G Model
AAP-2514; No. of Pages 7
ARTICLE IN PRESS
Accident Analysis and Prevention xxx (2011) xxx–xxx
Contents lists available at ScienceDirect
Accident Analysis and Prevention
journal homepage: www.elsevier.com/locate/aap

Road traffic injury incidence and crash characteristics in Dar es Salaam: A population based study

Karen Zimmerman[a,*], Ali A. Mzige[b], Pascience L. Kibatala[c], Lawrence M. Museru[d], Alejandro Guerrero[e]

[a] Amend, P.O. Box 152, New York, NY 10101, USA
[b] International Medical and Technological University, Dar es Salaam, Tanzania
[c] Ministry of Health and Social Welfare, Dar es Salaam, Tanzania
[d] Muhimbili Orthopaedic Institute, Dar es Salaam, Tanzania
[e] Intertrauma Medical Consulting, New York, NY, USA

ARTICLE INFO

Article history:
Received 31 March 2011
Received in revised form 23 June 2011
Accepted 28 June 2011

Keywords:
Road traffic injuries
Injury prevention
Tanzania
Trauma and population-based injury incidence

ABSTRACT

Road traffic injuries (RTI) are a public health threat and a major source of disability in developing countries. A population-based analysis of RTIs in a testimonially high-risk area of Dar es Salaam, the largest city in the East African country of Tanzania, was carried out with the goal of establishing an RTI incidence and to identify RTI characteristics that may be used for a targeted injury prevention program in these communities.

Geographic cluster sampling was completed in 2 adjacent wards of Dar es Salaam with household surveys administered in person to determine a denominator. Any household members 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 to injury severity and age specific tendencies.

Within the 30 clusters, 6001 individuals were interviewed. Of them, 196 were involved in non-fatal RTIs within the previous 12 months, resulting in a non-fatal incidence rate of 32.7 RTIs per 1000 person years. There were 4 deaths noted. Injuries resulting in a fracture correlated with a disability of more than 30 days. Children were injured as pedestrians 93% of the time and were more likely to be injured on small, unpaved side streets than adults. Most RTIs occurred on a highway and affected the lower extremities, required treatment at a hospital, and resulted in a police report being filed 50.2% of the time.

In conclusion, RTIs in this urban East African setting are a major source of disability. This study provides incidence data and crash characteristics that may be used to construct prevention programs and could validate secondary data sources.

1. Introduction

Road traffic injuries (RTI) are a major public health threat and without preventative measures are projected to increase significantly worldwide over the next 20 years (Peden et al., 2004). RTIs account for the largest proportion of unintentional injuries and are increasingly recognized in low-income countries as a major cause of morbidity and mortality (Chandran et al., 2010; Peden et al., 2004, 2009). The World Health Organization (WHO) projects that RTIs worldwide will be one of the leading causes of disability adjusted life years (DALYs) in 2030 (Peden et al., 2004). Despite discouraging statistics such as these, an increase in attention and research may be able to alter the increasing rate of RTIs. For example, the safe communities' model has demonstrated an injury reduction in some studies (Spinks et al., 2005). Certainly, speed bumps and infrastructure development have also demonstrated promise, as have seatbelt and motorcycle helmet legislation (Dinh-Zarr et al., 2001; Macpherson and Macarthur, 2002; Redelmeier et al., 2003; Servadei et al., 2003; Shults et al., 2001). However, there are serious obstacles that question the feasibility of these strategies in developing countries. A lower cost option, such as childhood education, may prove a successful approach in such countries.

A tool for gathering research, such as creating a successful injury surveillance system, is needed to provide accurate data for public health interventions and prevention measures. These surveillance systems provide the numbers and types of injuries that occur as well as the circumstances of the injuries. While this information is readily available in most developed countries in the form of regionally aggregated trauma registries, its implementation requires significant investment. This high cost leaves low-income countries' surveillance systems extremely limited or non-existent. In addition, the secondary data that are available in

* Corresponding author. Tel.: +1 215 262 9819.
E-mail address: kzimmerman@amend.org (K. Zimmerman).

0001-4575/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.aap.2011.06.018

Key messages
What is already known about the subject:

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

What this study adds:

- A population based RTI incidence, which can be used for comparison to other communities.
- Specific crash and injury characteristics valuable for constructing a targeted public health intervention.
- Children and adults have different crash characteristics.
- 50% of RTI victims filed a police report.

low-income countries rarely have population based data to validate them (Dandona et al., 2008).

A population-based study on injuries by Moshiro et al. (2001) found that between 1992 and 1998 transport related accidents were the leading cause of injury in Dar es Salaam, Tanzania. Despite RTIs being shown as the leading cause of injuries in Dar es Salaam, few studies have illustrated specific RTI incidence and crash characteristics (Moshiro et al., 2005). Since RTIs are a leading cause of injury, it is important to quantify the RTI incidence and understand specific crash characteristics.

Amend is a non-governmental organization with the goal of decreasing road traffic injury rates though advocacy, education, social marketing, and scientific research in Africa. Amend was responsible for funding this study, though all the authors participated on a voluntary basis. This study was conceived and designed to provide objective information for the development of an injury prevention strategy in this testimonially high-risk area of Dar es Salaam. Understanding Dar es Salaam's RTI impact and identifying specific crash characteristics is important in recognizing its subsequent impact on the community and may provide valuable information for constructing prevention measures.

2. Methods

2.1. Study setting

The study took place in the Azimio and Mtoni wards of Dar es Salaam, the largest city and commercial capital of Tanzania. The two wards are adjacent and have a single common highway bisecting them and were therefore treated as a single geographic area. This area was chosen because of testimonially high RTI rates.

2.2. Sampling strategy

A single-stage cluster sampling was used to select individuals and households for an interview. Because density statistics were not available, the study was carried out without regard for population density. This sampling strategy is used widely in low-income countries where accurate data on specific address locations is not available (Henderson et al., 1973; Henderson and Sundaresan, 1982; Kobusingye et al., 2001; Moshiro et al., 2001, 2005). In the two wards, a total of 30 global positioning satellite (GPS) points were randomly selected. By applying a grid to a satellite map of the study area and using a random number generator, coordinates on the grid were selected and converted to formal coordinates using Google Maps software (Google™, Mountain View, California). Each GPS point was termed a cluster.

Data was collected on 200 individuals closest to the actual GPS coordinates at each cluster. The sample size of 6000 individuals for the two wards combined 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 $n = 2670$ for 80% power and 95% confidence in a 2-tail analysis. Furthermore, a design effect coefficient of 2.0 was used, since there was no manner to quantify or estimate the intracluster variability. This value has been cited by other authors as a reasonable estimate in the absence of a pre-existing derivation (Bennett et al., 2002; Hayes and Bennett, 1999; Henderson et al., 1973; Henderson and Sundaresan, 1982).

2.3. Interview process

Research assistants were hired from the local allied health school to perform the interviews. The students were selected after undergoing an examination on the study protocol. The research assistants were taken to a specific cluster each day to collect the data. If any of the interviewed individuals reported being involved in an RTI in the previous 12 months, a 2-page questionnaire was administered in the relevant language. An individual was considered involved in an RTI if the interviewee stated that the individual had been involved in an RTI. There was no discrimination for number of disability days.

The questionnaire sought to gather 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 household members that 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 audited 10% of the clusters to ensure accuracy.

The study was pilot tested to ensure the interview methods and questionnaire was reasonable and problem free. Minor adjustments were made to ensure the accuracy and consistency of the interview process. The project was approved by the Tanzanian Ministry of Health and Social Welfare and the National Institute of Medical Research.

2.4. Data management

The data was entered into a Statistics Program for the Social Sciences version 18.0 database (SPSS inc, Chicago, IL) 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, as those with greater than 30 disability days. If an individual was still recovering from an RTI at the time of interview, the time from the RTI was used as disability days. For the purposes of analysis, children under the age of 1 were considered 1-year old.

In order to appreciate the economic impact of RTIs in this community, disability days were averaged and summed in total and for 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 get the broadest description of injury characteristics and circumstances (Mock et al., 1999a,b).

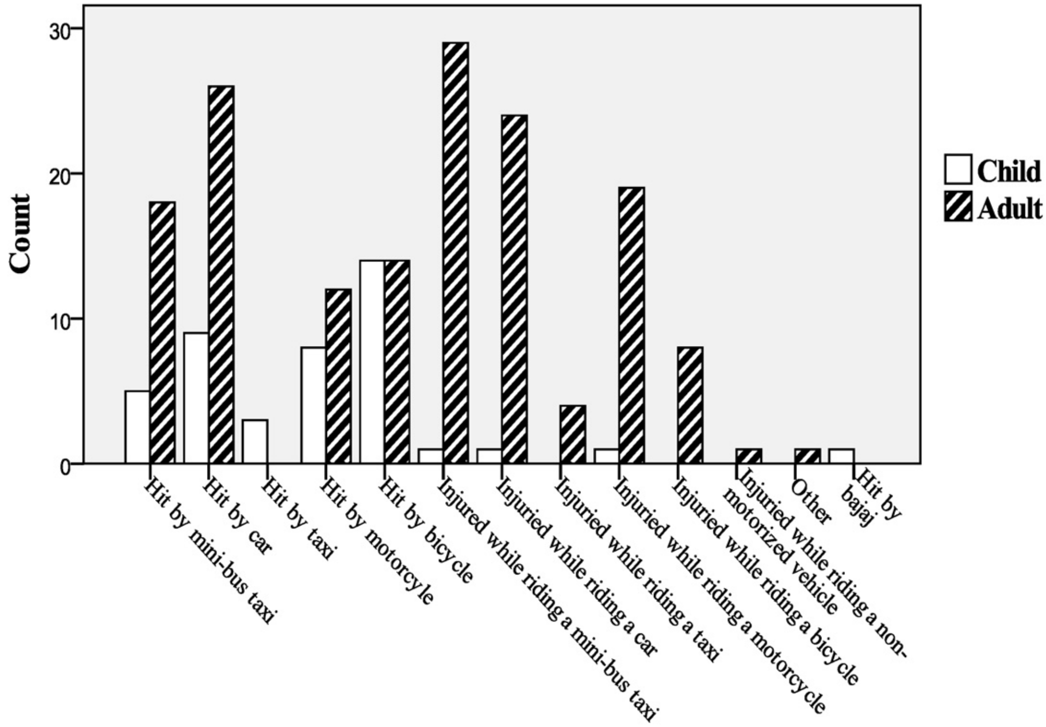

Fig. 1. Adult and child crash circumstances.

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

In addition to injury incidence, the *adjusted incidence rate* was calculated for any individuals that lost at least 1 day of normal activity. This was done to allow comparison to other studies, which used this definition (Mock et al., 1999b; Moshiro et al., 2001).

Of note, there were 4 fatal RTIs. These were excluded from the analysis and description, because the data available with regards to these injuries was determined to be contradictory and inconsistent. Additionally the low *n* made estimation of a mortality rate inaccurate.

3. Results

Data from 6001 individuals in the Azimio and Mtoni wards was collected for the denominator and made up the total sample size. There were 196 individuals (CI: 169.9–222.1) who reported a non-fatal RTI in the previous 12 months.

The RTIs were separated by age brackets to reflect preschool (0–4), school aged (5–14), working age (15–44), and older (>45). The age bracket specific injury incidences are described in Table 1. The total incidence of non-fatal RTI was 32.7 per 1000 person years. In the greater than 45 age bracket this figure was 48.0 per 1000 person years.

Fig. 1 demonstrates the circumstances related to each RTI, separated by children (ages 0–14) and adults (ages > 14). Bicycle-related

Table 1
Injury incidence and disability averages by age group.

Ages	0–4	5–14	15–44	>45	Total
RTI within last 12 months	13 (6.0–20.0)	29 (18.6–30.4)	122 (100.6–143.4)	32 (21.2–42.8)	196 (169.1–222.1)
Denominator[a]	780	1314	3241	666	6001
Male sex	38.5%	51.7%	68.0%	59.4%	62.2%
Incidence[b]	16.7 (7.0–25.7)	22.1 (14.2–30.0)	37.6 (31.0–44.2)	48.0 (31.8–64.2)	32.7 (28.2–37.2)
Adjusted[b,c]	5.1 (0–12.1)	16.0 (9.2–22.8)	28.0 (20.8–35.2)	45.0 (29.3–60.7)	24.2 (20.3–28.1)
Disability days[d,e]	34.40 ± 93.79 n = 10	25.19 ± 58.97 n = 26	49.21 ± 85.58 n = 107	73.28 ± 85.57 n = 32	49.19 ± 77.56 n = 175

[a] Denominator represents total number surveyed for each age group.
[b] Expressed in 1000 person years.
[c] Only includes those within the last year that missed at least 1 day of normal activity.
[d] Disability averages include those with at least 1 disability day.
[e] n = the number of RTIs in each age bracket with at least 1 disability day.

Please cite this article in press as: Zimmerman, K., et al., Road traffic injury incidence and crash characteristics in Dar es Salaam: A population based study. Accid. Anal. Prev. (2011), doi:10.1016/j.aap.2011.06.018

Table 2
Crash characteristics compared to injury severity.

		Minor[a]	Major	Total	p[b]
Crash type	Hit by mini-bus taxi	18 9.2%	5 2.6%	23 11.7%	0.62
	Hit by car	20 10.2%	15 7.7%	35 17.9%	0.11
	Hit by taxi	2 1.0%	1 0.5%	3 1.5%	n/a
	Hit by motorcyle	14 7.1%	6 3.1%	20 10.2%	n/a
	Hit by bicycle	22 11.2%	4 2.0%	26 13.3%	0.16
	Injured in mini-bus taxi	21 10.7%	9 4.6%	30 15.3%	n/a
	Injured while in a car	15 7.7%	9 4.6%	24 12.2%	0.48
	Injured while riding a taxi	3 1.5%	1 .5%	4 2.0%	n/a
	Injured while on a motorcycle	15 7.7%	5 2.6%	20 10.2%	0.80
	Injured while riding a bicycle	7 3.6%	1 0.5%	8 4.1%	0.44
	Other	2 1.0%		2 1.0%	n/a
	Hit by 3-wheeled vehicle	1 0.5%		1 0.5%	n/a
Circumst.	Playing	16 8.2%	16 1.5%	19 9.7%	0.02
	Walking to school	5 2.6%	1 0.5%	6 3.1%	0.68
	Walking from school	7 3.6%	2 1.0%	9 4.6%	n/a
	Walking to work	8 4.1%	1 0.5%	9 4.6%	0.45
	Walking from work	14 7.1%	5 2.6%	19 9.7%	n/a
	Walking elsewhere	22 11.2%	14 7.1%	36 18.4%	0.68
	Riding to school	1 0.5%		1 0.5%	n/a
	Riding from school	3 1.5%		3 1.5%	n/a
	Riding to work	18 9.2%	7 3.6%	25 12.8%	n/a
	Riding from work	10 5.1%	6 3.1%	16 8.2%	0.57
	Riding-other	26 13.3%	10 5.1%	36 18.4%	n/a
	Working as a driver	5 2.6%	4 2.0%	9 4.6%	0.46
	Working as a seller	4 2.0%	4 2.0%	8 4.1%	0.24
	Total	139 70.9%	57 29.1%	196 100.0%	

[a] Major injuries are those with greater than 30 disability days.
[b] *n/a* represents either an extremely low *n*, or $p = 1.0$.

injuries were found to be the same in both the child and adult groups, comprising 13.3% of all RTIs. Mini-bus taxis were implicated in the case of adults 30.5% of the time, though only 14.3% of the time in children (47/154 vs 6/42, $p = 0.11$). Private vehicles were implicated in 30.1% of injuries, with similar trends in both children and adults (10/42 vs 49/154, $p = 0.58$). The severity of injury, as defined by disability days, was compared to RTI circumstances and anatomic injury in Table 2 for all individuals. Major injuries, defined as a disability of greater than 30 days, represented 29.1% of all injuries. Individuals who missed at least 1 day of normal activity represented 74.0%, whereas 5.6% expected to never be able to return to work or school as a result of the RTI. The average length of disability of those individuals missing at least 1 day of normal activity was 49.19 ± 77.56 days. This study found that 34.2% of injuries occurred during the daytime, followed by 28.1% in the morning, 23.5% during sunset and 14.5% at night. Additionally, 43.9% of injuries occurred en route to work or school.

Fig. 2 demonstrates the anatomic location of injuries for all individuals. They were similar for both children and adults, with lower extremity injuries representing 39.5% of all injuries. Injuries to the upper extremities and head represented 16.3% and 14.3%, respectively. Fractures represented 16.3% of injuries, and correlated with a disability of more than 30 days (25/57 vs 7/139, $p = 0.001$).

Crash characteristics comparing children and adults are represented in Table 3. 55% of all injuries were pedestrian related (108/196). 93% of all children involved in an RTI were involved as a pedestrian, while 44.8% of adults in an RTI were pedestrians (39/42 and 69/154, $p < 0.001$). Similarly, adults were injured more as passengers (85/154 vs 3/42, $p < 0.001$). The majority of RTIs occurred on highways, representing 77.3% of adult RTIs and 50.0% of child-

Table 3
Crash characteristics compared to child/adulthood.

		Child[a]	Adult	Total	p
Injury severity	Minor	36 18.4%	103 52.6%	139 70.9%	0.36
	Major	6 3.1%	51 26.0%	57 29.1%	0.83
Ped vs pass.	Pedestrian	39 19.9%	69 35.2%	108 55.1%	<0.001
	Passenger	3 1.5%	85 43.4%	88 44.9%	<0.001
Commute	Going to/from work/school	9 4.6%	77 39.3%	86 43.9%	0.03
	Going elsewhere	33 16.9%	77 39.3%	110 56.1%	0.09
Road type	Highway	21 10.7%	119 60.7%	140 71.4%	0.004
	Paved non-highway	2 1.0%	16 8.2%	18 9.2%	0.38
	Non-paved road	3 1.5%	8 4.1%	11 5.6%	0.71
	Small side street	15 7.7%	9 4.6%	24 12.2%	<0.001
	Parking lot		2 1.0%	2 1.0%	n/a
	Playground	1 0.5%		1 0.5%	n/a
	N/A	11 5.6%	30 15.3%	41 20.9%	0.54
Total		42 21.4%	154 78.6%	196	

[a] Child is defined as less than 15 years old.

hood RTIs (119/154 vs 21/42, $p = 0.004$). Notably, children were more likely to be injured on a small unpaved side street than adults (15/42, vs 9/154, $p < 0.001$).

4. Discussion

This study was carried out to determine RTI incidence and crash characteristics in a testimonially high-risk area of Dar es Salaam in order to design an injury prevention program.

The results of this study show that about 33 out of every 1000 individuals reported being involved in a RTI within the past 12 months. This study supports other sources, which have identified RTIs as significant public health problem in sub-Saharan Africa (Andrews et al., 1999; Asogwa, 1992; Mock et al., 1999a,c; Moshiro et al., 2001, 2005; Odero et al., 1997). Comparison to other population based studies is not entirely appropriate, since often the study area is geographically wider and contains an average of high-risk and low-risk areas. This is particularly the case when examining data previously available from Dar es Salaam. For instance, Moshiro et al. found the rate to only be 5.98 per 1000 person-years, considerably lower than this study. Of note, this study used a stricter definition of RTI than others, since it included only individuals that missed at least 1 day of activity, and applied a two-stage sampling technique, which included the entire city (Kobusingye et al., 2001; Moshiro et al., 2001, 2005). When adjusted to that definition, our current study had an *adjusted incidence rate* of 24.2 per 1000 person years. A 2009 study from Nigeria found the RTI incidence rate to be 41.2 per 1000 person-years, considerably higher, and around the same level as both a Sri Lankan and a Ugandan population-based study which found an incidence there of 49.0 and 38.9 per 1000 person-years, respectively (Labinjo et al., 2009; Moshiro et al., 2005; Navaratne et al., 2009). Using the exact same methodology, and focusing exclusively on the testimonially "worst" area of Accra, a 2009 study by Amend, which is currently under review, found a very similar rate of 33.0 per 1000 person-years (Guerrero et al., 2011). When compared to countrywide estimates from the United Kingdom where the rate was found to be 4.3 per 1000 person years, the point is clear, that RTIs in this high-risk area pose a major public health risk (World Health Organization, 2009).

This study found that 4 individuals had a fatal RTI within the past year. The "verbal autopsy" information was contradictory between family members, and sensational. There has been much written recently about the reliability of "verbal autopsy" (Yang et al., 2006). Our first hand experience contradicts these presumptions, though the n was extremely limited. Therefore the fatal RTI characteristics were not included. With regards to deaths, other authors have a reported that 41% of injury related pre-hospital deaths have been attributed to RTIs in Dar es Salaam (Museru et al., 2002).

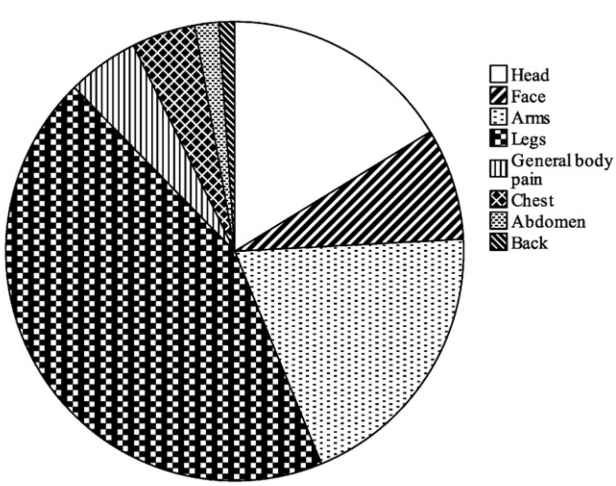

Fig. 2. Overall injuries sustained.

Please cite this article in press as: Zimmerman, K., et al., Road traffic injury incidence and crash characteristics in Dar es Salaam: A population based study. Accid. Anal. Prev. (2011), doi:10.1016/j.aap.2011.06.018

Individuals injured as a pedestrian represented over half of all the injuries. Children were found to be injured predominantly as pedestrians, often on small unpaved side streets. In a study which focused on perceived susceptibility to RTIs, Astrøm et al. (2006) found that 78% of the people included in their study in Dar es Salaam perceived being injured as a pedestrian likely or very likely. However, one hospital-based study done by Museru et al. (2002) found that 67.8% of parents believed that "accidents were unpreventable" and often quoted the Swahili saying of "*ajali haina kinga*", which makes fate the determining factor for RTIs. It is clear that pedestrians are particularly vulnerable to RTIs and future prevention programs should focus on this susceptible group. Based on the Astrøm data, a prevention program would be most effective if it focused on the message that the road is a serious threat and that an individual is able to minimize that threat by being proactive about safety (Astrøm et al., 2006).

Understanding the type of roads and motor vehicles involved in RTIs is important in constructing a prevention plan (Peden et al., 2004). This study found that most RTIs occur on a highway and was implicated with 77.2% of those individuals missing more than 30 days of activity. Many of the highways and side streets in Dar es Salaam do not have side pavements for pedestrians or cyclists and are often overcrowded (Museru et al., 2002). Additionally, there are few pedestrian crossing areas, which should be of particular concern to schools in close proximity to highways (Moshiro et al., 2005; Museru et al., 2002). Since 93% of children were involved in an RTI as a pedestrian, a program focusing on this RTI scenario is important. Many of the RTIs involved individuals being hit by or injured while riding in a car or mini-bus taxi. As such, prevention measures should target both drivers and passengers of these vehicles.

Whereas other studies have reported the majority of RTIs occurring at sunset, this study found that 34% of injuries occurred during the daytime, and affected individuals during their daily commute most of the time (Museru et al., 2002). This may be a product of the study area, since it represents a commuter area, dominated by a highway, and may lead to an overemphasis on this as a problem in Dar es Salaam in general.

Two-thirds of the surveyed population tended to seek medical attention at a hospital, and three fourths of those involved in an RTI received some form of roadside assistance. This is information that we have not seen described elsewhere. Additionally, police reports were filed for about half of all the injuries sustained. These findings may help provide a way to estimate the actual impact of RTIs from secondary data. That is to say, since half of the individuals filed police reports, perhaps a doubling of the police report derived secondary data may provide a more accurate estimation of the problem. This would have to be further validated in order to be used consistently, yet seems promising.

5. Conclusion

This study encountered limitations as a result of cluster methodology, the research environment and a single-stage sample. Ideally, a higher number denominator as well as a sampling strategy using randomly selected individuals, as opposed to geographic clustering, would have been preferred. Yet, these ideal preferences would prove impractical in this study's setting. This study modelled a 30-cluster method described by Henderson and Sundaresan (1982), which outlines how to achieve a logical balance between the ideal and the more realistic options in a population-based approach. Although this study could not control for the limitations inherent to a cluster sampling strategy, it did address many "classic" problems of geographic cluster sampling during the pilot testing phase. These included, teams positioning themselves as close as possible to an indiscernible location, and when feasible, using side streets to avoid the "main street" bias. The scope of this study was to identify specific information for a high-risk area within Dar es Salaam. Therefore, while some of the findings may be generalized to other settings, the incidence is likely to represent a rate, which is higher than a city-wide average.

In conclusion, this study found that RTIs in one high-risk area of Dar es Salaam account for a considerable amount of disability, resulting in a major public health burden evidenced by an average disability of 49 days. Child pedestrians were a particularly vulnerable group. Injuries resulting in a fracture were likely to result in a major disability. RTIs involving children occurred mostly as pedestrians and often on small unpaved side streets. Vulnerable groups and specific crash scenarios should be a priority for injury prevention programs. Highways were the most common site of RTIs, and the lower extremities were found to be the most common site of injury. Police reports were filed for about half of all reported RTIs in these two wards, indicating that it may be possible to correct or validate secondary data. Since population based data is now available in a high-risk area of Dar es Salaam, a targeted injury prevention program may now be constructed and implemented.

Funding source

The study was funded by Amend. However, all the authors worked on a voluntary basis.

Competing interest declaration

There are no competing interests to disclose.

References

Andrews, C.N., et al., 1999. Road traffic accident injuries in Kampala. East Afr. Med. J. 76, 189–194.
Asogwa, S.E., 1992. Road traffic accidents in Nigeria: a review and a reappraisal. Accid. Anal. Prev. 24 (2), 149–155.
Astrøm, A.N., et al., 2006. Perceived susceptibility to and perceived causes of road traffic injuries in an urban and rural area of Tanzania. Accid. Anal. Prev. 38, 54–62.
Bennett, S., et al., 2002. Methods for the analysis of incidence rates in cluster randomized trials. Int. J. Epidemiol. 31, 839–846.
Chandran, A., et al., 2010. The burden of unintentional injuries and an agenda for progress. Epidemiol. Rev. 32 (1), 110–120.
Dandona, R., et al., 2008. Under-reporting of road traffic injuries to the police: results from two data sources in urban India. Inj. Prev. 14 (December (6)), 360–365.
Dinh-Zarr, et al., 2001. Reviews of evidence regarding interventions to increase the use of safety belts. Am. J. Prev. Med. 21, 48–65.
Guerrero, A., et al., Paediatric road traffic injuries in urban Ghana: a population-based study. Inj. Prev., 2011, doi:10.1136/ip.2010.028878.
Hayes, R.J., Bennett, S., 1999. Simple sample size calculation for cluster-randomized trials. Int. J. Epidemiol. 28, 319–326.
Henderson, R.H., et al., 1973. Assessment of vaccination scar rates and small pox scarring in five areas of West Africa. Bull. World Health Organ. 48 (1), 183–194.
Henderson, R.H., Sundaresan, T., 1982. Cluster sampling to assess immunization coverage: a review of experience with a simplified sampling method. Bull. World Health Organ. 60 (2), 253–260.
Kobusingye, O., et al., 2001. Injury patterns in rural and urban Uganda. Inj. Prev. 7 (March (1)), 46–50.
Labinjo, M., et al., 2009. The burden of road traffic injuries in Nigeria: results of a population-based survey. Inj. Prev. 15, 157–162.
Macpherson, A.K., Macarthur, C., 2002. Bicycle helmet legislation: evidence for effectiveness. Pediatr. Res. 52, 472.
Mock, C.N., et al., 1999a. Incidence and outcome of injury in Ghana: a community-based survey. Bull. World Health Organ. 77 (12), 955–964.
Mock, C.N., et al., 1999b. The effect of recall on incident rates for injuries in Ghana. Int. J. Epidemiol. 28, 750–755.
Mock, C.N., et al., 1999c. Epidemiology of transportation-related injuries in Ghana. Accid. Anal. Prev. 31, 359–370.
Moshiro, C., et al., 2001. The importance of injury as a cause of death in sub-Saharan Africa: results of a community-based study in Tanzania. Public Health 115, 96–102.
Moshiro, C., et al., 2005. Injury morbidity in an urban and rural area of Tanzania: an epidemiological survey. BMC Public Health 28 (5), 11–21.
Museru, L.M., et al., 2002. Patterns of road traffic injuries and associated factors among school-aged children in Dar es Salaam. Afr. Saf. Promot. 1, 37–43.
Navaratne, K.V., et al., 2009. Population-based estimates of injuries in Sri Lanka. Inj. Prev. 15, 170–175.

Odero, W., et al., 1997. Road traffic injuries in developing countries: a comprehensive review of epidemiological studies. Trop. Med. Int. Health 2, 445–460.

Peden, M., et al., 2004. World Report on Road Traffic Injury Prevention. WHO Publishing, pp. 4–7.

Peden, M., et al., 2009. World Report on Child Injury Prevention. WHO Publishing, pp. 31–35.

Redelmeier, D.A., et al., 2003. Traffic-law enforcement and risk of death from motor-vehicle crashes: case-crossover study. Lancet 361, 2177–2182.

Servadei, F., et al., 2003. Effects of Italy's motorcycle helmet law on traumatic brain injuries. Inj. Prev. 9, 257–260.

Shults, R.A., et al., 2001. Reviews of evidence regarding interventions to reduce alcohol-impaired driving. Am. J. Prev. Med. 21, 66–88.

Spinks A, et al., 2005. The WHO safe communities model for the prevention of injuries in whole populations. Cochrane Database Syst. Rev. 18 (2).

World Health Organization, 2009. Global status report on road safety: time for action, www.who.int/violence_injury_prevention/road_safety_status/2009.

Yang, G., et al., 2006. Validation of verbal autopsy procedures for adult deaths in China. Int. J. Epidemiol. 35 (3), 748–750.

Please cite this article in press as: Zimmerman, K., et al., Road traffic injury incidence and crash characteristics in Dar es Salaam: A population based study. Accid. Anal. Prev. (2011), doi:10.1016/j.aap.2011.06.018