Pedestrian Injuries in the Most Densely Populated City in Nigeria—An Epidemic Calling for Control

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Received 11 December 2013, Accepted 3 May 2014

Objectives: Since the first pedestrian road fatality of 1896, pedestrians still remain vulnerable, with fatalities in Africa being 55% of global statistics. Many previous reports from Nigeria have emphasized passengers and drivers over pedestrians; this study was done in the most densely populated Nigerian city with no previous publication exclusively dedicated to pedestrians—the megacity has been projected by the World Bank to be the third largest in the world by 2015 (after Tokyo and Mumbai), so the study results would aid injury control and reduce morbidity and mortality.

Methods: This is a one-year prospective study on pedestrians attending the surgical emergency room of the busiest referral hospital in Lagos, Nigeria, detailing age, sex, occupation, regions injured, injury mechanism, incident vehicles, highway collisions, and immediate outcomes.

Results: Some 702 pedestrians were seen, including 494 (70%) males with overall peak incidence in the third decade, but the peak incidence among females is lower and in the first decade. Common injuries sustained were to the head (40%), lower limbs (35%), upper limbs (9%), multiple regions (6%), pelvis (3%), and others (7%). Gender differences also were noted—the predominant injury location in males was the head, followed by lower limbs; the opposite was true for females, though both regional injuries were fewer in females than in males. Students were 20% of the entire pedestrians, with nearly half of them injured by a motorcycle. The mechanism of injury included crossing a highway (63%), walking along the pavement (17%), standing by a bus stop (12%), at a shop/house (5%), and others (3%). However, 76% injuries occurred on highways, 22% on inner city roads, and 2% elsewhere. Vehicles included motorcycles (33%), cars (27%), buses (22%), trucks (6%), tricycles (2.4%), and other (9%). Overall fatality was 10% and about half were due to being knocked down by buses and cars.

Conclusions: This study suggests a high incidence and significant underreporting of pedestrian injuries. A reduction in morbidity and mortality is possible (from head and lower limb injuries) by traffic calming techniques in crossing the highway, especially injuries due to being struck by motorcycles, cars, and buses.

Keywords: pedestrians, injuries, motorcycles, Nigeria, fatality

Introduction

The first pedestrian fatality in the world from a road traffic crash (RTC) was in 1896 in the United Kingdom. Since then, the pedestrian has remained vulnerable worldwide varying according to age, gender, socioeconomic status, and geographical location. Pedestrian injuries represent an additional economic burden on victims, families, and the public health system (Berger and Mohan 1996; Naci et al. 2009; NHTSA 2012; Peden 2004). The global economic burden of motor vehicle collisions and pedestrian injuries totals $500 billion (Chakravarthy et al. 2007; Peden 2004). Pedestrians in the African region constitute more than half (55%) of all RTC fatalities (NHTSA 2012). Pedestrian deaths account for 45% of all RTC fatalities in low-income countries with more than 230,000 estimated deaths per year in this group (Naci et al. 2009; NHTSA 2012). Although published RTC figures from Nigeria showed a preponderance of passengers over pedestrians (Solagberu et al. 2002, 2003), reports from most other African countries showed more pedestrians than passengers in morbidity and mortality (Andrews et al. 1999; Ibrahim
et al. 2012; Mabunda et al. 2008; NHTSA 2012; Odero et al. 2003). It has become necessary to study pedestrian injuries in this metropolitan area in Nigeria where it is not uncommon to find corpses on the streets during peace time, usually arising from a hit and run vehicle. Despite pedestrians’ vulnerability, researchers in Nigeria have not dedicated a study exclusively to pedestrians, to the best of the authors’ knowledge. Consequently, what is not measured cannot be controlled and trends cannot become known via scientific study. Thus, this study is particularly needed for this most densely populated city (18 million people) in Nigeria, Africa’s third most densely populated city, to explore the indices on pedestrian injuries. Indeed, the World Bank predicted that Lagos would become the third most populous megacity in the World, after Tokyo and Mumbai, by 2015; the government has thus become more aware of the need to ensure a safer city. Available statistics are largely from empirical evidence and police reports, not from scientific studies—police reports are more concerned with determining fault from either the motorist or the pedestrian for legal pursuits and less for prevention strategies (Kim et al. 2008; Preusser et al. 2002). However, hospital reports are more accurate in seeking mechanisms of injury and epidemiology, focusing more on primary, secondary, and tertiary prevention strategies. Faster vehicle speeds are implicated in pedestrian–motor vehicle collisions, in part because a longer distance is needed to stop a speeding vehicle (Anderson et al. 1997). Faster speed is also associated with increased injury severity and fatality; one study found that the risk of pedestrian fatality was 5 times greater at speeds of 50 km/h versus 30 km/h (Rosén and Sander 2009). When the 3 factors suggested by Berger and Mohan (1996) are considered, local and global attention is drawn to the pedestrian in the mechanism of pedestrian–motor vehicle collisions with a view to protecting pedestrians and/or reducing the risks.

**Materials and Methods**

A one-year prospective study (December 7, 2011, to December 6, 2012) at the Surgical Emergency Room (SER) of the Lagos State University Teaching Hospital (LASUTH), Ikeja, Nigeria—a 750-bed hospital, a 2003 upgrading of the General Hospital in Ikeja (itself a 1967 upgrade of a Cottage Hospital built in 1955 during the British colonial rule in Nigeria). Due largely to its location in the heart of the capital city of Lagos State and to governmental policy of relatively free health care, LASUTH has the busiest SER not only in Lagos State but also in Nigeria, receiving a monthly average of over 1,100 trauma and nontrauma emergencies. Nigeria’s population is 167 million, about 20% of the population of the Africa and the highest population of any African country; Lagos State (one of 36 states) is the smallest in size but most densely populated (about 10% of the entire country). There are 3 other public tertiary institutions in Lagos State treating injured patients owned by the federal government of Nigeria—Lagos University Teaching Hospital, National Orthopaedic Hospital, and Federal Medical Centre, Ebute Metta—their combined surgical emergency patient load is less than the over 1,000 per month seen at LASUTH. It is not exactly known the exact proportion of pedestrians visiting LASUTH but it is most likely more than all of the other 3 tertiary centers receive.

The parameters studied include age, gender, occupation, the mechanism of pedestrian–vehicle collision, the road on which the pedestrian was hit (whether highway or inner city), as well as the incident vehicle. The body regions injured and, in the case of head injury, Glasgow Coma Scale (GCS) were determined. Finally, the immediate outcomes were analyzed and further related to various parameters of the patients’ age and sex using the Statistical Package for Social Sciences, version 16. Results are discussed and presented using tables and figures.

**Results**

**Demography (Age, Gender, and Occupational Differences)**

There were 702 pedestrians, including 494 males (70.4%) and 208 females (29.6%); the male : female ratio was 2.4:1 but equal male–female involvement in the first decade. The peak incidence was in the third decade (Figures 1a and 1b). The graph is generally male dominated but the observed difference between the genders was removed in the first decade and after the sixth decade. The total trauma in the SER for this period was 5,795 (inclusive of 2 months when the SER was on partial shutdown due to doctors’ industrial action); 2,213 were due to RTCs, giving a pedestrian load of 31.7% (702 of 2,213). The age distribution in the 2 most common injury regions, head injuries (HIs) and lower limb injuries (LLIs), showed 2 peaks in

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**Fig. 1.** a. Distribution of pedestrians by sex and age group. b. Age distribution of pedestrians by age group only, without gender bias.
the first and third decades (Figure 2a). Five common regions were injured: head (278 pedestrians, 39.6%), LL (245, 34.9%), upper limb (UL; 63, 9.0%), multiple injuries (40, 5.7%), pelvis (24, 3.4%), and other (52, 7.4%). All 5 common areas peaked in the third decade except LL with a plateau at third to fourth decades. The biphasic peaks of HI before being overtaken by LLIs after the third decade is notable. Additionally, Figure 2b shows gender differences in regional injury distribution, with HI as predominant in males but LLI in females. However, both HI and LLI had higher incidences in males. In both sexes, ULI was a distant third. Figure 2c shows the regional injuries at various road locations, predominantly HIs and LLIs on the highway and more LLIs than HIs on inner-city roads—however, both were much lower on inner-city roads. Students constituted the largest group (19.9%), nearly half of whom were injured by motorcycles, followed by civil servants, (government employees, 13.8%), traders (13.5%), and artisans (10.0%; see Table A1, online supplement).

Mechanism of Injury and Regions Injured

Pedestrian–Vehicle Collisions

Crossing the road accounted for nearly two thirds of the collisions (63.5%), with a majority due to motorcycles, whereas walking along the pavement (17.1%) and standing by a bus stop (12.0%) or in front of a shop/house (4.8%) all had varied injury rates (Tables A1 and A2, see online supplement). Crossing the road was responsible for HIs in 205 pedestrians (29.2%) and LLIs in 136 others (19.4%). Walking along the pavement and standing by a bus stop had more LLIs (7.3 and 5.4%, respectively) than HIs (4.7 and 3.6%, respectively; see Table A2). Approximately 33.3% of pedestrians were hit by motorcycles, followed by cars (27.4%) and buses (21.8%); injuries due to trucks, tricycles, and other are shown in Table A1.

Sites of Collision

Highway collisions involved 534 pedestrians (76.1%), mainly from motorcycles (25.9%), cars (19.2%), and buses (17.2%; see Table A1). Inner-city road collisions involved 157 pedestrians (22.4%), with a lower incidence of cars (7.5%) and motorcycles (7.3%). In 11 patients (1.5%), the injury location was not stated. HIs accounted for 33.2 and 7.4% on highways and inner-city roads, respectively, and 25.9 and 9.0% of LLIs occurred on highways and inner-city roads, respectively (see Table A2).

Outcome

Pedestrians were admitted for further treatment if not discharged immediately (37.2% and 18.4%, respectively; see Table A1). A third (33.6%) were referred to other hospitals due to acute bed shortages and 1% left against medical advice. Sixty-nine pedestrians (9.8%) died. A majority of those admitted had LLIs, followed by HIs, and those referred to other hospitals predominantly suffered from HIs, followed distantly by LLI (Figure 3a). A majority of the deaths were also due to HIs, followed distantly by LLIs; see Figure 3a. Most of the HI admissions and discharges were mild HI (GCS score of 13–15) and most of the referrals and SER pedestrian deaths were severe HIs (GCS score of 3–8; Figure 3b). The actual death rate is higher than the observed 9.8% because the final outcome of the referred HIs who were most severely injured could not be accounted for. Figure 3c shows the significance of tibia and fibula injuries among pedestrians, which are responsible for the highest numbers of admission, discharges, referrals, and deaths due to LLIs. The distribution of outcome among the various age groups closely follows the distribution of incidence; see Figure 3d. The ratios of death to admission, referrals, or discharges for the age groups above 50 years show worse outcomes compared to other age groups (Figure 3d).

Figure 4 shows a newspaper caption of school children crossing at a pedestrian marked area and a commercial bus that had failed to stop for them, reflecting risks faced in the first decade and by school children.
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Fig. 3. a. Type of outcome among the regions. b. Outcome for HIs based on severity of HI. c. Outcome for lower limb injuries. d. Distribution of pedestrian outcome by age group.

Discussion

This article reported that the highest incidence of pedestrian–vehicle collisions occurred due to motorcycles and showed that students constitute the highest at-risk group. The age, sex and regional differences should dictate the direction of injury research. Despite its being a single institution study, the fact that hundreds were injured in a year from a city without such previously published records is significant. Nonetheless, observed similarities and differences with other major African cities like Accra (Afukaar et al. 2003), Cairo (Ibrahim et al. 2012), Nairobi (Odero et al. 2003), Kampala (Cookson et al. 2009; Nakito et al. 2008), and some cities in South Africa (Mabunda et al. 2008) are noteworthy.

In 1975, Baker reported 2 visual descriptions of the distribution of injured pedestrians: a V-shape showing 2 peaks at 2 extremes (youth with no experience or skill in road crossing and the elderly, usually hard of hearing, slower to react, or under the influence of alcohol) occurred in Baltimore, Maryland, and an inverted V-shape (a pyramid) with one peak depicting adults who took risks crossing the road, as seen in Rio de Janeiro, Brazil. Whereas the Ghana study showed a V-shape distribution, our results resembles the inverted V-shape distribution (Afukaar et al. 2003) (Figures 1a and 1b). The second lower peak incidence additionally noted in the first decade when regional injuries were considered (Figure 2a) excludes the elderly in this report (Figures 1a and 2a). This may be a reflection of the population distribution of Lagos State, with less than 10% above the age of 50 years, with the remaining distribution as follows: 0–10 years, 23.2%; 11–20 years, 18.7%; 21–30 years, 23.9%; 31–40 years, 16.4%; and 41–50 years, 9.2% (Lagos State Bureau of Statistics 2011). The Ghana report also showed the highest casualties due to collisions with buses and cars, unlike the (commercial) motorcycles implicated in this study on the highway, closely followed by cars (Afukaar et al. 2003) (Tables A1 and A2, see online supplement). The South African report (Mabunda et al. 2008) is different from Baker’s V-shape description because it identified 3 categories of pedestrians based on gender, alcohol abuse, and time of injury, reporting male gender and alcohol abuse at 58% involvement, elderly females who were injured in the morning, and young children injured in the afternoon and evening—the age and gender distribution in this report is quite different (Figure 1a). This article showed an equal male : female distribution in the first decade, with the distribution of males peaking in the third decade, and females showing a plateau across all ages. Regarding the 20% of pedestrian incidents involving students, a major target group, students’ perceptions and practices or road risk-taking behaviors can be changed, as shown in the Cairo report (Ibrahim et al. 2012). A future study should reflect what impact the recent banning of motorcycles from the highways by the Lagos State government would have on pedestrian injuries in Lagos State because more than three quarters (76.1%) of the pedestrian–vehicle collisions occurred on the highway. The

Fig. 4. School pupils crossing at a pedestrian crossing as a commercial bus fails to stop for them (http://www.punchng.com, January 15, 2013).
Cairo report (Ibrahim et al. 2012) suggests the possible highest prevalence of traffic injuries involving pedestrians in Africa at 75%; South Africa had 38%, Uganda, Ghana, and Kenya had 40–45%, but this article showed 31%.

The authors advance 4 reasons why pedestrians in Lagos are on the road: for social human connections and recreation (visits to stadium, church or mosque, cinema, or families during festivities); to deliver goods or engage in street trading; to render professional services; and in the course of pursuing personal growth and learning (schooling). This is different from the predominantly leisure and health-related reasons for pedestrian movements in advanced countries (National Household Survey, www.walkinginfo.org/library/details). Pedestrian RTCs are a great threat to accomplishing these basic human needs of movement. Statistics from the United States showed a pedestrian injury incidence of 3%, unlike the 31.3% reported here, clearly a 10-fold difference. Furthermore, the pedestrian injury rates are decreasing in developed countries (Presseur et al. 2002), though not in developing countries. Many pedestrians are oblivious of what a vehicle can or cannot do at least because they have not owned one and probably know nothing about the workings of a vehicle but expect drivers to stop for them. Indeed, some drivers become pedestrians at some point in their journey, attempting to cross the road or while attending to some vehicular faults like overheating or changing punctured tires beside the highway with or without a C-caution sign—hence, in an uncontrolled environment with poor road infrastructure, everyone faces pedestrian risks.

Berger and Mohan (1996) suggested that the high prevalence of pedestrian injuries in Africa was due to the triad of high pedestrian population, rapid motorization, and inadequate road infrastructure. The new distractions from mobile phones (not studied here) have worsened the plight of pedestrians. This report on pedestrians should encourage greater attention to this and other vulnerable groups because existing injury control measures are concentrated on vehicle occupants. Reports on vehicular crashes from Nigeria predominantly showed passengers as victims, reflecting inter-city (rural) injuries rather than intra-city (urban) injuries as reported here. Urban injuries are commonly pedestrian dominated, as seen in other African cities, including Nairobi and Cairo (Ibrahim et al. 2012; Odero et al. 2003).

In both developed and developing countries, HIs and LLIs constitute the 2 most common pedestrian injuries, but facilities for managing post-crash HIs and LLIs are grossly inadequate—a common feature of health care in developing countries. As Figure 3b shows, a majority of patients secondarily referred elsewhere due to lack of bed space had severe head injuries. It is not too difficult to calculate the crude death rate as greater than 10%. Indeed, the actual death rate is 15% (1 in 7) when these referred patients whose eventual outcomes are not known are removed from the patient population. Nigeria, like most other African countries, does not have organized emergency medical services; thus, patients are routinely brought to hospital by themselves or their relatives in the majority of instances, police/ambulances, and bystanders (Solagberu et al. 2009). Although prehospital transport was not the focus of the present study, access to transport is purely by chance exposure to any of these 3 groups. Certainly, training these groups in basic resuscitation would improve morbidity and reduce deaths (Mock et al. 2002; Solagberu et al. 2009).

Apparent no pedestrian activity is safe, but safety is non-negotiable whether crossing the road, walking along the pavement, or standing at a bus stop; these results suggest poor observance of safety measures by all drivers. Motorcyclists are notorious for riding on walkways meant for pedestrians. Many pedestrians do not own their own vehicles and should be considered during road design and construction. The few road signs meant to protect pedestrians are not obeyed by drivers (Figure 4). This report has identified some of these prehospital tendencies that can be controlled. In addition, the high rate of admissions for ankle injuries compared to the high rate of referrals for severe HIs shows that there is need for further internal audit of the practice of admitting those with mild to moderate conditions and referring severe injuries despite the ability to handle them. Figure 3b shows that the majority of head-injured patients who were referred were actually severely injured, similar to those with LLIs, with many referrals for tibia/fibula fractures but an apparent preference for ankle fracture admissions (Figure 3c).

**Recommendations**

The first recommendation is the need to strengthen the existing health care system especially as it pertains to emergencies through research audit and injury control as shown in this article regarding the manner of determining who is admitted or referred for surgical emergencies. Additionally, there is need to improve on the capacity—both human and materials—of the hospitals to handle more emergencies rather than the perennial overload and tendency to refer to other centers, which in this instance have lower capacities. This should complement our second recommendation on improvements in road engineering. Although pedestrian bridges are few and far in between in Lagos State, it would seem appropriate and cheaper to build traffic calming and illuminated broad-based speed bumps in crowded areas rather than pedestrian bridges, which are often abandoned for a number of reasons. The typical pedestrian is poor, in a hurry, might be carrying a load, or may have knee problems—all possible reasons to avoid a pedestrian bridge and justifiable reasons to take the risky option of crossing the road. Speed bumps resolve these traffic complexities in favor of the pedestrian rather than vehicles. This should possibly reduce the high incidence of HIs and LLIs. Furthermore, construction of pedestrian barriers such as handrails along pedestrian walkways would prevent vehicles from encroaching upon the walkways; in addition, more walkways should be constructed. Thirdly, enforcement of safety measures preceded by health education using all effective means, including pamphlets, posters, and radio jingles, while ensuring involvement of the stakeholders in the community would be beneficial. Street or roadside trading, which encourages pedestrian–vehicle exposure, should be discouraged—existing laws should be enforced. The authors are aware of the social value of street trading in a poor economy, though an
ill-advised measure, and one in which the peddlers are often children who ought to be in school but need to augment the family income. Fourthly, the government should be more innovative in employment generation or in providing an environment conducive for pedestrians to ply their trade profitably. Additionally, improved city planning or where urban renewal is taking place like in Lagos, relevant stakeholders should be involved. A closer working relationship between researchers and city planners would be helpful. The discovery here of vehicles colliding with a pedestrian in the house at least more than 4 times more often on inner-city roads than on highways suggests poor city planning. The creation of pedestrian zones for pedal cycles and pedestrians is necessary.

Injuries to pedestrians in Lagos, Nigeria, have now been documented and are similar to what have been reported in other major African cities except for the unique role of motorcycles on highways, poor city planning that facilitates vehicle–pedestrian collisions at bus stops or in their houses, and the high involvement of students. This article has also shown the gender regional injury differences and different peaks for the sexes and highlighted many points of injury control. It also mentioned the 4 reasons why pedestrians are on the road in developing countries as opposed to the 2 reasons in developed countries. Implementation of findings of studies of this nature that are evidence based should help reduce the negative statistics from Africa and other low-income countries that contribute 55 and 45% fatality rates, respectively, to the global pedestrian injury burden. Further studies involving multiple institutions or that are community based have been suggested.

**Supplemental Materials**

Supplemental data for this article can be accessed on the publisher’s website.

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