# Unintentional Injury Outcomes Secondary to Pedestrian Traffic Crashes: A Descriptive Analysis from a Major Medical Center

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**Abbreviations:**
A&E = Accident and Emergency
FRSC = Federal Road Safety Corps
WHO = World Health Organization

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## Abstract

**Introduction:** An environment in which traffic regulations are not strictly enforced often is characterized by carnage from motor vehicular crashes resulting in severe injuries with unacceptably high mortality. The descriptive demographics and injury characteristics of pedestrian road crash victims presenting to a tertiary medical center in southwestern Nigeria are presented in order to provide baseline epidemiology as a first step in determining areas of potential mitigation for care of unintentional injuries.

**Methods:** Consecutive pedestrian road traffic crash patients treated in the Accident and Emergency Department of a tertiary hospital were prospectively reviewed from March 2007 to February 2008 to determine baseline demographics and clinical outcomes.

**Results:** A total of 184 patients with a mean value of the ages of 31.4 years were studied; 27% of the patients were <11 years of age. The male to female ratio was 1.6:1. Fifty-four percent of the victims were struck by automobiles and 29% were struck by motorcycles. Sixty-five percent were struck while crossing common thoroughfares. Head injury was sustained in 61% of patients. The mortality rate was 31.0% (n = 57). The clinical course leading to death showed 22.8% of the patients who died initially experienced hemorrhagic shock, 17.5% suffered a severe head injury, and 17.5% suffered aspiration. Autopsy confirmed brainstem herniation in 28.1% of the patients who died. The average interval between injury and death was 5.5 ±13.6 days (range: 0–77 days). In this setting, three out of every ten patients experiencing pedestrian vehicular trauma will die before leaving the hospital. The elderly are most at risk, with two-thirds of victims dying from injuries sustained.

**Conclusions:** This raises serious questions about the prehospital- and hospital-based emergency services for vehicular road crash victims in this environment, and confirms the World Health Organization findings that Africa has the highest rate overall for unintentional injury deaths. A system-wide program must be put in place that addresses proven prevention measures across all sectors of the community.

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## Introduction

The developing world is becoming increasingly aware of its worsening epidemic of road traffic crashes. More than one-third of the 1.2 million people killed and the 10 million injured annually in road traffic crashes worldwide are pedestrians, representing 70% of traffic fatalities in most developing countries.[1] The larger proportion of these occur on urban roads.[2] The incidence and pattern of traffic injuries in developing countries reflects their high pedestrian populations, rapid motorization, and the poor state of the road infrastructure.[3]

The World Health Organization (WHO) has identified that road crashes kill 260,000 children per year. Unfortunately, Africa has the highest rate of

| | Etiology of Pedestrian Crashes | | | | | |
|---|---|---|---|---|---|---|
| Age Range (years) | Car | Bus | Truck | Bike | Total | Mortality (%) |
| ≤10 | 28 (1) | 6 (2) | 1 (0) | 11 (0) | 46 | 3 (5.7) |
| 11–20 | 11 (4) | 4 (2) | 2 (0) | 7 (3) | 24 | 9 (17.0) |
| 21–30 | 13 (4) | 2 (0) | 2 (1) | 7 (2) | 24 | 7 (13.2) |
| 31–40 | 14 (6) | 2 (1) | 1 (0) | 3 (1) | 20 | 8 (15.1) |
| 41–50 | 7 (3) | 4 (1) | 1 (0) | 5 (0) | 17 | 4 (7.5) |
| 51–60 | 12 (5) | 1 (0) | -- | 5 (2) | 18 | 7 (13.2) |
| >60 | 7 (6) | 2 (1) | 1 (1) | 12 (7) | 22 | 15 (28.3) |
| Total | 92 (29) | 21 (7) | 8 (2) | 50 (15) | 171 | 53 (100.0) |



**Table 1**—Table showing etiology of pedestrian road traffic injuries, the age groups involved, and the associated mortality ($p = 0.367$)
*Number of mortalities in parenthesis unless otherwise indicated

unintentional injury deaths in the world, 10 times that of developed countries.[4]

In Nigeria, where traffic regulations are not strictly enforced, there is a high incidence of motor vehicular crashes resulting in severe injuries and unacceptably high mortality. Various government efforts through agencies like the Federal Road Safety Corps (FRSC) have yielded minimal improvements. The poor state of the roads, which often lack regular maintenance and asphalt resurfacing, coupled with vehicles that frequently are not road-worthy or regulated, are major contributing factors to the high incidence of road traffic accidents.

The main objective of this study was to descriptively characterize demographic injury patterns, severity factors, and mortality in pedestrian road crash victims presenting to one major medical center, a university teaching hospital situated in southwestern Nigeria. This center, an 900-bed facility, offers tertiary care to all Nigerians as well as referrals from neighboring West African countries.

## Methods

A prospective review was obtained of 184 consecutive patients treated in the Accident and Emergency (A&E) Department of the hospital for injuries sustained from pedestrian road crashes during the 12-month period from March 2007 through February 2008. The patients were evaluated clinically and resuscitated in the A&E according to Advanced Trauma Life Support protocol. Data regarding the mechanism of injury and injuries sustained were obtained upon admission. As ancillary investigations were performed during management by specialty and subspecialty teams, and until the transfer of the patient to the wards or their discharge. These details were recorded in a proforma. Mortality and the causes of death, when they occurred, were recorded after coroner's autopsies.

## Results

A total of 184 patients between the ages of 11 months and 90 years (mean = 31.7 ±23.6 years) presented with injuries due to road traffic crashes during the period of study. Fifty-four percent were struck by automobiles. The various causes of pedestrian crashes, age distribution of the subjects, and age-related mortality are listed in Table 1. There were 114 males and 70 females among the victims (ratio 1.6:1).

Sixty-five percent of the subjects were hit from the side. Details on the point of impact are listed in Figure 1. It was observed that while buses usually hit their victims from behind or head-on, automobiles and motorcycles tended to hit victims from the side ($p = 0.000$).

Age had no significant relationship to the etiology of the crash ($p = 0.34$) or the point of impact ($p = 0.66$). There was a statistically significant relationship between age range and open fractures. Patients aged between 41–50 years and older than 60 years were particularly at risk for open fractures ($p < 0.05$).

Sixty-nine percent of the patients hit by an automobile and 55.8% of those hit by motorcycles suffered head injury (relationship was not statistically significant; $p = 0.246$). The summary of injuries sustained by subjects studied is in Table 2.

A mortality rate of 31.0% (57 subjects) was found, with raised intracranial pressure and subsequent brainstem herniation determined as the leading cause of death (28.1%) based on autopsy findings. All the patients who died from aspiration suffered a concomitant head injury. The average interval between injury and death was 6.2 ±14.9 days (range: 0–86 days), with 51.8% of the mortality recorded within 24 hours of the injuries (Table 3).

## Discussion

Children <11 years of age, representing more than one-quarter of all cases, were the most frequent groups of victims of pedestrian road traffic crashes. They were twice as likely to be struck compared to any other age group, especially when crossing roads (as deduced from the high number of the injuries occurring with the point of impact occurring from the side). A similar analysis found children to be three

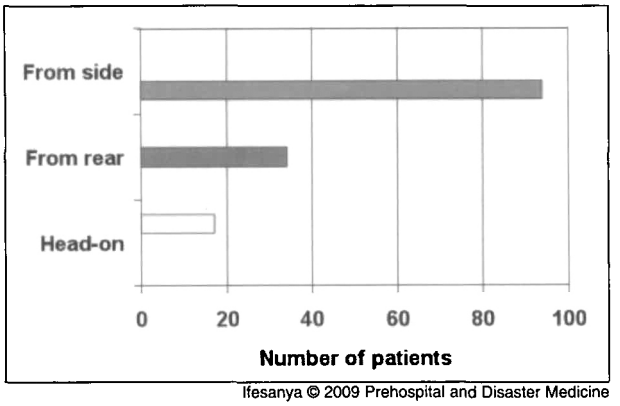




Figure 1—Point of impact of the vehicle on the patient during pedestrian road traffic crashes ($p$ = 0.000)

| Injury Sustained | Frequency (% of total subjects) |
|---|---|
| Head* | 112 (60.7) |
| Upper limb fractures | 21 (11.4) |
| Lower limb fractures and dislocations | 66 (35.9) |
| Chest | 24 (13.0) |
| Abdomen | 9 (4.9) |
| Spine | 10 (5.4) |
| Maxillofacial | 8 (4.3) |
| Other | 76 (41.3) |
| Total injury count | 326 |



Table 2—Injuries sustained by subjects involved in pedestrian road traffic crashes
*39 (34.8%) of the head injuries were severe (Glasgow Coma Score <9)

| | Time of death relative to the time of injury | | | | |
|---|---|---|---|---|---|
| Cause of Death | First two days | Rest of 1st week | 2nd week | 5th–13th week | Total (%) |
| Hemorrhagic shock | 12 | -- | -- | -- | 12 (21.4) |
| Head injury | 5 | 3 | 2 | -- | 10 (17.9) |
| Sepsis | -- | -- | 3 | 3 | 6 (10.7) |
| Aspiration | 5 | -- | 4 | 1 | 10 (17.9) |
| Raised ICP + herniation | 11 | 3 | 2 | -- | 16 (28.6) |
| Others | 2 | -- | -- | -- | 2 (3.5) |
| Total | 35 | 6 | 11 | 4 | 56 (100.0) |



Table 3—Causes of death and timing of death in patients presenting to the hospital following pedestrian traffic crashes

times more predisposed to pedestrian crashes.[5] Studies suggest that children <10 years of age are unable to make the complex judgments about distance and speed that enable adults to make a judgment to stop or avoid the oncoming vehicle traffic. Furthermore, their developing mobility, underdeveloped cognition, inefficient peripheral vision, and poor directional hearing making them highly vulnerable to pedestrian road traffic crashes.[6,7] Crossing a street safely involves the rapid and complex process of identifying safe crossing gaps in traffic, assessing the speed of traffic, assessing acceleration/deceleration, assessing distance of moving vehicles in at least two directions, judging the speed with which one would cross the street, and recognizing and coping with visual occlusions such as parked cars, bushes, curves, and inclines of the roadway.[6]

The 21–60-year-olds appeared to be at risk according to of being struck from behind. All other age groups share casualties fairly evenly up to 60 years of age. However, a disproportionately high mortality rate was found in those >60 years old. Older pedestrians are known to be at a higher risk of mortality.[8,9] They also are more likely to succumb due to metabolic, infectious, or surgical complications from their injury.[10]

Male dominance as victims (61.5% of deaths) is a trend that also was observed in those <11 years of age, where boys made up 59% of those struck, and two out of three of the victims experiencing mortality were boys. Male gender has been implicated as a risk factor for pedestrian injury in children.[7] Boys tend to have more impulsive behavior that leads to risk for unintentional injury.[11] Secondly, boys are more likely to attribute injuries to bad luck rather than their own behavior and decisions, leading boys to repeat injury risk behaviors more often than girls.[12] Boys also are twice as likely to be killed when injured by a car.[13]

Passenger autos accounted for half the injuries in this study, followed by motorcycles, buses, and trucks. About two-thirds of the victims were struck in the side by autos and motorcycles, while buses usually hit victims head-on or

from behind. The dense traffic, poor illumination and signage, poor road maintenance, and the absence of pedestrian curbs on roads in Nigeria and other developing countries are implicated for this pattern.[14] A curious finding was the slight predisposition of females to being knocked down by commercial motorcyclists. The last decade witnessed a resurgence of the motorcycle as a popular means of commercial transport, due to the breakdown of the commuter bus system and the non-existence of the railway system in Nigeria. Motorcyclists tend to flagrantly disobey traffic regulations and refuse to wear crash helmets, a suggested explanation of the frequency and greater severity of injuries resulting from motorcycle crashes in this study. Alcohol intake, darkness, and wet roads (especially at night) are other factors known to increase the risk of crashes with adult pedestrians.[15]

Head injuries occurred in almost two-thirds of the cases, with one-third of the head injuries severe enough to require intensive care and experiencing subsequent high mortality rates. Severe head injury (Glasgow Coma Scale Score <9) was a significant risk factor for death in this study, as 9 out of every 10 victims with severe head injury in this study died. In contrast, only one-fifth of patients with mild (score >12) to moderate head injuries died. Other physical regions frequently injured are the limbs and the chest. Crandall *et al* also found head injury to be the most common cause of pedestrian mortality.[16] The legs often are injured by impact with the bumper, but head injuries are more often caused by the head striking the vehicle, especially the windscreen, and then the ground.[17] More than half of the deaths in this series occurred within the first day of injury. The incidence of head injury tended to increase significantly when the victim is older than 20 years and is highest after 50 years of age. The incidence of open fractures was high in this series (42%).

Compared to injured vehicle occupants, pedestrians sustain more multisystem injuries with concomitantly higher injury severity scores and mortality.[18] Unlike vehicle occupants, the entire unprotected body of the struck pedestrian is vulnerable. Moreover, safety features often present in motor vehicles such as air bags and seat belts are not available to the pedestrian. No doubt, the situation is worsened in developing countries due to poor compliance with traffic regulations in general.

The high mortality rate in this series, half of which was due to hemorrhagic shock, aspiration, and sepsis raises serious questions about the emergency services for road crash victims in this environment. Whereas a multi-sector approach must occur, this also must include re-equipping, retraining of staff, and increased availability of blood for resuscitation.

Apart from wearing light-colored clothing, especially at night, by pedestrians,[19] modification of environmental factors, including aspects of vehicle design (e.g., lower bumpers)[15,20] and road and signal construction (e.g., demarcation of parking slots for vehicles along roads and speed control bumps),[21] have been shown to have an impact on the incidence of injury and injury severity. A reduction of 16 km/hr (10 mph) on minor roads, where most young children are struck, is projected to halve the number of injuries.[22] The narrowing of minor residential roads could reduce traffic speed.[22] Pedestrian walkways/curbs should be used more often by pedestrians to reduce the incidence of other forms of pedestrian crashes.

## Conclusions

The high mortality rate seen in this study from pedestrian traffic crashes at one major medical center in Nigeria confirms the multi-sector issues involved in prevention and mitigation of the consequences of traffic crashes in Africa. The baseline epidemiology from this study should lead decision-makers to better plan the various areas required for prevention and improvements, especially in prehospital and hospital management.


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