Published in final edited form as:
Accid Anal Prev. 2010 July ; 42(4): 1080–1088. doi:10.1016/j.aap.2009.12.016.

Pedestrians Injury Patterns in Ghana

James Damsere-Derry[a], **Beth E. Ebel**[b], **Charles N. Mock**[b], **Francis Afukaar**[a], and **Peter Donkor**[c]

[a] CSIR-Building & Road Research Institute, Kumasi, Ghana

[b] Harborview Injury Prevention & Research Center, University of Washington, Seattle, USA

[c] Department of Surgery, Kwame Nkrumah University of Science Technology, Kumasi, Ghana.

Abstract

Objective—To establish the associations between pedestrian injury and explanatory variables such as vehicular characteristics, temporal trends, and road environment.

Methods—A retrospective analysis of de-identified pedestrian crash data between 2002 and 2006 was conducted using the Building & Road Research Institute's crash data bank. We estimated the odds ratios associated with casualty fatalities using a multinomial logistic regression.

Results—There were 812 pedestrian casualties reported, out of which 33% were fatal, 45% sustained serious injuries requiring hospitalization, and 22% were slightly injured but were not hospitalized. Crossing the roadway accounted for over 70% of all pedestrians deaths. Whereas fatalities in 2002 and 2003 were statistically indistinguishable from those of 2004($p>0.05$), in comparison with 2004, there were significantly fewer fatalities in 2005 and 2006 (78% and 65% reduction respectively). According to police report, the probability that a pedestrian fatality occurring in Ghana is attributable to excessive speeding is 65%. The adjusted odds ratio of pedestrian fatality associated with speeding compared with driver inattentiveness was 3.6(95% CI: 2.5 to 5.2). It was also observed that generally, lighter vehicular masses were associated with lower pedestrian fatalities. Compared with buses, pedestrians were less likely to die when struck by private cars (52%), pick-up trucks (57%), and motorcycles (86%).

Conclusion—Pedestrian death remains the leading cause of fatality among urban road users in Ghana. Risk factors associated with pedestrian fatality include being hit by heavy vehicles, speeding, and roadside activities such as street hawking, jaywalking and nighttime walking. Steps which may contribute to reducing pedestrian fatalities include measures to reduce vehicles speeds in settlements, providing traffic medians and lighting streets in settlements, and discouraging street and roadside activities such as hawking.

Keywords

pedestrians; speeding; casualties; injuries; fatalities; Ghana

Corresponding author's damsere@u.washington.edu;jdamserederry@yahoo.com.

1. Introduction

Pedestrian crashes are the leading cause of traffic injury deaths in Ghana. Vehicular-pedestrian collisions account for over 60% of all urban road user deaths in Ghana (Afukaar et al., 2008). Rapid global motorization has been associated with increased traffic fatalities and injuries (Peden et al., 2004); (Tunali 1996); (Vasconcellos 2001). Eighty percent of the world's vehicles are owned by 15% of the world's population in North America, Japan, and Western Europe. One might expect the distribution of traffic injuries and fatalities to follow a similar pattern. Paradoxically, the burden of road traffic crashes is disproportionately borne by citizens in developing countries. More than 85% of fatalities and 90% of disability-adjusted life years lost from road traffic injuries occur in developing countries (Peden et al., 2004); (Nantulya and Reich 2002); (Mock et al. 2003); (Mock et al. 2005); (Asiamah et al. 2002). Pedestrian injury and fatality rates are considerably higher in developing countries than in developed economies. For example, pedestrian fatality rates were 65% in Nairobi, Kenya (Khayesi 1997), 54% in Latin America (Donroe et al., 2008), and 60% among urban regions in Ghana (Afukaar et al., 2008), compared with 11% in the US (Retting et al., 2003); (Zhu et al. 2008); (NHTSA, 2004). The livability of modern cities in developing countries poses a challenge to vulnerable road users. Pedestrian safety is not a high priority in most developing countries (Khayesi, 1997); (Kwakye et al., 1997). According to Zhu et al., (2008); and Mutto et al., (2002), 82% Mexican and 78% Ugandan urban dwellers felt unsafe while using public transport and while walking in the street. Pedestrians compete with motorists for road space at their peril.

1.1. Risk factors

This report analyzes pedestrian risk according to individual, behavioral and environmental factors.

1.1.1. Individual factors- Gender and Age—Research has shown that pedestrian crashes are more common among males in all regions and across all age groups (Yee et al., 2006); (Peden et al., 2004); (Nantulya and Reich 2002); (Odero et al., 2003). Pedestrian injuries and fatalities are most prevalent among young children between the ages of 5 and 9 years, and older adults over 70 years of age, (Retting et al., 2003); (Traffic Safety Facts 2001); (Vestrup and Reid 1989). Children with disabilities also face elevated pedestrian injury risk (Mann et al., 2007).

1.1.2. Pedestrian behavior—Pedestrian action may predispose them to injury. Bungum et al., (2005) found that pedestrians contribute to injury risk through inattention and distraction. According to this report, risk factors include wearing headphones, talking on a cell phone, and eating, drinking, smoking or talking while crossing the roadway. The authors also identified lack of pedestrian caution as a risk factor. Pedestrians who looked left and right, and entered the crosswalk only when the crossing signal was flashing, were at lower risk of being struck by a vehicle.

1.1.3. Alcohol—Pedestrian alcohol use is an established risk factor for pedestrian traffic injury (Vestrup and Reid 1989). Data from the Insurance Institute for Highway Safety (1997) indicated that among US pedestrians aged 16 years or older who were fatally injured at night, 55% had blood alcohol concentrations of 0.10% or more. Conversely, the intoxication rate among drivers involved in pedestrian collision was only 12% during the same period (LaScala et al., 2001); (National Highway Traffic Safety Administration 1997). Studies in Ghana are lacking, but anecdotal evidence suggests that alcohol consumption may be high among teen and adult pedestrians in Ghana, perhaps higher than reported rates of drunk driving in the country (Mock et al., 2000).

1.1.4. Environmental risk factors -Vehicular speed and traffic volume—Traffic volumes and vehicular speed have been identified as risk factors for traffic crashes in general, and pedestrian crashes in particular. Researchers found a strong association between child pedestrian crash risk and traffic volume (Christie, 1995); (Roberts et al., 1995). According to Roberts et al., (1995) the risk of pedestrian injury at high volume traffic sites was 14 times greater than at low volume sites.

There is an exponential relationship between vehicular speed and pedestrian fatality rates (Peden et al., 2004). Vehicle speeds in built-up areas in Ghana are excessive and pose a serious risk to pedestrians (Damsere-Derry et al., 2008). Notwithstanding these extremely high vehicular speeds in built-up areas in Ghana, speed calming measures have not been universally embraced. Speed humps and rumble strips have been used to calm traffic in built-up areas on some highways in Ghana. Evaluation of these engineering devices in other contexts has reduced pedestrian injury (Afukaar 2003); (Jones et al., 2005).

In addition to traffic volume and speed, Donroe et al., (2008) identified roadside development such as the presence of street hawkers and the absence of lane demarcation as serious risk factors for pedestrian crashes.

The objective of the study is to explore the associations between pedestrian injury and explanatory variables such as demographic and vehicular characteristics, temporal trends, and the road environment.

2. Methodology

The crash database at the Building & Road Research Institute (BRRI) was used to examine pedestrian injury patterns in Ghana between 2002 and 2006. The database is managed using the Microcomputer Accident Analysis Package (MAAP) developed by the Transport Research Laboratory UK. Each year, the BRRI collates crash data from police reports using standard crash forms and enters these data in the MAAP database.

2.1 Data Quality

Two major shortfalls characterized with police crash reports are under-recording and under-reporting. Under-recording arises when data personnel are unable to retrieve all the crashes available on the police accident files. Police are sometimes hesitant in giving out crash files to data personnel when the accident case is still pending in the court. Under-reporting on the other hand occurs when parties involved in a traffic crash decide to settle the crash case out of court and thus fail to report the incident to the police. This occurs when the offending driver accepts responsibility for the payment of damaged vehicle repairs and hospital bills if any casualties were involved. Delays and bureaucracies in the judiciary system in Ghana compel people to resolve collisions that do not involve fatality or are not life-threatening out of court. Salifu and Ackaah, (2009) have recently reported on both under-recording and under-reporting of traffic crashes in Ghana. According to the report, under-recording of traffic crashes has considerably declined from 37% in 1997-1998 to 27% in 2003-2004. Less severe crash outcomes such as property damage was more likely to be under-reported (57%) compared to serious injuries (8%) and fatality (0%). Pedestrian collisions (for that matter, data used herein) are less likely to be under-reported due to the attendant severe injuries. Additionally, over the past 10 years, there has been a gradual increase in efforts to better train the police for more accurate recording on police crash reports (upon which the database used in this study is based). Accompanying this, there seems to have been a gradual decrease in the percent of variables that are left blank or not coded in the accident forms.

2.2. Classification of pedestrian injury casualties

By definition, injured casualties refer to the count of pedestrian victims following collision with a vehicle. In Ghana, when a pedestrian collision is reported to the police, there is police follow-up for hospitalized victims until discharge or death, or after the offending driver has been prosecuted. Pedestrian injury severity is classified as fatal, hospitalized or slight injury. Fatal pedestrian injury is defined as death occurring within 30 days of the crash event, and hospital injury is defined as injury requiring at least 24 hours of hospital care. Other injury which does not result in a 24 hour hospital stay is defined as slight injury.

2.3. Setting

The study site constitutes a 250 kilometer stretch of the Kumasi-Accra highway, a predominantly single carriageway road linking the national capital, Accra and the second largest metropolis, Kumasi. It is the major northbound trunk road linking the coast (south) to northern Ghana through Kumasi. The Accra-Kumasi highway is the most highly-travelled road in Ghana. The road traverses many settlements of varying sizes and engenders disproportionate pedestrian crashes.

2.4. Human Subject Approval

The committees on Human Research and Ethics of the Kwame Nkrumah University of Science & Technology (KNUST) and the University of Washington granted approval for analysis of the retrospective de-identified BRRI accident database between the periods of 2000 to 2006.

2.5. Study period

Study data on pedestrian crashes on the Accra-Kumasi highway were collected for a five-year period between 2002 and 2006.

2.6. Analysis

Both descriptive and inferential statistics were used in the analysis. We estimated the odds ratios associated with injury fatalities using multinomial logistic regression. The covariates used were age, gender, road environment, vehicle type, and pedestrian action immediately preceding the crash.

2.7. Variables

2.7.1. Dependent variables—The dependent variable investigated is pedestrian injury severity. Originally, pedestrian injury severity in the accident database at the BRRI is at three levels; fatal, hospitalized and injury. For logistic regression analysis, pedestrian injury was collapsed into binary levels and coded 1 if fatal, and 0 if otherwise.

2.7.2. Independent variables—Major covariates investigated were grouped into four categories: (a) socio-demographic characteristics, (b) road characteristics, (c) temporal trends and (d) vehicle characteristics.

2.7.2.1 Socio-demographic characteristics: Pedestrian age, driver age and driver experience were first used as continuous variables and later converted into binary levels as appropriate. Drivers in this context refer to drivers who were involved in pedestrian collision. Gender of the pedestrian and driver involved in pedestrian collision represent another two-level independent variable considered.

2.7.2.2 Road characteristics: The major road features considered in the model were: (1) Road separation (presence or absence of median), (2) Road description e.g. straight, curve, incline or bridge, and (3) whether the road traverses a rural, village or urban environment.

2.7.2.3Temporal trends: Hour of the day, day of the week, month of the year, and year of the crash were used for the model.

2.7.2.4 Vehicle Characteristics: Vehicle ownership (commercial or private), vehicle maneuvering and driver error were vehicle characteristics considered in the model.

3.0. Results

3.1. General Overview

Pedestrian injury refers to a count of pedestrian victims resulting from a vehicle-pedestrian collision. For example, three pedestrian injuries are recorded if, following a single collision, three pedestrians were involved. Pedestrian injury severity is stratified into fatal, hospitalized (24 hours or more), or other injury within 30 days of the collision event. During the 5-year period between 2002 and 2006, there were 812 pedestrian injuries, of which 33% were fatal, 45% were serious injuries requiring hospitalization, and 22% were injured but not hospitalized.

3.2. Temporal Trends

Table 1 illustrates the temporal trends of pedestrian injury, stratified by year, days of the week, and hours of day during which the crash occurred. Among all the identified severity levels, pedestrian injuries initially increased from 2002, peaked in 2004, and declined thereafter to the minimum in 2006. Using 2004 as the reference year, we tested the null hypothesis H_o: the difference (2004-year X)=0 versus the alternative H_a: the difference (2004-year X)>0. Injury fatalities in 2004 were significantly higher than in most other years (2002 (*p=0.04*), 2005 (*p=0.01)* and 2006 *(p=0.003)*. Similar patterns were observed among injury requiring hospital care, other injury, and total injury.

3.3. Day of the week

Pedestrian injury was more frequent near the end of the work week. Injury fatality was most common on Friday (18%) and least common on Tuesday (13%). A two-sample proportion comparison test indicated that pedestrian fatalities recorded on Fridays were no different from those on Saturdays and Mondays (*p=0.122)*. Pedestrian fatalities were significantly greater on Fridays than on Tuesdays; (*p=0.05)*, and marginally higher than proportions on Wednesdays (p=0.08), Thursdays and Sundays; (*p=0.06)*, Table 1.

3.4. Hour of day

Hours of the day were categorized into eight three-hour groups, and each category was compared to a reference period (09-12 Greenwich Mean Time (GMT)). Crash time was further collapsed into two categories: daytime and nighttime. Among pedestrian fatalities, there were no discernible difference between most of the strata compared with 09-12 GMT (*p>0.05)*. A two-sample comparison test showed that proportion for 09-12 GMT was significantly higher than early hours of the day 00-03 GMT (*p<0.001)* and 03-06 GMT (*p=0.02)* during which pedestrian mobility and activities are limited. Fatalities between 15-18 GMT and 18-21 GMT were significantly greater than between 09-12 GMT (*p=0.04 and p=0.005 respectively)*. Comparing fatality rates between daytime and nighttime showed that pedestrian casualties were significantly higher in the nighttime than the daytime period (*p<0.001)* at each severity level (Table 1).

3.5. Road Characteristics

3.5.1. Settlement type—Based on population of towns, settlements in which pedestrian injury occurred were classified into three categories: (i) urban (population greater than 5000); (ii) village (residents are less than 5000) and (iii) rural (where there are no permanent inhabitants). Considering the relative safety among settlement types, living in villages was more pernicious than living in an urban center, as 63% of all deaths occurred in villages, compared with 27% of death occurring in urban centers. However, almost half (49%) of pedestrians requiring hospitalization occurred in urban settlements, while 44% occurred in villages (Table 2). As expected, pedestrian casualties on the rural segments constituted the least; 8% for total injuries, and 10% among fatalities.

3.5.2. Road separation—Most pedestrian fatalities (92%) occurred on road sections without a central median, while the remaining fatal injuries (8%) took place on sections with traffic median islands (Table 2).

3.5.3. Road description—The data was stratified into five sub-divisions based on whether the road section on which the pedestrian collision occurred is straight only, curve only, incline only curve and incline, bridge or on the crest of a hill. This attempt to quantify the actual sight distances available to both drivers and pedestrians to enable them react appropriately when the need arises. Majority of pedestrian fatality (82%) occurred on straight sections. Some 10% and 7% of pedestrian fatality happened on incline only, and curve only sections respectively. A two-sample proportion comparison test showed that pedestrian fatality, hospitalization and all casualties occurring on straight only sections were significantly higher ($p<0.001$) than all other road descriptions (Table 2).

3.5.4. Location Type—Most pedestrian crashes (80%) occurred at sites described as "Not at Junction" across all severity levels (Table2). Two-sample proportion comparison between pedestrian collisions at "Not at Junction" to all other location types (Crossroads, T-Junctions, Staggered Crossroads, and Y-Junction) yielded a statistically significant difference ($p<0.001$).

These sites are generally perceived to be inherently safer than other locations due to their simplicity in design. More pedestrian crashes occur on simple sites than more complex ones. T-Junctions were the next important locations, accounting for 10% of all pedestrian crashes, 12% of all fatalities, and 9% of all hospitalizations among pedestrians (Table 2).

3.6. Driver and vehicle characteristics

The predominant vehicle type which caused majority of the pedestrian crashes was not immediately known by the police and was classified as "unknown". The majority of these "unknown" vehicles comprised "hit-and-run" events and were either driven by minors without driving licenses or adult drivers who committed other traffic offenses such as drunk-driving and left the scene to escape from the police. Generally, 68% of fatalities, 65% of pedestrian hospitalized injury, and 50% of slight injury resulted from "unknown" vehicle type. Private cars and buses were the most common vehicles involved in pedestrian crashes at all levels (Table 3).

3.6.1. Driver Factors—The most common driver factor contributing to fatal pedestrian injury was excessive speed (44%) followed by driver inattentiveness (30%). A two-sample test of proportion comparing too fast (excessive speeding) with inattentiveness revealed that drivers' error attributed to excessive speeding was significantly greater than inattentiveness ($p<0.001$). Similarly, excessive speeding was significantly higher ($p<0.001$) than all other driver factors contributing to pedestrian fatality. Among pedestrians hospitalized for traffic collisions, over 70% resulted from driver inattentiveness and excessive speeding (Table 3). There were however pedestrian crashes resulting in 7% fatality, 9% serious injuries, and 13% slight injuries in which drivers were not at fault whatsoever.

3.7. Pedestrian characteristic and action

Table 4 shows that males were overrepresented in pedestrian injuries during the study period, constituting 68% of fatalities, 63% of hospitalizations, and 63% among other injuries. Comparison of two sample proportions; male versus female showed that male pedestrian involvement at each level of severity was significantly higher than their female counterparts ($p<0.001$).

3.8. Pedestrian action and location

Crossing the roadways constituted a serious predisposition of pedestrians to traffic collisions. Seventy-three percent (73%) of pedestrian fatality, 70% pedestrian hospitalization and 58% of slight pedestrian injuries resulted as pedestrians attempted to cross the roadways. A vast majority (68%) of pedestrians were knocked down when they were right in the middle of the roadways. Only 3% of total pedestrian casualties resulted at designated pedestrian crossings; and 0.4% on central reservations (Table 4).

3.8. Multiple logistic regression analysis

Among the fifteen independent variables used, age was the only continuous predictor and the rest were categorical of different levels. In an attempt to simplify an overly complicated model and developing a parsimonious one, the stepwise logistic regression model using the backward elimination procedure was used and the results displayed in Table 5.

We specified the elimination cut-off probability at 0.05%. Thus all covariates or their levels having coefficients significantly higher than the 0.05 level were removed from the model.

The logistic function which describes the mathematical form on which the logistic model is based is given by

$$f(z)=\frac{1}{1+e^{-z}} \quad (1)$$

To derive the logistic model from the logistic function we expand equation 1 to

$$Z=\alpha+\beta_1X_1+\beta_2X_2+\ldots..\beta_kX_k \quad (2)$$

where Z is an index which combines the X*'s* which are independent variables to be considered whilst α and β_i are constant terms representing unknown parameters to be determined from the data.

The probability of pedestrian fatality $P(D)$ is given by:

$$P(D=1|X_1,X_2\ldots..,X_k)=\frac{1}{1+e^{-(\alpha+\Sigma\beta_iX_i)}} \quad (3)$$

For notational convenience, we will denote the probability statement $P(D=1|X_1,X_2\ldots..,X_k)$ as $P(X)$. Hence the logistic model may be written as

$$P(X) = \frac{1}{1+e^{-(\alpha+\Sigma\beta_i X_i)}} \quad 4$$

Substituting the logit equation into equation 2, we derive the full model for age, speed, unknown vehicle, nighttime collision, year 2005 and collision within 50 meters from Zebra crossing as follows: $z = -0.68 + 0.012Age + 1.28sp + 2.14unk + 0.51NT - 0.50Yi + 1.33AZ$, where −0.68 is a constant, *Age* denotes (age of the pedestrian victim), sp denotes (drivers' error classified as excessive speeding), *Yi* denotes (accident year 2005), *unk* denotes (vehicle type involved in a collision type classified as "unknown"), *NT* denotes (pedestrian collision occurring at nighttime), and *AZ* denotes (pedestrian collision within 50 meters away from Zebra crossing). Thus substituting the logit coefficients into equation 4, we derive equation 5 which can be used to determine the predicted probability of pedestrian fatality as follows:

$$P(X) = \frac{1}{1+e^{-\left(-0.68+0.012\text{Age}+1.28sp+2.14unk+0.51NT-0.50Yi+1.33AZ\right)}} \quad 5$$

Using equation 5 to estimate, the probability that a pedestrian fatality occurring in Ghana in 2005 comparing with 2004 was attributable to excessive speeding alone after accounting for other covariates is 65%. In other words, 3 out of 5 of pedestrian fatalities are attributable to excessive speeding. The adjusted odds ratio comparing inattentiveness with speeding resulted in a positive and a significant association with fatality (P<0.001). The adjusted odds ratio of pedestrian deaths resulting from drivers error classified as excessive speeding compared with inattentiveness was 3.6 (95% CI: 2.5 to 5.2) (Table 5).

Considering the seven vehicle types involved in pedestrian casualty fatality, only four were significantly associated with pedestrian fatality when compared with buses. Generally, after controlling for age, time of day, driver error, year of crash and pedestrian action, "unknown" vehicles were positively associated with pedestrian deaths (P=0.0001). Comparing with buses, the adjusted odds ratio for pedestrian fatality associated with "unknown" vehicles was 8.5 (95% CI: 2.3 to 30.7). Conversely, compared with buses, pedestrians were significantly less likely to die when knocked down by private cars (p<0.001), pick-ups (p=0.024), and motorcycle (P=0.016). As illustrated in Table 5, there was 52%, 57% and 86% chance of pedestrian survival associated with pedestrian collision with private cars, pick-ups and motorcycles respectively, compared with buses.

Pedestrian fatality was not significantly different among the eight strata of three hour classification of the hours of the day (P>0.05). After dichotomizing the hours of the day into daytime and nighttime however indicated that nighttime pedestrian fatalities were significantly higher than those occurring at daytime (p=0.005). The adjusted odds ratio associated with nighttime pedestrian fatality compared with daytime was 1.7 (95% CI: 1.2 to 2.4).

Among the five years studied, pedestrian fatalities during the index year (2004), compared with fatalities in 2002 and 2003 were not statistically different (p>0.05). There was a 78% reduction in pedestrian fatality (adjusted odds ratio, 0.2; 95% CI: 0.002 to 0.09) and 65% (adjusted odds ratio 0.4; 95% CI: 0.1 to 0.9) for 2005 and 2006 respectively.

Finally, we determined the risk of fatal injury associated with pedestrian locations immediately preceding the collision. Getting killed at some 50 meters away from designated Zebra Crossings and "Others" were significantly higher than at Zebra Crossings (p=0.004) and (p<0.001) respectively. Pedestrian locations classified as "Other" include those knocked down while hawking on the roadside or those hit in structures abutting the roadways such as kiosks, shops and buildings. The adjusted odds ratios associated with pedestrian fatality within 50 meters from Zebra Crossings and “Other” compared with pedestrian death at Zebra Crossings were respectively 3.8, (95% CI: 1.5 to 9.3) and 16.7, (95% CI: 4.6 to 61.2).

4.0. Discussion and recommendation

Unlike the developed countries where people walk for pleasure and to improve upon their health statuses through this physical activity (Parks and Schofer, (2006); Gårder, (2004)), walking in developing countries is essentially a transport mode on its own and as such a necessity. Car ownership is generally low in Ghana and public transport is either non existent in some areas or associated with prohibitive fares when available, thus compelling people to make most of their journeys on foot. Pedestrian volume counts are not routinely collected in Ghana. Nonetheless, walking along and crossing roads constitutes an important proxy for measuring pedestrian exposures. Road construction in Ghana has not adequately incorporated non-motorized facilities. On the strength of this, pedestrian-vehicular interactions in Ghana offer scenes of utter misunderstandings. Pedestrians resort to haphazard ways of crossing the roads and are therefore predisposed to needless crashes. On the rural trunk roads, pedestrians generally prefer walking along the hard tarred road or road shoulders to walking in the bushy, muddy and dusty paths. Typically, school children, farmers and traders among others, walk along the roads for considerable distances and thus stand the chance of being knocked down, especially whenever crossing the roadways as shown in (Table 4). Jubilant crowds sometimes throng the principal streets of towns when their political parties win an election or national/ favorite football teams win a tournament and are most often involved in pedestrian-vehicular crashes (The Daily Graphic, Saturday October 24, 2009). Pedestrian crash risk is therefore very high considering the fact that walking trips remain inevitable.

Another important pedestrian exposure is vehicular speeds. Research has established that there is an exponential relationship between vehicular speed and pedestrian fatality rates (Peden et al., 2004). Vehicle speeds in built-up areas in Ghana are excessive and pose a serious risk to pedestrians (Damsere-Derry et al., 2008). As shown in Table 5, police reports indicate that speed account for 65% of pedestrian fatalities in Ghana. Thus 3 out 5 of pedestrian fatalities in this country are attributable to speeding. Notwithstanding the extremely high vehicular speeds in built-up areas in Ghana, speed calming measures have not been universally embraced. Speed humps and rumble strips have been used to calm traffic in built-up areas on some highways in Ghana. Evaluation of these engineering devices in other contexts has reduced pedestrian injury (Afukaar 2003); (Jones et al., 2005). The preeminence of pedestrian casualties in Ghana suggests that pedestrian planning should be prioritized in this country. It is worth noting however, that pedestrian fatality has significantly declined since 2004, suggesting that safety interventions such as traffic calming measures, provision of ambulatory and emergency medical services, and pedestrian education over the years have chalked some success and should be replicated in areas lacking them.

Eventhough pedestrian behaviour such as inattention and distraction in traffic, (Bungum et al. 2005; and alcohol use, (LasCala et al, 2001) may lead to pedestrian crashes, little is known in Ghana in this regard. The police accident forms in Ghana do not have specific fields describing pedestrian faults/errors leading to crashes in Ghana. Nevertheless, it is plausible to reason that a substantial proportion of crashes in which drivers’ faults were described as ‘none’ could be attributed to pedestrians’ mistakes. As illustrated in (Table 3), this surrogate estimate of pedestrian faults accounted for 7% fatality, 9% of severe injuries resulting in hospitalization, and 13% of slight injuries.

Also, nighttime fatality rates were notably higher compared with daytime rates (adjusted odds ratio 1.7, *p=0.005)*. Research shows that poor luminous intensity is a precursor of many pedestrian collisions at nighttime (Plainis et al. 2006), (Owens et al. 1996), (Owens and Sivak 1993), (Elvik, (1995). Nighttime pedestrian visibility in Ghana is further compromised as many settlements lack street lights. The traditional dress code; black and red, for funeral ceremonies which predominate at evenings and nighttimes of weekends could worsen pedestrian visibility situation at nighttime when there are no street lights. It is recommended that adequate lightings be provided in built-up areas along the major highways in Ghana to improve upon pedestrian visibility at nighttime.

Pedestrian collisions in Ghana are ubiquitous phenomena, occurring both in settled and non-settled environments. Pedestrian fatality predominated (63%) in village settlements greatly because of excessive prevailing speeds. Severe crash outcomes are generally found in villages. In larger urban settlements however, side frictions and the presence of local traffic (associated with lower speeds); have a mediating effects on speeds. Consequently, compared with villages, casualty crashes in urban centers were less severe and frequent. As shown in Table 2, pedestrian casualties on the rural segments constituted the least; 8% for total injuries, and 10% among fatalities. Pedestrian fatalities were significantly higher at road sections without traffic medians compared with those with traffic medians. This suggests that increasing these engineering devices in built-up sections of the roads might improve upon pedestrian safety. The presence of traffic medians simplifies crossing decisions for pedestrians, as they can cross opposing carriageways in stages.

Apart from the “unknown” vehicle modes which are usually associated with hit and run crashes with high pedestrian fatality rates, private cars, pick-ups, and motor cycles were associated with a reduction of pedestrian fatality risk; between 50 and 90% reduction compared with buses. Relating the masses of vehicular types involved in the pedestrian collisions to the reference (buses) lends credence to the hypothesis that the likelihood of pedestrian fatality is higher among heavy vehicles when compared with lighter ones (Paulozzi 2005) (Bellesteros et al. 2004), (Lefler and Gabler 2004) (Roudsari et al. 2004). A study in the US found that when vehicles were classified according to weight quartiles, vehicles in the upper quartile which collided with pedestrians were almost twice as likely to result in fatality compared with pedestrian collisions with vehicles in the lowest quartile (Ballesteros et al. 2004). It is recommended that bypasses are provided to reduce high speeding and the presence of heavy vehicles in settlements.

Generally, roadways in Ghana are important social facilities and as such vital activity generators. Lorry parks, street selling and shops abound along the roadways because there are no definite punishments for such activities. According to Donroe et al. (2008), Inclan et al. (2005), and Wedegama et al., (2006) the presence of roadside activities is positively associated with pedestrian injury.

Compared with death at zebra crossings, pedestrian death at location other than within 50 meters of zebra crossing, on traffic medians, in road center, and on footpath adjoining roadways and for that matter classified as “other” stand an unprecedentedly high risk; (OR=16.7; $p <$ 0.001). Pedestrian injury may increase from nearby hawking on sidewalks and on the road, social and religious processions and it is likely that such factors are operating in Ghana (Inclan et al. 2005).

4.1 Conclusion

Pedestrian death remains the leading cause of fatality among urban road users in Ghana. Major risk factors associated with pedestrian fatality include heavy vehicles, speeding, roadside activities (e.g. hawking, jaywalking and nighttime walking). There has been a considerable reduction in pedestrian fatality rates since 2004, corresponding with an increase in traffic calming and focus on pedestrian safety. Since walking remains essentially an important mode of travel in Ghana, improving pedestrian safety in this country should be a high public health priority. There remains the challenge of reducing pedestrian fatality by increasing use of speed reduction techniques, building traffic medians and lighting streets in settlements, and discouraging street and roadside activities such as hawking. With continued attention to these safety measures, the downward trend in fatal pedestrian injury can continue.

Acknowledgments

This study was funded, in part, by a grant from the Fogarty International Center, US National Institutes of Health (D-43TW007267), and a grant from the National Center for Injury Prevention and Control, US Centers for Disease Control and Prevention (R49 CE000197). The authors thank the staff of the Building & Road Research Institute, Kwame Nkrumah University of Science and Technology, and the Harborview Injury Prevention and Research Center, University of Washington, who assisted with the study.

References

Afukaar, FK., et al. Road traffic crashes in Ghana, Statistics 2007. 2008.

Afukaar FK. Speed control in developing countries: Issues, challenges and opportunities in reducing road traffic injuries. Injury Control and Safety Promotion 2003;Vol.10(No.1-2):77–81. [PubMed: 12772489]

Afukaar FK, et al. Pattern of Road Traffic Injuries in Ghana: Implications for Control. Injury Control and Safety Promotion. 2003 Vol.10(No.1-2):69–76. [PubMed: 12772488]

Asiamah G, et al. Understanding the knowledge and attitudes of commercial drivers in Ghana regarding alcohol impaired driving. Injury Prevention 2002;Vol. 8:53–56. [PubMed: 11928975]

Ballesteros MF, et al. Pedestrian injuries and vehicle type in Maryland, 1995-1999. Accident Analysis & Prevention 2004;36:73–81. (2004). [PubMed: 14572829]

Bungum TJ, et al. The association of distraction and caution displayed by pedestrians at a lighted crosswalk. Journal of Community Health August;2005 Vol.30(No.4) 2005.

Christie, N. The high risk child pedestrian: socio-economic and environmental factors in their accidents; TRL research report. 1995. p. 117

Damsere-Derry J, et al. Assessment of vehicle speeds on different categories of roadways in Ghana. International Journal of Injury Control and Safety Promotion 2008;15(2):83–91. [PubMed: 18642165]

Donroe J, et al. Pedestrian road traffic injuries in urban Peruvian children and adolescents: case control analysis of personal and environmental risk factors. Plos ONE 2008;Vol.3(Issue 9):e3166. [PubMed: 18781206]

Elvik R. A meta-analysis of evaluation of public lighting as an accident countermeasures. Transportation Research Record 1995;1485:112–13.

Gårder PE. The impact of speed and other variables on pedestrian safety in Maine. Accident Analysis & Prevention 2004;36:533–542. [PubMed: 15094405]

Inclan C, et al. Social capital in settings with a high concentration of road traffic injuries. The case of Cuernavaca, Mexico. Social Science and Medicine 2005;61:2007–2017. (2005). [PubMed: 15922497]

Jones SJ, et al. Traffic calming policy can reduce inequalities in child pedestrian injuries: database study. Injury Prevention 2005;11:152–156. 2005. [PubMed: 15933407]

Khayesi M. Livable streets for pedestrians in Nairobi: The challenge of road traffic accident. World Transport Policy and Practice 1997:4–7.

Kleinbaum, D,G.; Klein, M. Statistics for Biology and Health. 2nd edition. Springer; 2002. Logistic regression: A self-learning text.

Kwakye EA, et al. Developing strategies to meet the transport need of the urban poor in Ghana. World Transport Policy and Practice 1997:8–14.

LaScala EA, et al. Neighborhood characteristics of alcohol-related pedestrian injury collisions: A geostatistical analysis. Prevention Science 2001;Vol.2(No.2)

Lefler D,E, Gabler HC. The fatality and injury risk of pedestrians in the United States. Accident Analysis & Prevention 2004;36:295–304. (2004). [PubMed: 14642884]

Mann JR, et al. Children with hearing loss and increased risk of injury. Annals of Family Medicine 2007;vol.5(No.6) www.annfammed.org.

Mock C, et al. A random, roadside breathalyzer survey in Ghana. Journal for Crash Prevention and Injury Control 2000;Vol. 2(3):193–202.

Mock CN, et al. Economic consequences of injury and resulting family coping strategies in Ghana. Accident Analysis and Prevention 2003;Vol. 35:81–90. [PubMed: 12479899]

Mock C, et al. Human resources for the control of road traffic injury. Bulletin of World Health Organization 2005;83(4):294–300.

Mutto M. The effect of an overpass on pedestrian injuries on a major highway in Kampala-Uganda. African Health Sciences 2002;Vol2(No.3)

Nantulya VW, Reich MR. The neglected epidemic: Road traffic injuries in developing countries. Education and Debate, BMJ 2002;volume 324:1139–1141.

National Highway Traffic Safety Administration. Pedestrians. National Highway Traffic Safety Administration; Washington, DC: 1997. Traffic safety facts 1997.

Owens DA, Sivak M. Differentiation of visibility and alcohol as contributors to twilight road fatalities. Hum Factors 1996;38:680–9. [PubMed: 8976629]

Owens, D.; Sivak, M. The role of visibility in night-time traffic accidents. 2nd International Symposium on visibility and luminance in Roadway lighting; Orlando. 1993. p. 133-47.1993

Parks JR, Schofer JL. Characterizing neighborhood pedestrian environments with secondary data. Transportation Research Part D 2006;11:250–263.

Paulozzi JL. United States pedestrian fatality rates by vehicle type. Injury Prevention 2005;11:232–236. 2005. [PubMed: 16081753]

Peden, M., et al., editors. World report on road traffic injury and prevention. World Health Organization; Geneva: 2004. p. 71-97.p. 114-129.

Retting AR. A review of evidence-based traffic engineering measures designed to reduce pedestrian-motor vehicle crashes. American journal of public health 2003;vol.93(No.9)

Roberts I, et al. Effects of Environmental factors on risk of injury of child-pedestrians by motor vehicles: a case-control study. British Medical Journal 1995:91–94. [PubMed: 7833733]

Roudsari BS, et al. Pedestrian crashes: higher injury severity and mortality rate for light truck vehicles compared with passenger vehicle. Injury Prevention 2004;10:154–158. (2004). [PubMed: 15178671]

Salifu, M.; Ackaah, W. Under-reporting of road traffic crash data in Ghana. Abstract for the 4th IRAD conference; Seoul, Korea. 16-17 September, 2009; [Access on 16th October, 2009]. 2009 from (www.internationaltransportforum.org/Irtad/pdf/seoul/4-salifu.pdf)

Hit-and-run driver kills satellite fun; The Daily Graphic. Oct 24. 2009 p. 30

Traffic Safety Facts 2001. National Highway Traffic Safety Administration; Washington DC: 2002.

Vasconcellos, EA. Urban transport, environment and equity: the case for developing countries. Earth-scan Publication; London: 2001.

Vestrup JA, Reid JD. A profile of urban pedestrian trauma. J Trauma 1989;29:741–745. 1989. [PubMed: 2500534]

Wedegama, et al. The influence of urban land-use on non-motorised transport casualties. Accident Analysis and Prevention 2006;38:1049–1057. [PubMed: 16876100]

Yee WY, et al. Road traffic injuries in the elderly. Emergency Medical J 2006;23:42–46.

Zhu M, et al. Urban and rural variation in walking patterns and pedestrian crashes. Inj. Prev 2008;14:377–380. [PubMed: 19074243]

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 1

Temporal Trends of Pedestrian Injury in Ghana

Variable	Fatal Injury n (%)	Hospitalized n (%)	Other Injury n (%)	Total Injury n (%)
Crash Year				
2002	52 (19.2)	76 (20.8)	35 (19.9)	162 (20.0)
2003	60 (22.1)	84 (23.0)	33 (18.8)	177 (21.8)
2004	69 (25.5)	94 (25.8)	42 (23.9)	205 (25.3)
2005	47 (17.3)	61 (16.7)	35 (19.9)	143 (17.6)
2006	43 (15.9)	50 (13.7)	31 (17.6)	124 (15.3)
Day of Week				
Monday	39 (14.4)	50 (13.7)	22 (12.5)	111 (13.7)
Tuesday	35 (12.9)	51 (14.0)	29 (16.5)	115 (14.2)
Wednesday	37 (13.7)	42 (11.5)	16 (9.1)	95 (11.7)
Thursday	36 (13.3)	65 (17.8)	27 (15.3)	128 (15.7)
Friday	49 (18.1)	55 (15.1)	27 (15.3)	131 (16.1)
Saturday	39 (14.4)	52 (14.2)	31 (17.6)	122 (15.0)
Sunday	36 (13.3)	50 (13.7)	24 (13.6)	110 (13.5)
Hour of Day				
00-03	4 (1.5)	3 (0.8)	3 (1.7)	9 (1.1)
03-06	20 (7.4)	12 (3.3)	5 (2.8)	37 (4.6)
06-09	29 (10.7)	37 (10.1)	23 (13.1)	89 (11.0)
09-12	35 (12.9)	50 (13.7)	34 (19.3)	119 (14.7)
12-15	39 (14.4)	67 (18.4)	29 (16.5)	135 (16.6)
15-18	50 (18.5)	93 (25.5)	46 (26.1)	189 (23.3)
18-21	60 (22.1)	80 (21.9)	28 (15.9)	168 (20.7)
21-24	34 (12.5)	23 (6.3)	8 (4.5)	65 (8.0)
Daytime	88 (32.5)	102 (27.9)	64 (36.4)	254 (31.3)
Nighttime	183 (67.5)	263 (72.1)	111 (63.1)	557 (68.6)
Total	*271 (100.0)*	*365 (100.0)*	*176 (100.0)*	*812 (100.0)*

Table 2

Road Characteristics and Injury Crash Severity in Ghana

Variable	**Fatal Injury n (%)**	**Hospitalized n (%)**	**Other Injury n (%)**	**Total Injury n (%)**
Settlement type				
Urban	73 (26.9)	180 (49.3)	105 (59.7)	358 (44.1)
Rural	28 (10.3)	23 (6.3)	12 (6.8)	63 (7.8)
Village	170 (62.7)	162 (44.4)	59 (33.5)	391 (48.2)
Road Separation				
Median	22 (8.1)	27 (7.4)	8 (4.5)	57 (7.0)
No Median	249 (91.9)	338 (92.6)	168 (95.5)	755 (93.0)
Road Description				
Straight only	221 (81.5)	287 (78.6)	140 (79.5)	648 (79.8)
Curve only	19 (7.0)	21 (5.8)	11 (6.3)	51 (6.3)
Incline only	28 (10.3)	46 (12.6)	18 (10.2)	92 (11.3)
Curve & Incline	2 (0.7)	5 (1.4)	4 (2.3)	11 (1.4)
Bridge	1 (0.4)	5 (1.4)	3 (1.7)	9 (1.1)
Crest	0 (0.0)	1 (0.3)	0 (0.0)	1 (0.1)
Location Type				
Not at Junction	222 (81.9)	308 (84.4)	155 (88.1)	685 (84.4)
Crossroads	6 (2.2)	6 (1.6)	0 (0.0)	12 (1.5)
T/Junctions	32 (11.8)	34 (9.3)	14 (8.0)	80 (9.9)
Staggered				
Crossroads	3 (1.110)	8 (2.2)	1 (0.6)	12 (1.5)
Y/Junction	0 (0.0)	2 (0.5)	2 (1.1)	4 (0.5)
Other	4 (1.5)	3 (0.8)	2 (1.1)	9 (1.1)
Railway	4 (1.5)	4 (1.1)	2 (1.1)	10 (1.2)
Total	*271 (100.0)*	*365 (100.0)*	*176 (100.0)*	*812 (100.0)*

Table 3

Driver Factors and Vehicle Characteristics Associated with Pedestrian Crashes in Ghana

Variable	Fatal Injury n (%)	Hospitalized n (%)	Other Injury n (%)	Total Injury n (%)
Vehicle type				
Car	28 (10.3)	58 (14.8)	32 (14.7)	118 (13.3)
HGV	19 (7.0)	14 (3.6)	12 (5.5)	45 (5.1)
Bus	30 (11.0)	49 (12.5)	45 (20.6)	124 (14.0)
Motor Cycle	1 (0.4)	8 (2.0)	10 (4.6)	19 (2.1)
Pickup	7 (2.6)	8 (2.0)	7 (3.2)	22 (2.5)
Bicycle	0 (0.0)	1 (0.3)	2 (0.9)	3 (0.3)
Unknown	185 (67.8)	254 (64.6)	110 (50.5)	549 (62.1)
Other	3 (1.1)	1 (0.3)	0 (0.0)	4 (0.5)
Total	*273 (100.0)*	*393 (100.0)*	*218 (100.0)*	*884 (100.0)*
Driver Factors				
None	19 (7.0)	30 (9.2)	20 (13.4)	69 (9.2)
Inexperience	2 (0.7)	4 (1.2)	3 (2.0)	9 (1.2)
Inattentive	80 (29.5)	166 (50.9)	70 (47.0)	316 (42.4)
Too Fast	119 (43.9)	68 (20.9)	21 (14.1)	208 (27.9)
Too Close	2 (0.7)	4 (1.2)	1 (0.7)	7 (0.9)
Improper Overtaking	3 (1.1)	3 (0.9)	2 (1.3)	8 (1.1)
Improper Turning	0 (0.0)	1 (0.3)	0 (0.0)	1 (0.1)
Loss of Control	8 (3.0)	14 (4.3)	3 (2.0)	25 (3.4)
No Signal	1 (0.4)	0 (0.0)	0 (0.0)	1 (0.1)
Fatigue/Asleep	0 (0.0)	1 (0.3)	0 (0.0)	1 (0.1)
Other	20 (7.4)	32 (9.8)	24 (16.1)	76 (10.2)
Unknown	17 (6.3)	3 (0.9)	5 (3.4)	25 (3.4)
Total	*271 (100)*	*326 (100)*	*149 (100)*	*746 (100)*

Table 4

Characteristics and Actions of Pedestrian Injury in Ghana

Variable	Fatal Injury n (%)	Hospitalized n (%)	Other Injury n (%)	Total Injury n (%)
Casualty Sex				
Male	183 (67.5)	228 (62.5)	111 (63.1)	522 (64.3)
Female	87 (32.1)	137 (37.5)	62 (35.2)	286 (35.2)
Unknown	1 (0.4)	0 (0.0)	3 (1.7)	4 (0.5)
Pedestrian Action				
No Action	0 (0.0)	2 (0.5)	0 (0.0)	290.20
Crossing Road	197 (72.7)	254 (69.60	102 (58.0)	553 (68.1)
Walking Along Road	12 (4.4)	24 (6.6)	11 (6.3)	47 (5.8)
Walking Along Edge	21 (7.7)	24 (6.6)	21 (11.9)	66 (8.1)
Playing On Road	0 (0.0)	1 (0.3)	0 (0.0)	1 (0.1)
On Footpath	3 (1.1)	5 (1.4)	2 (1.1)	10 (1.2)
Other	32 (11.8)	55 (15.1)	38 (21.6)	125 (15.4)
Unknown	6 (2.2)	0 (0.0)	2 (1.1)	8 (1.0)
Pedestrian Location				
On Pedestrian				
Crossing	7 (2.6)	10 (2.7)	3 (1.7)	20 (2.5)
Within 50m of Crossing	5 (1.8)	3 (0.8)	1 (0.6)	9 (1.1)
On Central Refuge	1 (0.4)	2 (0.5)	0 (0.0)	3 (0.4)
In Road Center	197 (72.7)	253 (69.3)	105 (59.7)	555 (68.3)
On Footpath/Verge	20 (7.4)	35 (9.6)	20 (11.4)	75 (9.2)
Other	36 (13.3)	62 (17.0)	45 (25.6)	143 (17.6)
Unknown	5 (1.8)	0 (0.0)	2 (1.1)	7 (0.9)
Total	*271 (100.0)*	*365 (100.0)*	*176 (100.0)*	*812 (100.0)*

Table 5

Odds Ratio of Pedestrian Fatality in Ghana (2002 – 2006)

Variable	Logit	Adjusted Odds Ratio	P-Value (P>Z)	95% CI (OR)
Age	0.012	1.012	0.011	1.003 – 1.021
Driver error				
Inattentiveness	Reference	-	-	-
Speeding	1.28	3.59	0.000	2.47 – 5.23
Vehicle Type				
Bus	Reference	-	-	-
Car	−0.73	0.48	0.000	0.33 - 0.70
Pick-up	−0.85	0.43	0.024	0.20 – 0.89
Motorcycle	−1.94	0.14	0.016	0.030 – 0.70
Unknown	2.14	8.47	0.0001	2.33-30.71
Time of Day				
Daytime	Reference:	-	-	-
Nighttime	0.51	1.67	0.005	1.16-2.38
Year				
2004	Reference:	-	-	-
2005	−0.50	0.22	0.002	0.087 – 0.57
2006	−1.05	0.35	0.024	0.14 – 0.87
Pedestrian location				
Zebra crossing	Reference:	-	-	-
50 meters from zebra	1.33	3.79	0.004	1.54 – 9.33
Others	2.8	16.73	0.000	4.57 – 61.21
Constant	***−0.68***	-	-	-