Paediatric road traffic injuries in urban Ghana: a population-based study

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ABSTRACT

Objective/setting To provide a population-based analysis of childhood road traffic injuries (RTI) in two communities of the greater Accra region of Ghana, with the goal of establishing an RTI incidence baseline in these communities and to identify RTI characteristics in order to model a targeted injury prevention programme.
Study design Geographical cluster sampling was performed in two separate communities with household surveys administered in person to determine a denominator. The guardian responsible for any household members below the age of 15 years involved in an RTI within the previous 12 months received an in-depth questionnaire. Demographics, incident characteristics, medical attention, injuries and disability days were noted. These are described and compared with injury severity and age-specific tendencies.
Results 5128 children were interviewed in 60 clusters. Of them, 172 were involved in an RTI within the previous 12 months. This resulted in a rate of 34 RTI/1000 person-years, and 43 RTI/1000 person-years in the 5—14-year-old age group. RTI involving a mini-bus taxi, as a pedestrian, correlated with a disability of greater than 30 days, as did fractures. 35.8% of injuries occurred at sunset. Most RTI occurred on a highway and involved the lower extremities. There were two deaths resulting in an incidence of 39.0/100 000 person-years.
Conclusion Childhood RTI in this urban west African setting are a major source of disability. Specific injury circumstances are reviewed in detail. This study provides baseline incidence data that may be used to measure injury prevention efforts and to validate secondary data sources.

In recent years road traffic injuries (RTI) have become appreciated as a major cause of morbidity and mortality in low-income countries.[1 2] Whereas many high-income countries have well-established injury surveillance systems in place, such as aggregated national trauma registries, which include injury aetiology, these are not available without a significant investment of resources. Injury prevention efforts rely on accurate data that provide insight into aspects of the problem that are amenable to public health interventions and that can be used to grade the effectiveness of such programmes over time. Without this infrastructure it is difficult to plan and grade an injury prevention programme. In low-income countries, these surveillance systems are either not available or are of extremely limited value.

Deaths are often not reported to government agencies, police reports are often not filed, and formal medical attention may not be sought.[3–5] Without knowing what the true baseline is for injuries, there can be no 'gold standard' even to measure secondary data sources.

In 1999 Mock *et al*[6] performed a population-based study in Ghana, a west African nation with a gross domestic product of US$1410 per person, to [1] look at injury aetiology and incidence in the rural and urban setting. Based on the results of these findings, attention was placed at the national level on RTI prevention. Since then there has been a concerted effort to reduce RTI by the government and through various non-governmental organisations. There has, however, not been a population-based assessment since that time, and the current collection system, consisting mostly of police reports, has not been compared with any gold standard.

The goal of this study was to provide accurate population-based data about the scope and demographics of childhood RTI in an urban west African setting; to include crash-specific details such as time of day and economic as well as health impact. Knowledge of these variables is valuable to understand the impact that RTI have on society, and may help maximise the impact of targeted injury prevention programmes. It may also serve as a standard by which to compare the data currently available from mortuary, police and hospital sources. In addition, having this baseline data will allow comparison over time to grade intervention effectiveness, and to compare this setting with others in a consistent and repeatable manner.

METHODS

Study setting

The study took place in two communities, Nima and Ashaiman, of the greater Accra region, in the national capital of Ghana from 1 to 21 August 2009. These communities represent a combined population of 219 356 of the approximately 4 million inhabitants of the greater Accra region. Both were chosen because of testimonially similar RTI issues, and similar social characteristics, yet geographically distinct enough to allow for a control community should a public health intervention be undertaken in one of the communities. Both communities have a major paved street, with street vendors trying to sell to passing cars, and no pavements notable.

Sampling strategy

Individuals and households selected for interview were chosen using a one-stage cluster sampling, without regard for population density, because density statistics were not available. This is a sampling strategy that has been used extensively in low-income countries where accurate data on specific address locations are not available.[7–10] In each district 30 global positioning satellite (GPS) points were chosen at random. This was done by applying a grid to an enumerator area map provided by the Ghana Statistical Service. Using a random number generator, coordinates on the grid were selected and converted to formal coordinates using Google Maps software (Google, Mountain View, California, USA). Each GPS point was termed a cluster.

At each cluster, the goal was to collect data on the 89 children closest to the actual GPS coordinates. The only discriminator for selecting households was proximity to the actual GPS coordinate. The sample size of 2670 children for each of the two districts was desired because of the following assumptions: if the incidence was taken to be 30 per 1000 person-years, and we sought a 50% reduction, then in order to achieve significance with a design effect of 2.0, we would require a sample size of 2670 for 80% power and 95% confidence in a two-tail analysis. A design effect coefficient of 2.0 was used, as there was no manner to calculate it, and this value has been cited by other authors as a reasonable estimate in the absence of a pre-existing derivation.[7 11–13] This attempted sample size allowed an appropriate baseline to be established for any future programme evaluations.

Interview process

Student research assistants were hired from the local allied health school and performed the interviews. They were selected on the result of an examination about the research protocol. Each day they were taken to a specific cluster and collected the relevant data. The guardian of each household was questioned. If any of the children in the household were involved in an RTI in the previous 12 months, a two-page questionnaire was administered in the relevant language with regard to the circumstances of the incident. An individual was considered involved in an RTI if the guardian stated that the child had been involved in an RTI. There was no discrimination for the number of disability days.

The questionnaire developed for this study consisted of the following information: demographics; circumstances of the incident; health consequences; long-term functional status; economic impact and length of disability. Information was also collected on any children who may have died. A household member was considered any individual spending the majority of nights at a location with a primary entrance shared by the other household members over the previous 12 months.

The principal investigator reviewed each completed questionnaire with the research assistants, and randomly visited 10% of the clusters to ensure accuracy.

The protocol for sending the interviewers to the correct location, the interview methods, and the questionnaire itself were pilot tested for 1 week, during which adjustments were undertaken to ensure the accuracy and consistency of the interview process. The project was approved by the Committee on Human Research, Kwame Nkrumah University of Science and Technology.

Data management

The data were entered into a Statistics Program for the Social Sciences version 17.0 database by the research team. Demographics were calculated for the denominator, and an injury incidence was tabulated. Frequencies and means were calculated for categorical and continuous variables, respectively. Minor injuries were defined as those with disability days less than or equal to 30 days, and major injuries those with greater than 30 disability days. If a child was still recovering from an RTI, the time from the RTI was used as disability days. For the purposes of analysis, children under the age of 1 year were considered to be 1 year old.

In order to appreciate the economic impact of the RTI in this community, disability days were averaged and summed in total and in each age group without regard for severity. While recall has been found to be variable, and most accurate for minor injuries within 3 months, all injuries from the previous 12 months were included to obtain the broadest description of injury characteristics and circumstances.[14] A CI of 95% was used and modified for cluster design.

Inferential analysis was performed to identify crash characteristics that correlated with increased disability days. Fisher's exact test was used for contingency analysis in categorical variables and analysis of variance was used for comparing multiple groups. Significance was taken to be $p<0.05$.

In addition to injury incidence, a separate incidence rate, termed the adjusted incidence rate, was calculated for any children that lost at least 1 day of normal activity. This was done to allow comparison with other studies that used this definition.

Of note, two fatal RTI were noted. These were excluded from the analysis and description. The data available with regard to fatal injuries were contradictory and incoherent. In addition, the low number made estimation of a mortality rate of limited value.

Table 1 Study demographics and cluster characteristics

	Study location		
	Nima (95% CI)	**Ashaiman (95% CI)**	**Total**
Total sampled	2606	2522	5128
RTI total	82 (54.9 to 109.2)	90 (61.2 to 118.8)	172 (150.8 to 193.2)
Incidence*	31.5 (28.7 to 34.9)	35.7 (32.2 to 39.7)	34.0 (28.0 to 40.0)
Adjusted†	77 (50.8 to 103.2)	86 (58.6 to 113.4)	163 (138.0 to 188.0)
Adjusted incidence	29.5 (24.5 to 34.4)	34.1 (28.1 to 40.1)	31.8 (26.5 to 36.8)
Age±SD	7.52±4.31	7.64±4.35	7.58±4.33
Male sex	58.5%	66.6%	62.8%
Average households‡	34.7±16.0	41.6±13.4	38.1±15.0
Households with no answer‡	12.1±10.2	20.1±11.5	16.2±11.5
Households that refused‡	2.0±1.8	2.2±1.5	2.1±1.7

*Per thousand person years.
†Adjusted includes only those individuals who missed at least 1 day of activity.
‡Per cluster.
RTI, road traffic injury.

RESULTS

Data were collected on 5128 children. The average age for the Nima and Ashaiman denominator group was 7.52±4.31 and 7.64±4.35, respectively, with a combined average of 7.58±4.33 years.

Those individuals reporting an RTI in the past year were 172 (95% CI 150.8 to 193.2) in total, or 82 (95% CI 54.9 to 109.2) and 90 (95% CI 61.2 to 118.8) in Nima and Ashaiman, respectively. When corrected to include only individuals who missed at least 1 day of normal activity in the past year, these values were found to be 163 (95% CI 138.0 to 188.0), 77 (95% CI 50.8 to 103.2) and 86 (95% CI 58.6 to 113.4) for the combined Nima and Ashaiman groups, respectively. Additional demographics are described in table 1.

The majority of variables from the two sites were similar; however, Ashaiman had more injuries associated with mini-bus taxis (10/82 vs 4/90, p=1.01). Ashaiman also had more pedestrian injuries (74/82 vs 61/90, p=0.25) and more injuries while riding a bicycle (5/82 vs 17/90, p=0.04).

The RTI were segregated by age brackets to reflect preschool (0–4 years), or school aged (5–14 years). The age bracket-specific injury incidences are described in table 2. Notable is the incidence of RTI in total, which was 34 per 1000 person-years. In addition, in the 5–14 year age group this figure was 43 per 1000 person-years. Disability days are also noted in table 2 and are segregated by age brackets. Of the 163 children who missed at least 1 day of normal activity, the average length of disability was 29.5±63.9.

Bicycle-related injuries were found to be common in children (63/172), representing 36.6% of all RTI; 78.5% of children were injured as pedestrians and most often by motorcycles (19.2%) and bicycles (25.6%). Lower extremity injuries represented 58.1% of all injuries followed by upper extremity at 14.5% and head injuries at 9.5%.

The severity of injury, as defined by disability days was compared with RTI circumstances and anatomical injury in table 3; 84.3% of injuries resulted in disability of less than 30 days. This comparison identified two factors that correlated with a major disability; these were the presence of a fracture (10/145 vs 15/27, p<0.001) and a pedestrian injury involving a mini-bus taxi (7/145, vs 8/27, p=0.0014). Of note, no specific anatomical region of injury, road type, time of injury or other crash circumstance correlated with a major injury; 38.6% of injuries occurred on the highway; however, 32.6% occurred on small side streets; 32.6% of injuries occurred at sunset and 30.4% during the day. Only 2.7% occurred at night.

DISCUSSION

This study supports the testimonial evidence, and earlier studies that found that RTI are a significant public health problem in urban Ghana.[6 15–17] Whereas other studies in Ghana have provided incidence data for injuries in general, this was the first population-based study in Ghana to address paediatric RTI circumstances exclusively and in depth. Direct comparison with other data sources cannot be reliably made, because the secondary data are often referred to in units such as 'crashes per thousands of registered vehicles' and rely on hospital, mortuary or police records. A similar population-based study that looked at all injuries, performed in another Ghanaian city in 1999, found the RTI incidence to be 22/1000 person-years in those individuals missing at least 1 day of activity.[6] Using the same definition, our study found an RTI incidence of 32/1000 person-years. Of note, the earlier study looked at all age groups and our study was limited to children.

When one considers the notion that each year approximately three to four out of every 100 children will be involved in an RTI, the point is made that RTI are a major public health problem.

In addition to the incidence of RTI, there are several specific key findings of this study. Most notable of these findings are

Table 2 RTI prevalence, incidence and disability days by age groups

Ages, years	0–4	5–14	Total
RTI within past 12 months	21 (12.1–29.9)	151 (127.5–174.5)	172 (150.8–193.2)
Denominator*	1647	3481	5128
Incidence†	12 (6.7–17.3)	43 (36.6–49.7)	34 (30.8–37.2)
Adjusted†‡	12 (6.7–17.3)	34 (28.0–40.0)	32 (26.2–37.8)
Disability days§	14.64±19.74	31.93±77.13	29.5±63.89

*Denominator represents total number surveyed for each age group.
†Expressed in 1000 person-years.
‡Only included those within the past year who missed at least 1 day of normal activity.
§Disability averages include those with at least 1 disability day.
RTI, road traffic injury.

Table 3 Children (aged <15 years) RTI characteristics compared with severity*

	Minor*	Major	Total	p Value
Injuries sustained				
Head	13 (9.0%)	3 (11.1%)	16	0.72
Face	8 (5.5%)	2 (7.4%)	10	0.66
Neck	1 (<1%)	1 (3.7%)	2	0.30
Chest	1 (<1%)	0	1	NA
Abdomen	4 (2.7%)	0	4	NA
Back	21 (14.4%)	4 (14.8%)	25	NA
Arms	83 (56.5%)	17 (63.0%)	100	0.86
Legs	11 (7.5%)	0	11	0.37
General body pain	3 (2.0%)	0	3	NA
Other	13 (9.0%)	3 (11.1%)	16	0.72
Type of injury				
Cut	60 (41.4%)	8 (29.6%)	68	0.54
Bruise	55 (37.9%)	4 (14.8%)	59	0.12
Fracture	10 (6.9%)	15 (55.6%)	25	<0.001
Other	20 (13.8%)	0	20	NA
Crash type				
Hit by mini-bus	6 (4.1%)	8 (29.6%)	14	<0.001
Hit by car	14 (9.7%)	8 (29.6%)	22	0.03
Hit by taxi	19 (13.1%)	2 (7.4%)	21	0.74
Hit by motorcycle	30 (21.0%)	3 (11.1%)	33	0.42
Hit by bicycle	43 (29.7%)	1 (3.7%)	44	<0.001
Hit by other	1 (<1%)	0	1	NA
Injured while riding a mini-bus	2 (1.4%)	2 (7.4%)	4	0.12
Injured while riding a car	9 (6.2%)	0	9	0.35
Injured while riding a motorcycle	2 (1.4%)	0	2	NA
Injured while riding a bicycle	19 (13.1%)	3 (11.1%)	22	0.90
Circumstances of injury				
Playing	33 (22.8%)	10 (37.0%)	43	0.26
Walking to/from school	21 (14.5%)	3 (11.1%)	23	0.78
Walking to/from work	3 (2.1%)	1 (3.7%)	4	0.51
Walking elsewhere	55 (37.9%)	9 (33.3%)	64	0.84
Riding to/from school	1 (<1%)	1 (3.7%)	2	NA
Riding to/from work	7 (4.8%)	0	7	NA
Riding other	11 (7.6%)	2 (7.4%)	13	0.90
Working as a seller	1 (<1%)	0	1	NA
Going to/from place of worship	3 (2.1%)	1 (3.7%)	4	0.50
Total				
	145	27	172	

*Minor injuries represent those that resulted in less than 30 days of missed activities of daily living.
RTI, road traffic injury.

that mini-bus taxis are an enormous source of injury and disability for children as pedestrians. Highways are intuitively a major source of injuries. Whereas this is supported by this study, it was also noted that an almost equal number of children were injured on side streets. In addition, approximately one-third of childhood RTI took place at sunset and during the day, but rarely at night. These specifics are valuable towards structuring an injury prevention programme and, with regard to the morbidity of mini-bus taxis, have been noted by other studies in a similar setting.[6 17]

This study also found that fractures strongly correlated with major disability in children. Knowing that a fracture/dislocation in a child is a marker for major morbidity is worth noting so that these injuries may be treated aggressively, and so parents have a realistic appreciation of the impact that these injuries will have on children.

There are several limitations to this study; some are intrinsic to cluster methodology and the research environment, whereas others are to some extent within the control of the research team. When no addresses or consistent population-based data exist, there are few ways to obtain reliable demographics. A sample of the entire district would be ideal, followed by a randomised geographical sample, with many clusters and small cluster sizes with a high ratio of total sample size to population. Both of these options are impractical in this setting. Henderson
2 and Sundaresan[7] described a method in 1982, which represents a reasonable balance between the practical and the ideal options in a population-based approach. We chose this 30-cluster method as a cost-effective and feasible option to answer important questions that could only be answered at a population level. We attempted to identify the 'classic' problems of geographical cluster sampling during the pre-implementation phase and deliberately address them. Therefore, when clusters fell in an inconvenient location, the teams tried to arrive as close to the point as reasonable before beginning the cluster investigation. Also, teams went far off the main streets when required to avoid the 'main street' bias. Some biases were beyond the control of the investigators. For example, individuals may not have been home when the study team passed by their area, and houses with aggressive dogs were generally avoided. Through pilot studies it became apparent that having teams with one man and one woman made most households comfortable enough to allow an interview. This has been observed in other studies.[10]

In conclusion, this study found that RTI in greater Accra posed a major public health threat to children, and that these communities may benefit from targeted public health interventions. Bicycle-related injuries were common, although mostly minor. No other study to our knowledge has shared this finding. RTI that involved a mini-bus taxi, or any injury that involved a fracture/dislocation correlated strongly with major morbidity. Highways are the most common site of RTI, followed closely by small side streets, and the lower extremities are the most common site of injury. A third of all childhood injuries take place at sunset.

Amend.org is a non-governmental organisation, which seeks to reduce childhood road traffic injuries in Africa mostly through a classroom programme, but also with advocacy and infrastructure development. Based on the results of this study, the http://amend.org educational programme has been modified in the following specific ways: a strong focus is on looking for bicycle riders, and for trying to 'be seen' by mini-bus taxi drivers. There is now more focus on traffic awareness while playing on small side streets. Because of this population-based baseline data, we can objectively measure the impact the educational programme has on the study community, and see how the RTI characteristics change with time.

What is already known on the subject

- RTI are a major source of morbidity in developing countries.
- Secondary data sources are of inconsistent value.
- Children are particularly vulnerable to RTI.

What this study adds

- A population-based paediatric RTI incidence that can be used for comparing with other communities.
- Specific crash and injury characteristics valuable for constructing a targeted public health intervention.
- Baseline data for measuring public health interventions with a community control.

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Competing interests None.

Ethics approval This study was conducted with the approval of the Committee on Human Research, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Contributors All authors have participated sufficiently in the work to take public responsibility for the content.

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