], Adam Gyedu[3], Kwabena Agbedinu[3], Johathan Boakye[4]

[1]Department of Orthopaedics and Trauma, Komfo Anokye Teaching Hospital, Kumasi, Ghana
[2]School of Medical Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[3]Department of Surgery, Komfo Anokye Teaching Hospital, Kumasi, Ghana
[4]Department of Emergency Medicine, Komfo Anokye Teaching Hospital, Kumasi, Ghana
Email: *domiyk@yahoo.com

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Abstract

Purpose: The aim of this study was to determine the incidence and pattern of injuries resulting from auto-tricycle crashes among patients in a tertiary referral centre in Ghana. **Methods:** Data were retrospectively extracted from hospital records of patients who got involved in auto-tricycle crashes and presented to the Accident and Emergency Centre of the Komfo Anokye Teaching Hospital (KATH), over a one-year period using a structured questionnaire. The gathered data were then entered into an electronic database and then analysed with SPSS version 20.0. **Results:** The incidence of injury following auto-tricycle crashes over the one-year period was 5.9% (95% CI: 4.9% - 7.0%) with a case fatality rate (FR) of 3.8% (95% CI: 1.3% - 8.7%). All the mortalities resulted from head and neck injuries and none of the patients involved wore a crash helmet. Only 5% of those studied wore crash helmets and were all drivers. Closed fractures accounted for 58% of the injuries, followed by open fractures, 28%. The most commonly fractured bones were the tibia/fibula, followed by the femur and then radius/ulna. The most common mechanism of injury was auto-tricycle toppling over (29%). Passengers were the most injured (48%), followed by drivers (37%) and pedestrians (15%). Most (72%) injuries among participants involved a single body part. On the injury severity scale, most (61%) of patients had minor trauma and 38% had major trauma. **Conclusion:** Auto-tricycle crashes account for 5.9% of injuries at the study site with a case fatality rate of 3.8%. Passengers had a higher injury rate (48%) than drivers (37%). Fractures of the tibia/fibula were most commonly associated with auto-tricycle crashes. Injuries to the head and neck were

responsible for the deaths in the study participants and non-use of a crash helmet was associated with mortalities.

Keywords

Auto-Tricycle, Knock-Down, Rickshaw, Road Traffic Crashes

1. Introduction

Road traffic crashes (RTC) are a major cause of morbidity and mortality globally. Deaths and disabilities due to RTC in Low- and Middle-income Countries constitute a major public health burden. The world health organization (WHO), reports that approximately 1.35 million people die each year as a result of road traffic crashes [1]. Between 20 and 50 million more people suffer non-fatal injuries, with many, sustaining a disability as a result of road traffic crashes [1]. On the average, 2000 Ghanaians reportedly die annually from road traffic crashes [2]. From January to October 2020, there were 12,096 RTCs in Ghana, resulting in 12,380 injuries and 2080 deaths [3].

Much has been reported concerning buses and other four-wheeled vehicular involvement in these crashes [3]. There have been studies outlining the involvement of two-wheeled motorcycles in RTCs in Ghana [4]. However, little has been published concerning auto-tricycles and their contribution to road-traffic related deaths and disabilities in Ghana; an auto-tricycle, is a three-wheeled vehicle. There are two types that are currently used in Ghana—one designed with a bucket to transport cargo (called "aboboyaa" in Ghana) and the other fitted with seats for 2 or 3 passengers (referred to as "pragia" in Ghana). They are a widely-used means of transport in the developing world, partly due to their ability to reach inaccessible city parts through narrow and poorly paved roads [5]. However, auto-tricycles have been reported to have limited crashworthiness and lack safety devices such as seatbelts or air bags. Auto-tricycles have higher crash rates since the majority of their drivers do not have proper training, have no license and do not follow safety measures [6] [7] [8]. Thus, in the event of a crash, occupants are at risk of severe injuries. In spite of these negativities, they are a significant source of employment for young adults [8]. The National Crime Records Bureau of India reported that auto tricycles were responsible for about 5900 deaths from RTC, making up 5.6% of all deaths in India in 2006 [9]. Crashes involving auto tricycles have been reported to result in major injuries such as avulsion injuries, closed fractures of different complexity, open fractures, crush injury, mangled extremity, head injury and cervical spine injury among others [8].

Despite its public health importance, there is paucity of published literature on the contribution of auto-tricycles to the road traffic-injury burden in Ghana. It was considered necessary, therefore, to conduct a study to determine the incidence and pattern of injuries from auto-tricycle crashes among trauma patients in Ghana.

2. Methods

2.1. Setting

This study was conducted at the Accident and Emergency (A&E) centre of the Komfo Anokye Teaching Hospital (KATH), which is the second-largest tertiary hospital in Ghana with a bed capacity of 1200. The hospital is situated in Kumasi, the capital city of the Ashanti Region of Ghana. The region is home to 6 million people. Due to its central location in the country, KATH receives referrals from 14 of the 16 regions of Ghana and provides trauma care for approximately 14,000 patients per year. The accident and emergency centre of KATH offers 24 hour-emergency services. It is equipped to offer basic and advanced life support for critically ill patients. KATH uses an electronic medical record system that captures and stores patients' medical information.

2.2. Study Design

A retrospective case review.

2.2.1. Data Gathering

The hospital records of patients who got injured following auto-tricycle crashes and presented to the accident and emergency centre of the Komfo Anokye Teaching Hospital, from 1st August 2020 to 31st July 2021 were extracted and reviewed. The key words for data extraction included: "road traffic accident", "RTA", "crash" and "knock down". From this group another search was done to filter out all the injuries which were the result of auto-tricycle crashes. The search used the key words: "auto tricycle", "Pragia", "auto rickshaw" and "Aboboyaa".

A structured questionnaire (Appendix A) was designed and tested in the same facility. It was then used to record extracted information from the electronic medical record system. The data collected involved patient demographics, injury mechanism and the nature of the crash-head-on, head-to-side or side-to-side, or whether or not there was auto tricycle topple over or pedestrian knock down.

The types of injuries sustained were recorded and broadly categorized into soft tissue or bony injury. Data on soft tissue injury were recorded under the headings: head, neck, chest, abdomen, back/spine, upper limb, lower limb and pelvis. These included laceration/abrasion, avulsion/degloving injury and other specific injuries such as cerebral contusion, diffuse axonal injury and intracranial bleeding for the head injured, haemothorax/pneumothorax and tension pneumothorax for patients with chest injury, bladder/urethral injury for the pelvic injured patient as well as mangled extremity or traumatic amputation for patients with injuries to the upper or lower limbs. Information on injuries to bones and joints were collected under broad headings: skull, cervical spine, clavicle, humerus, elbow joint, ulna, radius, wrist, pelvis, femur and knee. Bone and/or joint injuries were captured as closed or open fractures, articular fractures or dislocations. This information was used to determine the injury severity score of

each patient. The interventions administered were recorded as conservative management, minor surgery or major surgery. Outcomes of treatment, time to discharge and time to death were recorded as well. Occupants of other vehicles colliding with an auto-tricycle were excluded.

2.2.2. Ethical Approval

Ethical approval for this study was obtained from the institutional review board of the Komfo Anokye Teaching Hospital, Kumasi (Approval number: KATH IRB/AP/126/21).

2.2.3. Data Analysis

Data were analyzed using the statistical package for the social sciences (SPSS) version 20 (SPSS Inc., Chicago, Illinois). Frequencies and percentages were used for categorical data; median with interquartile range was used for skewed continuous variables. Chi-square test of association and rank-sum test were used to compare categorical and continuous variables respectively. Odds ratios were used in bivariate analysis to compare risk of injuries. A p-value of less than 0.05 was considered statistically significant.

3. Results

A total of 130 out of 2208 trauma patients recorded over the period, met inclusion criteria giving an annual incidence rate (IR) of 5.9% (95% CI: 4.9% - 7.0%) of auto-tricycle-related injuries. Of the study participants, most (99%) were males with a mean age of 30.5 (range: 6 - 73) years. The age of peak incidence was 18 - 39 years (66%). Almost half (48%) of all the injuries occurred among passengers of auto-tricycles; the drivers were the second largest group injured (36%), with 14% of injuries occurring among pedestrians. Passengers were injured more commonly in passenger auto-tricycle crashes with 34 incidents making 60% of injuries in that group. Among the passengers of cargo auto-tricycle (aboboyaa), 29 (40%) sustained injuries, this difference was statistically significant, ($p = 0.013$). More drivers of cargo auto-tricycle, sustained injuries, 35 (48%), as compared to the drivers of passenger auto-tricycle (pragia) 13 (23%). This difference was statistically significant ($p = 0.013$). Most injuries 73 (56%), were associated with cargo auto-tricycle crashes and 57 cases (44%) with passenger auto-tricycle; this difference was not statistically significant ($p = 0.11$). The majority of the crashes involved auto-tricycles alone (42%), followed by crashes of an auto-tricycle with other vehicle types, (20%). The most common mechanism of injury (29%) was 'auto-tricycle toppling over', head-on collisions with other vehicles accounted for another 20%. Auto-tricycle-related pedestrian injuries accounted for 19% of injuries. Most (74%) of injuries resulted from auto-tricycle toppling over, followed by head-on collision with other vehicles (62%). Auto-tricycle toppling over was more common with cargo auto-tricycle, 28 (36%), than with passenger auto-tricycle, 10 (18%) This difference was, however, not statistically significant ($p = 0.11$).

Pedestrian injury was more associated with passenger auto-tricycle (56% of pedestrian knock-down and 60% of pedestrian run over) than with cargo auto-tricycle crash. In total, 123 patients, representing 95% of all participants had no crash helmet on at the time of the crash. None of the passengers had crash helmet on, all the 7 participants (5%) who wore helmets were drivers of auto-tricycle; 6 of the 7 drivers who wore helmets (85%) were in cargo auto-tricycles, with only one passenger auto-tricycle driver using a crash helmet. There was no statistically significant difference as far as helmet use was concerned ($p = 0.10$). Injury characteristics of study participants have been summarized in Table 1.

Table 1. Distribution of participants by gender, age, occupation, mechanism of injury, injury type, GCS and ISS.

Factor	Overall	Auto-Tricycle Type		P-value
		Cargo auto tricycle, n (%)	Passenger auto tricycle, n (%)	
Gender				0.060
Female	31 (23.85)	13 (17.81)	18 (31.58)	
Male	99 (76.15)	60 (82.19)	39 (68.42)	
Age in years, median (IQR)	30 (20 - 37)	28 (21 - 33)	33 (20 - 43)	
Range (min, max)	6 - 73	7 - 53	6-73	0.135**
Age group				0.002*
Less than 18 years	15 (11.54)	5 (6.85)	10 (17.54)	
18 - 39 years	86 (66.15)	58 (79.45)	28 (49.12)	
40 - 59 years	26 (20.00)	10 (13.70)	16 (28.07)	
60 years above	3 (2.31)	0 (0.00)	3 (5.26)	
Occupational status				0.06*
Artisan	10 (7.69)	7 (9.59)	3 (5.26)	
Auto tricycle driver/rider	37 (28.46)	28 (38.36)	9 (15.79)	
Civil servant	4 (3.08)	0 (0.00)	4 (7.02)	
Farmer	11 (8.46)	4 (5.48)	7 (12.28)	
Student	13 (10.00)	5 (6.85)	8 (14.04)	
Trader	23 (17.69)	9 (12.33)	14 (24.56)	
Unemployed	32 (24.62)	20 (27.40)	12 (21.05)	
Mechanism of injury				0.110
Auto-tricycle head-to another vehicle	3 (2.31)	2 (2.74)	1 (1.75)	
Auto-tricycle toppling over	38 (29.23)	28 (38.36)	10 (17.54)	
Head-on collision with another vehicle	26 (20.00)	16 (21.92)	10 (17.54)	

Continued

Other vehicle head-to auto-tricycle	25 (19.23)	12 (16.44)	13 (22.81)	
Pedestrian falling out of auto-tricycle	10 (7.69)	4 (5.48)	6 (10.53)	
Pedestrian knocked down	16 (12.31)	7 (9.59)	9 (15.79)	
Pedestrian ran over	10 (7.69)	4 (5.48)	6 (10.53)	
Side-to-side collision with another vehicle	2 (1.54)	0 (0.00)	2 (3.51)	
Injury Host				0.013*
Driver	48 (36.92)	35 (47.95)	13 (22.81)	
Passenger	63 (48.46)	29 (39.73)	34 (59.65)	
Pedestrian	19 (14.62	9 (12.33)	10 (17.54)	
Type of injury				
Head & Neck injury, n = 36				
Cerebral contusion	12 (33.33)	7 (35.00)	5 (31.25)	0.339*
Diffuse axonal injury	1 (2.78)	0 (0.00)	1 (6.25)	
Intra cranial bleeds	1 (2.78)	1 (5.00)	0 (0.00)	
Laceration/abrasion	19 (52.78)	9 (45.00)	10 (62.50)	
Presence of paralysis	3 (8.33)	3 (15.00)	0 (0.00)	
Soft tissue injury, n = 56				
Avulsion/degloving injury	5 (8.93)	3 (9.68)	2 (8.00)	0.188*
Laceration/abrasion	47 (83.93)	24 (77.42)	23 (92.00)	
Traumatic amputation	4 (7.14)	4 (12.90)	0 (0.00)	
Bone tissue, n = 99				
Closed fracture	70 (70.71)	40 (71.43)	30 (69.77)	0.857
Open fracture	29 (29.29)	16 (28.57)	13 (30.23)	
GCS Score				
4 - 7	1 (0.77)	0 (0.00)	1 (1.75)	0.211*
8 - 10	4 (3.08)	1 (1.37)	3 (5.26)	
11 - 15	125 (96.15)	72 (98.63)	53 (92.98)	
Use of helmet by victim				
Helmeted	7 (5.38)	6 (8.22)	1 (1.75)	0.105
Unhelmeted	123 (94.62)	67 (91.78)	56 (98.25)	
Severity				
Major trauma	50 (38.46)	30 (41.10)	20 (35.46)	0.485
Minor Trauma	80 (61.54)	43 (58.90)	37 (64.91)	

***Ranksum test. *Fisher's exact test. IQR: Interquartile range.*

The lower extremities were the most commonly injured body part, accounting

for 38% of all injuries, followed by the upper extremities, (12%). Head injury accounted for 9% of all injuries. Chest injury was recorded among 7% of participants. The abdomen was the least injured body part with 2% of cases. Single body part injuries were observed in 72% of cases, with 28% sustaining multiple injuries; 27% of occupants sustained multiple injuries. Among pedestrians, 31% of patients sustained multiple injuries. The most common soft tissue injury was a laceration/abrasion accounting for 84% of soft tissue injuries. The most common bony injury sustained was closed fractures, which accounted for 71% of bony injuries, open fractures, occurring in 28% of patients. The bones that were most commonly fractured were the tibia/fibula, the femur, and the radius/ulna, in that order. Most of the tibia/fibula fractures were open, whilst the fractures of the femur and radius were mostly closed. The most common soft tissue injury in the lower limb was a laceration or abrasion, occurring in 32% of patients. Four patients sustained traumatic amputations and three of these were involved the upper limb.

Of the patients who sustained chest injuries, 11 had contusions (8%), and 4 patients had haemothorax and/or pneumothorax, representing 3%. Lower limb injuries were the most predominant among pedestrians, making up 37%; 68% of pedestrians sustained multiple injuries; 63% of all pedestrian injuries were closed fractures. Open fractures occurred in 21% of pedestrians. There were no statistically significant differences in the type of injury sustained among the two groups-passengers and pedestrians ($p = 0.84$). The majority of patients, 125 (96%), had Glasgow coma scores between 11 - 15. Three patients had a GCS of between 8 and 10 and one patient had a GCS of between 4 and 7. There was no statistically significant difference in the GCS of patients in the two groups ($p = 0.22$). Based on their injury severity scores (ISS), 61% of the patients had minor trauma and 38% had major trauma. Most patients, 48%, had an ISS score of below 9 (mild injury). Using their ISS scores, 63% of pedestrians suffered mild injury with the remaining 36% recording moderate injuries. There was no statistically significant difference in the injury severity scores of patients in the two groups studied ($p = 0.58$).

The majority of patients constituting 40%, required no surgical intervention, and were managed conservatively with plaster casts and splints. Minor surgery was required in 24% of cases with 6% of patients requiring major surgery. Overall, 30% of patients refused treatment and 32% requested discharge against medical advice. Fifteen percent of patients were discharged home on the same day and 72%, were discharged between 2 and 7 days of admission; 1.5% of patients were admitted for at least one month; 5 patients died giving a case fatality rate of 3.8%. Of those who died, 60% died within the first 3 days of admission, the rest died on the same day of admission. The leading cause of death was spinal cord injury, accounting for 60% of deaths, followed by intracranial injury, making up 40%. All the mortalities recorded were among passengers of cargo auto-tricycle; 80% of fatal crashes resulted from auto-tricycle toppling over. None of the patients who died had a crash helmet on. Of the injuries associated with cargo auto-tricycle crash, 32% were severe (ISS 16 - 24) and 10% were profound ($ISS \geq 25$). Of the injuries associated with passenger auto-tricycle crash, 32% were severe and 4%

Figure 1. Passenger auto-tricycle, "pragia".

Figure 2. Cargo auto-tricycle, "aboboyaa".

were profound. There was no statistically significant difference in the severity of injuries sustained by the two groups as determined by the ISS scores ($p = 0.48$). Figure 1 shows a passenger auto-tricycle (pragia) with seats for carrying passengers and Figure 2 depicts a cargo auto-tricycle (aboboyaa) with a bucket for cargo.

Analysis of injury characteristics among cargo auto-tricycle and passenger auto-tricycle users

The injury characteristics of cargo auto-tricycle and passenger auto-tricycle passengers were explored in bivariate analysis. It was found that there was a high risk of injury for males (OR: 2.13, 95% CI: 0.94 - 4.83), in the age groups of 18 - 39 years (OR: 4.14, 95% CI: 1.29 - 13.27), and 40 - 59 years (OR: 1.25, 95% CI: 0.33 - 4.74) in cargo auto-tricycle compared to passenger auto-tricycle users. There was a four-fold risk of usage of cargo auto-tricycle by the 18 - 39 age group passengers and this was statistically significant. For mechanism of injury, cargo auto-tricycle passengers had a higher risk of experiencing auto-tricycle toppling over (OR: 1.40, 95% CI: 0.11 - 17.17) than auto-tricycle head-on collision than passenger auto-tricycle passengers. However, the other mechanisms of injury had lower risks compared to auto-tricycle head-to-head collision with another vehicle and were not statistically significant. Riders of cargo auto-tricycle compared to passengers had a three-fold higher risk of injury than those in passenger auto-tricycle, this difference was not significant. Riders of cargo auto-tricycle had a three-fold higher risk of injury than those of passenger

auto-tricycle, this difference was not significant. Passengers with head and neck (OR: 0.97, 95% CI: 0.45 - 2.10), and soft tissue injuries (OR: 0.94, 95% CI: 0.47 - 1.90) had a lower risk of injury for cargo auto-tricycle passengers compared to those of passenger auto-tricycle. However, there was a 7% higher risk of bone injury for cargo auto-tricycle than passenger auto-tricycle users. Participant and injury characteristics have been summarized in Table 2.

Table 2. Bivariate analysis of injury characteristics among cargo auto-tricycle and passenger auto-tricycle users.

Factor	OR	95% CI	p value
Gender (female: ref)			
Male	2.13	0.94 - 4.83	0.070
Age group (less than 18 years: ref)			
18 - 39 years	4.14	1.29 - 13.27	**0.017**
40 - 59 years	1.25	0.33 - 4.74	0.743
60 years above	-	-	-
Mechanism of injury (auto-tricycle head-to another vehicle: ref)			
Auto-tricycle toppling over	1.40	0.11 - 17.17	0.792
Head-on collision with another vehicle	0.80	0.06 - 10.01	0.863
Other vehicle head-to auto-tricycle	0.46	0.04 - 5.77	0.548
Pedestrian falling out of auto-tricycle	0.33	0.02 - 5.03	0.427
Pedestrian knocked down	0.39	0.03 - 5.21	0.476
Pedestrian ran over	0.33	0.02 - 5.03	0.427
Side-to-side collision with another vehicle	-	-	-
Injury host (passenger: ref)			
Driver	3.17	1.41 - 7.07	**0.005**
Pedestrian	1.06	0.38 - 2.95	0.918
Type of injury			
Head & Neck injury (No: ref)			
Yes	0.97	0.45 - 210	0.932
Soft tissue injury (No: ref)			
Yes	0.94	0.47 - 1.90	0.873
Fractures (No: ref)			
Yes	1.07	0.48 - 2.41	0.866
GCS Score (8 - 10: ref)			
4 - 7	-	-	-
11 - 15	4.08	0.41 - 40.28	0.229
Use of helmet by victim (unhelmeted: ref)			
Helmeted	5.01	0.59 - 42.90	0.141
Severity injury (minor trauma: ref)			
Major trauma	1.29	0.63 - 2.64	0.485

OR: Odds ratio. CI: Confidence interval. Ref: Reference point.

4. Discussion

In our study, we observed an annual incidence rate of auto-tricycle-related injuries of 5.9%. This was lower than the rate of 11% reported in Egypt in 2020 by Hegazi *et al.* [10]. This may be due to the greater dependence of that population on three wheeled vehicular transport than the Ghanaian population [5]. In Ghana 4-wheeled vehicular transport is the most common means of transport. As reported in several studies, including those by Omoke *et al*, Hegazi *et al* and Schmucker *et al.*, males are disproportionately affected by auto tricycle crashes [8] [9] [10]. In our study, the mean age of those injured was 30 years. Similar to the report of Schmucker *et al* in Hyderabad, India, where the mean age was 34years [9]. The peak age of incidence in this study was 18 - 39 years, this finding is similar to that reported by Omoke *et al* [8].

The most common mechanism of injury was auto tricycle toppling over, 29%. In Hyderabad India, Schmucker and colleagues, found that a third of all injuries resulted from the toppling over of auto-tricycle [9]. We also found in this study, that toppling over occurred more frequently with cargo auto-tricycle, 74% compared to 26% with the passenger auto-tricycle. Cargo auto-tricycle is more commonly used to transport farm produce along foot paths which are grossly uneven. Gawade *et al* reported that the design of the auto tricycle is believed to affect its stability [11]. In our study, occupants of auto-tricycles were injured 85% of the time, (passengers 48%, the riders of the auto-tricycle, 37%) pedestrians were injured 15% of the time. Schmucker and Dandona reported from a study in India that although occupants were the most injured in auto-tricycle crashes (66%), a larger proportion of pedestrians were injured as well (34%) [9]. This might be because, in their study, they considered only auto-tricycles which carried passengers and therefore plied roads that had many pedestrians. The cargo auto-tricycle, which we considered in addition to the passenger auto-tricycle in our study, may be used in areas where there are fewer pedestrians, to carry cargo, this may have resulted in fewer cargo auto-tricycle-related pedestrian injuries observed in our study.

It is worthy of note however, that in our study, the majority of pedestrian injuries were the result of passenger auto-tricycle crashes 53%, with cargo auto-tricycle crashes being responsible for 47% of them.

Most riders who sustained injuries rode cargo auto-tricycle, 73%, as compared to the 27% of injured riders who used passenger auto-tricycle. This may be due to differences in vehicular stability. Also, the cargo auto-tricycle may be more commonly used on untarred roads, for the transport of cargo, this may further challenge the vehicle's stability and result in crashes [11]. Among the passengers injured, 54% boarded passenger auto-tricycle, with 46% being passengers on cargo auto-tricycle. This may be explained by the fact that passenger auto-tricycle is designed with seats to transport mainly passengers, while cargo auto-tricycle has a bucket for carrying cargo, but many use them to carry passengers as well. Multiple injuries were reported in 27% of occupants and 31% of

pedestrians. This is different from what was reported by Schmucker and colleagues. They reported a higher incidence of multiple injuries among occupants, 63%, while 59% of pedestrians were reported to have multiple injuries [9]. The lower limbs were the most commonly injured body parts, accounting for 38% of all injuries. The second highest injuries were sustained to the upper extremities, (12%). Head injury accounted for 9% of all injuries. In Nigeria Omoke had similar findings with lower extremity injuries contributing 50% of all injuries. In their study, however, head injuries made up 38.6% and upper extremity injuries made up 30.4% [8]. Similarly, in Hyderabad, India, Schmucker reports that, among both occupants and pedestrians, fractures and crush injuries were recorded more frequently in the lower limb region than in the head, neck, or trunk regions [9]. Dongo and his colleagues also reported from Irrua Nigeria, that a third of all injuries involved the lower limbs [12].

The bones that were most commonly fractured were the tibia/fibula, femur, radius/ulna in order of decreasing frequency. Most of the tibia/fibula fractures were open, while the fractures of the femur and radius/ulna were mostly closed. Omoke had similar findings with the top three fractures in their study involving the tibia, maxillofacial bones, and the femur [8].

None of the injured passengers of the auto-tricycles wore helmets and 95% of all injured occupants had no helmets on. Only 7 of the riders wore crash helmets, representing 5% of all occupants. Omoke *et al* also reported that none of the patients in their study, sustaining injury as an occupant of an auto-tricycle, wore a helmet [8]. Auto-tricycles have no restraints, no seatbelts, airbags or padding systems. They are open vehicles and occupants easily fall out of them or have their limbs coming in direct contact with hard surfaces in the event of a crash resulting in injuries.

5. Limitation of the Study

We extracted data from electronic medical records of patients. Any lapses in documentation could have affected the quality of data available and the subsequent findings of our work.

6. Conclusion

Young males are the most affected in auto-tricycle related injuries and the most common mechanism of injury was auto-tricycle toppling over. The incidence of injuries secondary to auto-tricycle crashes over the study period was 5.9% with a case fatality rate of 3.8%. All fatal cases sustained head and neck injuries, were all passengers of cargo auto-tricycle and none of them wore a crash helmet. Passengers of auto-tricycles were the most injured in auto-tricycle crashes as compared to drivers. Lower limb fractures were the most common auto-tricycle related injuries.

7. Recommendations

Laws mandating crash helmet use by occupants of auto-tricycles must be en-

forced in Ghana to reduce the severity of head injury sustained in the event of a crash. Additionally, we recommend improvement of stability of auto-tricycles to reduce the toppling over rate. Also, riders of these vehicles should be trained and licensed. The introduction of seat belts and padding to the portions of the vehicle abutting the shins and other bony areas of passengers, should be considered to reduce the incidence of fractures to the lower limbs in the event of a crash.

Conflicts of Interest

The authors have no conflict of interest.

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Appendix

Questionnaire

Injuries Associated with Auto-tricycle Crashes in an African City: Incidence and Pattern.

This questionnaire is to enquire about the types of injuries associated with auto-tricycle accidents reporting to KomfoAnokye Teaching Hospital, Kumasi from 1st August 2020 to 31st July 2021.

Study ID…

Section 1. Demographics

1. Date patient reported to KATH (dd/mm/yy) …..

2. Time …

3. Sex (circle as Appropriate)

male 1

female 2

4. Age … (years)

5. Occupation (circle as appropriate)

Student/pupil 1

Auto tricycle Driver/rider 2

Trader 3

Farmer 4

Civil servant 5

Artisan 6

House wife 7

Unemployed 8

Others (specify) 9

Section 2. Accident characteristics

6. Injury Host status

Driver 1

Passenger 2

Pedestrian 3

7. Time of accident

Morning (6am-11.59am) 1

Afternoon (12noon- 3:59pm) 2

Evening (4pm- 6:59pm) 3

Night (7pm- 2:59am) 4

Dawn (3am-5:59am) 5

8. Road users Involed in Accident

Auto Tricycle vs Auto tricycle collision 1

Auto tricycle vs 2 wheeled motorcycle 2

Auto tricycle vs $\geq$ 4 wheel vehicle 3

Auto tricycle vs Pedestrian 4

Auto tricycle alone 5

9. Mechanism of Accident

Head-on collision with another vehicle 1
Side-to-side collision with another vehicle 2
Auto tricycle head to other vehicle side 3
Other vehicle head to auto tricycle side 4
Auto tricycle topple over 5
Pedestrian- knocked down 6
Pedestrian- ran over 7
Passenger falling out of auto tricycle 8

10. Use of a helmet by victims

Yes 1
No 2

Section 3. Injury Characteristics

11. Glasgow coma score on admission

3 1
4-7 2
8-10 3
11-15 4

12. Which part of the body was injured?

Head 1
Neck 2
Chest 3
Abdomen 4
Back 5
Upper Limb 6
Lower Limb 7
Pelvis 8

13. Types of Soft Tissue Injuries

a. Head

Laceration/Abrasion 1
Avulsion/degloving injury 2
Cerebral contusion 3
Diffuse Axonal injury 4
Intra cranial bleeds 5
Other (specify) 6

b. Neck

Laceration/Abrasion 1
Presence of Paralysis 2
Other (specify) 3

c. Chest

Laceration/Abrasion 1
Contusion 2
Avulsion/degloving injury 3
Haemothorax/Pneumothorax (or both) 4
Tension Pneumothorax 5

Other (specify) 6

d. Abdomen

Laceration/Abrasion 1

Contusion 2

Haemoperitoneum/Visceral injury 3

Other (specify) 4

e. Back/spine

Laceration/Abrasion 1

Avulsion injury 2

Presence of paralysis 3

Other (specify) 4

f. Upper limb

Laceration/Abrasion 1

Contusion 2

Avulsion/degloving injury 3

Mangled extremity 4

Traumatic amputation 5

Other (specify) 6

g. Lower limb

Laceration/Abrasion 1

Contusion 2

Avulsion/degloving injury 3

Mangled extremity 4

Traumatic amputation 5

Other (specify) 6

h. Pelvis

Bladder/Urethral injury 1

Other (specify) 2

14. Types of bone and joint injuries

a. Skull

Base of skull fracture 1

Maxillofacial fractures 2

Others (specify) 3

b. Cervical spine

Fractures 1

Others (specify) 2

c. Clavicle

Closed Fracture 1

Open fracture 2

d. Shoulder joint

Dislocation 1

Intrarticular fractures 2

Scapula fractures 3

e. Humerus

Closed Fracture	1
Open fracture	2
e. Elbow joint	
Dislocation	1
Intrarticular fractures	2
Open Fractures	3
f. Radius	
Closed Fracture	1
Open fracture	2
g. Ulna	
Closed Fracture	1
Open fracture	2
h. Wrist joint	
Dislocations	1
Intrarticular fractures	2
i. Hand	
Closed Fracture	1
Open fracture	2
j. Spine	
Fractures 1	
k. Ribs	
Closed Fracture	1
Open Fracture	2
l. Pelvis	
Closed Fracture	1
Open fracture	2
m. Femur	
Closed Fracture	1
Open fracture	2
n. Knee joint	
Dislocations	1
Intrarticular fractures	2
Traumatic Arthrotomy	3.
Patella fractures	4.
Others(specify)	5
o. Tibia	
Closed Fracture	1
Open fracture	2
p. Fibula	
Closed Fracture	1
Open fracture	2
q. Ankle	
Closed Fracture	1
Open fracture	2

r. Foot

Closed Fracture 1

Open fracture 2

Section 4. Interventions and Outcomes

15. Interventions required

Conservative management 1

Minor Surgery 2

Major Surgery 3

Refused Treatment 4

16. a. Outcomes- Discharge

Same day Discharge 1

Within 2 - 3 days 2

Within 3 days - 1 week 3

Within 1 - 2 weeks 4

Within 3 - 4 weeks 5

1 Month or More 6

Death 7

b.Outcomes – Time to Death

Within 1st 24 hours 1

Within 3 days 2

Within 1 week 3

After 1 week. 4

17. Injury Severity Score (ISS)

Mild (<9) 1

Moderate (10 - 15) 2

Severe (16 - 24) 3

Profound (≥25) 4

18. Severity

Minor trauma (ISS ≤ 15) 1

Major trauma (ISS >15) 2