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Characteristics of Pedestrian Accidents on Trunk Roads in Ghana

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ABSTRACT: *Annually, pedestrian accidents account for over forty percent (40%) of all road traffic accidents whilst trunk roads record two-thirds of all road traffic fatalities. Whilst the unpredictability nature of accidents is well documented, diagnostic tools require to establish causality and to inform intervention strategies have been many but with varied successes. Over the years, accident statistics have shown no discernible pattern in improvement levels even with so much efforts and pedestrians continue to bear the brunt of the inefficiencies on the trunk road environment. This study employed descriptive analysis to identify potential pedestrian accident causal factors from key attributes of the road transport system. A 5-year accident data, i.e. from 2006 to 2010, on a trunk road length totalling 13,263km, was processed using the Microcomputer Accident Analysis Package (MAAP) 5 software. The analysis of the national and regional data sets resulted in a variety of distinct risk factors obtained for different regions in the study area. This rudimentary method of accident investigation identified the unique characteristics of potential and possible risk factors of pedestrian accidents in different socio-economic environments. It has also reinforced the need for proper accident problem contextualization and data representation using more sophisticated methods for accident investigation.*

Keywords – *Characteristics, Descriptive Analysis, Ghana, Pedestrian Accident, Trunk Road.*

I. INTRODUCTION AND APPROACH TO THE STUDY

In developing countries, pedestrians represent the most dominant users of road space but there is a huge deficit in the provision of pedestrian infrastructure. This often results in pedestrian accidents as it is established that annually pedestrian accidents accounted for over forty percent (40%) of the distribution of road traffic accidents by road user type (Afukaar, 2001 [1]). Trunk roads (highways) account for two-thirds of all road traffic fatalities with pedestrians representing about forty percent (40%) of the accident victims (BRRI, 2010 [2]).

Over the years, several approaches and methods have been used to assess road traffic safety; from single accident rate to accident prediction models that relate the expected accident frequency at a road location to its traffic and geometric characteristics, users of the road as well as its operating system (G-Basyonny and Sayed, 2006 [3]). The unpredictability nature of pedestrian accidents however requires a more thorough and systematic diagnosis of the accident problem in order to inform appropriate intervention strategies. Using rudimentary analytical tools, key attributes of the road transport system are assessed and their relationships with pedestrian accident incidence established. This preliminary investigation therefore offered the opportunity to identify potential and possible causal factors from the attributes of the 'pedestrian' accident victim, the vehicle, road alignment elements and type of land use within the accident's environment.

In Ghana, the Transport and Research Laboratory (TRL) Microcomputer Accident Analysis Package (MAAP) 5 software has been the main tool for accident analysis and reporting. Though quite elementary, it presents accident and casualty data including details of the vehicle involved, climatic conditions and the road environment. A 5-year pedestrian accident data, i.e. from 2006 to 2010, on the trunk roads were processed employing the MAAP 5 software.

From the synthesized data, descriptive analysis techniques were used to identify potential pedestrian accident causal factors (Analysis, Ch. 3 [4]). A general description of pedestrian accidents was presented at the national and regional levels to show the distinct differences in risk factors. From these perspectives, safety practitioners are well informed on the uniqueness of the problem and the appropriateness of methods employed in accident investigation.

II. SCOPE OF STUDY

Since 2001, the Ghana Highway Authority (GHA) has been improving and maintaining a total trunk road network of 13,263 km. In terms of function, the network has been categorized into three groupings, namely: national (roads linking regional capitals to national capital), inter-regional (roads linking regional capitals) and regional (roads linking district capitals to regional capitals) roads (MRH, 2005 [5]).

The Ghana Highway Authority uses a Pavement Management and Maintenance Programme (PMMP) as its Pavement Management System (PMS) tool to effectively allocate resources to address the management and maintenance requirements of the trunk road network (GHA, 2010 [6]). From its portfolio of paved and gravel roads, condition scores computed for homogeneous sections are reported. It was indicated that the overall condition mix of the trunk road network had dropped substantially compared to trends in recent past. The reasons assigned to the drop were attributed to very little or no routine maintenance interventions in the previous year, among others. Table 1.1 presents the overall condition mix of the trunk road network as at the end of 2010.

Table 1.1 – Road surface condition mix

Condition Description	Length (km)	Percentage (%)
Good	3,865	29
Fair	5,841	44
Poor	3,56	27
Total	13,263	100

Source: Road Condition Report, 2010, GHA, MRH

Geographically, the study domain covered pedestrian accident data recorded on all trunk roads in the ten (10) regions of Ghana. Fig. 1.1 shows the map of the trunk road network and the different trunk road types.

Fig. 1.1 – Trunk road network

III. DATA PROCESSING AND ANALYSIS

Information on road traffic accidents is available at the National Road Traffic Accident database at the Building and Road Research Institute (BRRI) in Kumasi, Ghana. The database is compiled from police files using a standard accident report form. This form includes information about the accident location, the vehicle(s) involved and casualty details. In general, a police report contains additional information from casualties, witnesses, and report by a vehicle examiner from the Driver and Vehicle Licensing Authority (DVLA), a plan of the accident indicating the location and a general report by the investigator summarizing the facts surrounding the accident. The accident information is then coded and stored in computers at the BRRI and analyzed with the help of the MAAP software. The software has capacity to analyze accidents at specific locations, using stick diagrams to display key accident features in the form of a column (or stick) of data. The investigator then chooses from a number of different sticks and can sort the variables into any specified order. It also provides a priority listing of the worst accident sites in a city or area. Accident reference numbers can be quickly obtained and individual records displayed or printed.

For this study, relevant information for each accident was retrieved and analyzed using the kilometer analysis facility and cross-tabulations available in the MAAP software. Accident and casualty data obtained included characteristics of victim (age and sex), type of vehicle involved and its movement, month, day and hour of accident, accident and casualty severity, visibility, direction and accident location type.

IV. DATA PRESENTATION AND DISCUSSION

The processed pedestrian accident data and the results of the synthesized data were presented as accident severity by location type, casualty severity by age group, casualty by gender, accident by vehicle type, and accident by time of day. The distributions and summaries provided a general description at the national level (Wikipedia [7]). In providing additional perspective to the character of pedestrian accidents on trunk roads, regional differences were discussed based on the extent of dispersion of computed regional values from the national average for different established pedestrian accident attributes.

4.1 General Characteristics of Pedestrian Accidents

4.1.1 Accident Severity by Location Type

Table 4.1 illustrates the national distribution of accident severity and also presents accident severity as recorded in the non-urban environment. In all, a total of 15,710 pedestrian accidents were recorded, out of which, 10,626 represented fatal and serious injury accidents (67.6%) and 5,084 accounted for minor accidents (32.4%) (National Road Safety Commission, 2011 [8]). From the statistics on road deaths and serious injuries, it is evident that the outcome of a pedestrian accident is most usually very severe.

Table 4.1 – Distribution of Accident Severity by Location

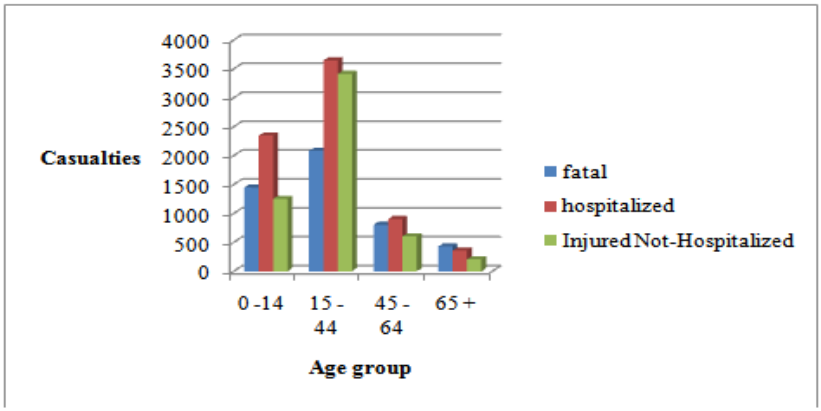
Accident Severity	National		Non-Urban Environment	
	Number	Percentage (%)	Number	Percentage (%)
Accidents				
Fatal	4,088	26.0	2,233	39.8
Hospitalized	6,538	41.6	2,361	42.1
Injured Not-Hospitalized	5,084	32.4	1,014	18.1
Total	15,710	100.0	5,608	100.0

Source: National Pedestrian Accident Data, 2006 – 2010, BRRI

In the non-urban environment, out of a total of 5,608 accidents, 4,594 were fatal and injury accidents representing 82% of the total pedestrian accidents recorded in that setting. The proportion of deaths and serious injuries in rural settlements along trunk roads was substantial as four out of every five persons involved in pedestrian accidents was either killed or had some form of serious disability.

4.1.2 Casualty Severity by Age Group

The distribution of casualties by the different age groups is illustrated in Fig. 4.1. It indicates the number of persons killed or seriously injured as against minor injuries for the various age groups. From Fig. 1.1, persons aged between 14 and 45 years were most at risk as the group alone accounted for 48% of pedestrian deaths and persons with serious disability. Children below the age of 15 years represented the next sizeable number of persons at risk representing 32% of persons with serious injuries. Those above 65 years were the least vulnerable in terms of age grouping but one in two persons of that age group risk dying when involved in an accident. It was also quite revealing that persons between the ages of 44 and 65, supposed to be actively working, only accounted for 13% of the total casualties recorded. This economically active age group is presumed to represent a sizeable proportion of the pedestrian volume that uses the road space and will therefore be susceptible to road traffic accidents.



Source: National Pedestrian Accident Data, 2006 – 2010, BRRI
Fig 4.1 – Distribution of casualties by age group

A Traffic Safety Fact Sheet publication from the US Department of Transportation showed that persons between the ages of 15 and 45 years were most at risk of death (41%) followed by persons between the ages of 45 and 65 years (34%). Persons above 65 years accounted for 19% of pedestrian deaths and children below the age of 15 years represented only 7% of pedestrians killed (Traffic Safety Facts 2009 [9]).

It is instructive to note that while persons between the ages of 15 and 45 years share commonality either in Ghana or in the United States of America (USA) regarding the proportion of pedestrians most at risk, the other age groups show reasonable degree of variance in the distribution of pedestrians most at risk. For instance, children below 15 years in Ghana represented a sizeable proportion of persons with serious disability as a result of pedestrian accidents (32%) but the same age group in the USA recorded only 7% of pedestrian deaths. This development suggests a serious defect with our traffic safety education programme (Downing, C. S., 1987 [10]). There is the need to review our strategies by targeting children in the schools and outside the school system to inculcate in them safe road use habits and to encourage them to teach other children on road safety issues (Jacobs and Aeron-Thomas, 2000 [11]).

4.1.3 Casualty by Gender

According to the 2010 Population and Housing Census, males constitute 48.8% of the national population. However, the casualty distribution by gender as illustrated in Table 4.2 shows high percentages for male fatalities and total casualties as 64.4% and 60.2% respectively. This implies that high numbers of the male population are either being killed or maimed as a result of pedestrian accidents. The reason may perhaps be attributed to the leadership roles they play as heads of households and the attendant responsibilities which require them to make more trips.

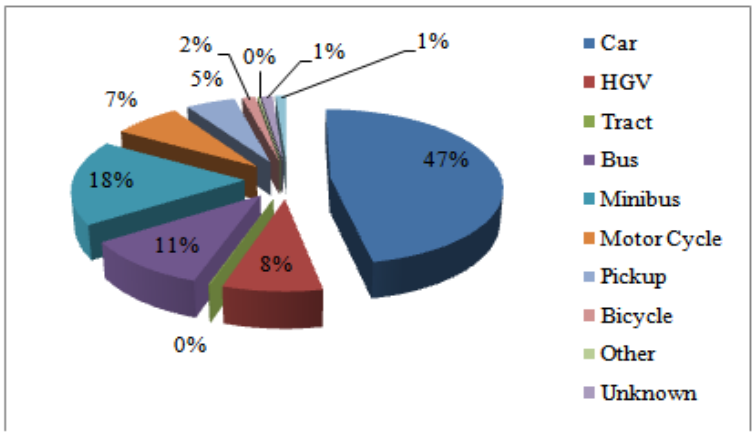
Table 4.2 – Distribution of Casualties by Gender

Gender	Fatalities		Total Casualties	
	Number	Percentage (%)	Number	Percentage (%)
Male	3,107	64.4	10,742	60.2
Female	1,714	35.6	7,111	39.8
Total	**4,821**	**100.0**	**17,853**	**100.0**

Source: National Pedestrian Accident Data, 2006 – 2010, BRRI

4.1.4 Accident by Vehicle Type

The proportion of vehicle types involved in pedestrian accidents is presented in Fig 4.2. From the distribution, it is clear that light vehicles (cars, pick-ups and minibuses) were over-represented and accounted for 76% of the total vehicles involved in pedestrian accidents. This is foreseen, especially, as light vehicles constitutes about 70% of the total number of registered vehicles in the main traffic stream (DVLA, 2010 [12]). Heavy goods vehicles and cycles were also observed to be involved in pedestrian accidents as they represented 8% and 7% of the total vehicles involvement respectively. Buses and minibuses together constituted 29% of the total vehicles involved in pedestrian accidents. Thus, drivers of vehicles mostly involved in pedestrian accidents should feature prominently in road safety education and enforcement programmes.



Source: National Pedestrian Accident Data, 2006 – 2010, BRRI

Fig 4.2 – Distribution of vehicle types involved in pedestrian accidents

4.1.5 Accident by Time of Day

Table 4.3 shows the distribution of pedestrian accident severity by time of day. The time of day that pedestrian accidents occur was then defined from 6am to 6pm to represent times of some appreciable visibility (day) and from 6pm to 6am to represent night time. From the Table, day time accidents represented 64%, while night time accidents recorded 36%. Generally, pedestrian activities at night are less pronounced than during the day. However, in terms of fatality, the rates are about the same for both day time and night time accidents; an implication that a pedestrian risk of death when knocked down by a vehicle is the same at night and during the day. The situation is quite worrisome as activities and interactions on the road environment at night are less intense and thus poor visibility may have been responsible for this phenomenon. This finding situates well with the outcome of a study on the characteristics of pedestrian accidents in eight (8) countries by Downing (Downing, 1991 [13]), it was revealed that the proportion of pedestrians killed on unlit roads was 2 or 3 times higher in developing countries than in developed countries; assigning problems of inadequate street lighting and poor pedestrian conspicuity as the reasons.

Table 4.3 – Distribution of Accident Severity by Time of Day

Accident Severity	**Time of Day**		**Total**
	06:00 – 18:00	**18:00 – 06:00**	
Fatality	2,199	1,890	**4,089**
Hospitalized	4,228	2,315	**6,543**
Not Hospitalized	3,590	1,496	**5,086**
Total	**10,017**	**5,701**	**15,718**

Source: National Accident Data, 2006 – 2010, BRRI

4.1.6 Summary of Risk Indicators

The data described the character of the national pedestrian accident situation and established the extent of risk in a rural setting along a trunk road. Pedestrians of 15 - 45 years in the traffic stream were found to be the most vulnerable and every three out of five male pedestrian risked serious injury when crossing a road in a rural settlement. Light vehicles (cars, pick-ups and minibuses) accounted for 76% of vehicles that were involved in pedestrian accidents. Considering the fact that pedestrian activity at night is less pronounced, it was not surprising that substantial numbers of pedestrian accidents were recorded during the day than at night. In terms of fatality, the risk of a pedestrian dying when hit by a vehicle at night was higher than during the day.

In order to provide a regional perspective to the pedestrian accident situation, the extent of deviations of regional values from the "national" average were estimated. The key accident risk factors used in the assessment were the most vulnerable age group, male pedestrian at risk, vehicles involved in accidents, day time accidents and accident distribution in rural settlements. These factors were considered key elements in the traffic system whose interactions were responsible for pedestrian accident causation.

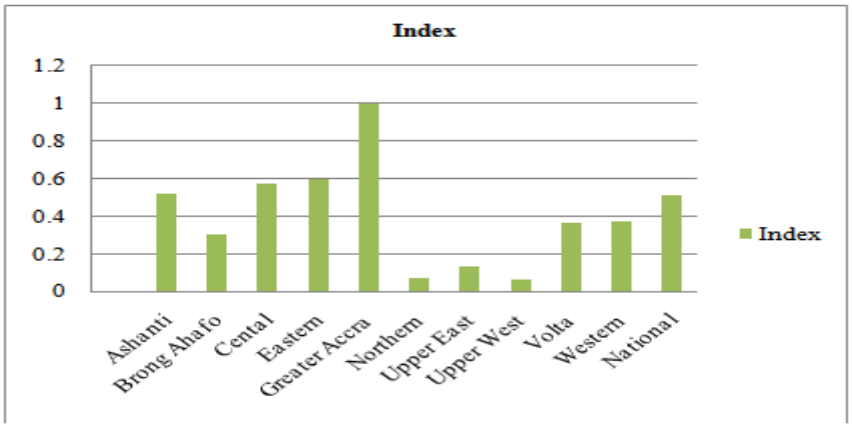
4.2 Regional Characteristics of Pedestrian Accidents

4.2.1 Most Vulnerable Age Group

The distribution of serious injury accidents of pedestrians in the 15 – 45 year group is presented in Fig. 4.3. From the chart, it is clear pedestrians in this age group who lived in the three (3) northern regions of Ghana, namely; Northern, Upper West and Upper East are reasonably safe. The Volta, Western and Brong Ahafo

regions provided the next group of pedestrians who showed some relative safety as their average index (0.34) was below the national index of 0.50. Pedestrians in the Ashanti, Eastern and Central regions were found to be most at risk as they recorded an average index of 0.56. In Greater Accra region, the situation was alarming as it recorded an index of almost unity (0.99). The implication is that a pedestrian belonging to the most vulnerable age group in the Greater Accra region stands 100% risk of death or serious disability when hit by a vehicle than a pedestrian in the Upper West region.

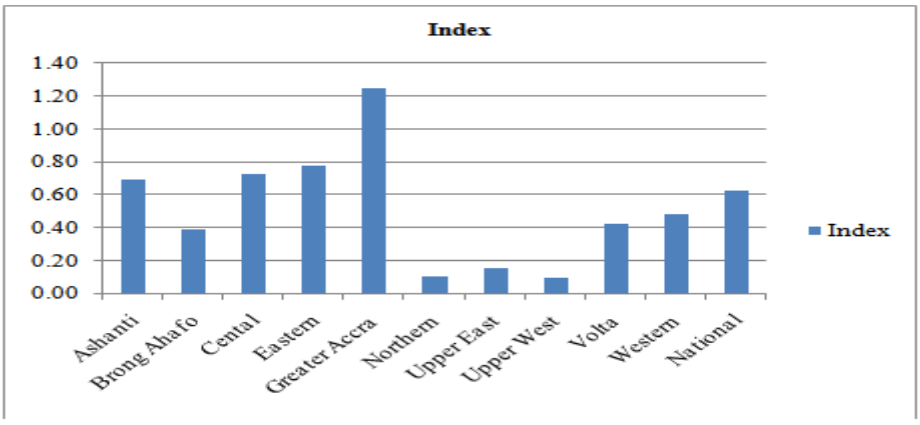
This outcome is not surprising as the most economically active persons are accident prone, especially, those in the Greater Accra region because the region experienced the highest population growth rate (3.1%) between 2000 and 2010, and from the distribution of vehicles registration, recorded the highest growth rate of 44% (Ghana Statistical Services, 2012 [14]). It is evident that the intensity of socio-economic activity, human and vehicular traffic interactions have significant impact on the incidence of pedestrian accidents.



Source: National Pedestrian Accident Data, 2006 – 2010, BRRI
Fig. 4.3 – Distribution of most vulnerable pedestrians by regions

4.2.2 Male Pedestrian at Risk

Fig. 4.4 illustrates the regional profile of the male pedestrian casualty. From the index computation, it is clear that the male pedestrian in the Ashanti, Central, Eastern and Greater Accra regions are at risk but the male pedestrian in the Greater Accra region is most at risk. An index of 1.25 shows the gravity of the vulnerability and the need to appraise the situation in order to find the right interventions. The reason though may not be far-fetched as enormous social and economic challenges pose to the male pedestrian required him to make trips more frequently and therefore exposed to the risks of road traffic accidents.



Source: National Accident Data, 2006 – 2010, BRRI
Fig. 4.4 – Distribution of male casualties across regions

4.2.3 Vehicle Involvement

The distribution of pedestrian accidents by the most involved vehicle types in the regions is presented in Table 4.4. Generally, it was found that the types of vehicles mostly involved in pedestrian accidents are light vehicles (cars, pick-ups and minibuses). In terms of ranking, however, almost all the vehicle types were represented in one region or the other. The Ashanti, Central and Greater Accra regions were represented by cars,

minibuses and buses, while, the Brong Ahafo, Eastern and Western regions showed similar ranking in cars, minibuses and heavy goods vehicles. The trend however changed in the remaining regions and was irregular. For instance, in the Upper East and West regions, motorcycles ranked first, while it ranked second in the Northern region and third in the Volta region. It is not surprising that motorcycles featured as one of the most vehicle involved in pedestrian accidents due to the high patronage of motorcycles in these regions. Therefore strategies to address safety concerns should be different in the regions and for different targets of the most involved vehicles causing pedestrian accidents.

Table 4.4 – Distribution of vehicles most involved in accidents across the regions

Region	Vehicle Involvement					
	Rank 1	%	Rank 2	%	Rank 3	%
Ashanti	Car	44	Minibus	20	Bus	14
Brong Ahafo	Car	49	Minibus	11	HGV	11
Central	Car	49	Minibus	18	Bus	11
Eastern	Car	47	Minibus	23	HGV	10
Greater Accra	Car	50	Minibus	16	Bus	12
Northern	Car	31	Motor Cycle	17	HGV	17
Upper East	Motor Cycle	36	Car	27	HGV	12
Upper West	Motor Cycle	48	Pickup	15	Minibus	13
Volta	Car	39	Minibus	26	Motor Cycle	11
Western	Car	50	Minibus	14	HGV	11
National	Car	49	Minibus	18	Bus	11

Source: National Pedestrian Accident Data, 2006 – 2010, BRRI

4.2.4 Day Time Accidents

Table 4.5 shows pedestrian accident distribution by day in the regions. Day time accidents were not serious issues in the Northern, Upper East and Upper West regions. In the Brong Ahafo, Western and Volta regions, pedestrians showed some measure of risk to accidents. The situation is however different in the Ashanti, Central, Eastern and Greater Accra regions, where the indices computed are above the national average of 0.26.

It is important to note that traffic flow and human activities during the day are more pronounced than at night. Moreover, the size of the working population and the intensity of social and economic activities in the Ashanti, Central, Eastern and Greater Accra regions are reasonably high and may have accounted for the degree of pedestrian vulnerability. It is important to note the regional differences in pedestrian risks and to identify the effective safety appurtenances that will impact day time accidents. The exception to this situation however is in the Upper West region where the number of pedestrian accidents recorded in the day and night was the same. A different diagnosis and strategy will be required to address this peculiar phenomenon.

Table 4.5 – Distribution of Serious Pedestrian Injury Accidents by Day Time in the Regions

Region	Day Time		Index
	Serious Injury Accidents	Population	
Ashanti	1,465	4,780,380	0.306
Brong Ahafo	387	2,310,983	0.167
Central	647	2,201,863	0.294
Eastern	915	2,633,154	0.347
Greater Accra	1,904	4,010,054	0.475
Northern	101	2,479,461	0.041
Upper East	77	1,046,545	0.074
Upper West	34	702,110	0.048
Volta	397	2,118,252	0.187
Western	500	2,376,021	0.210

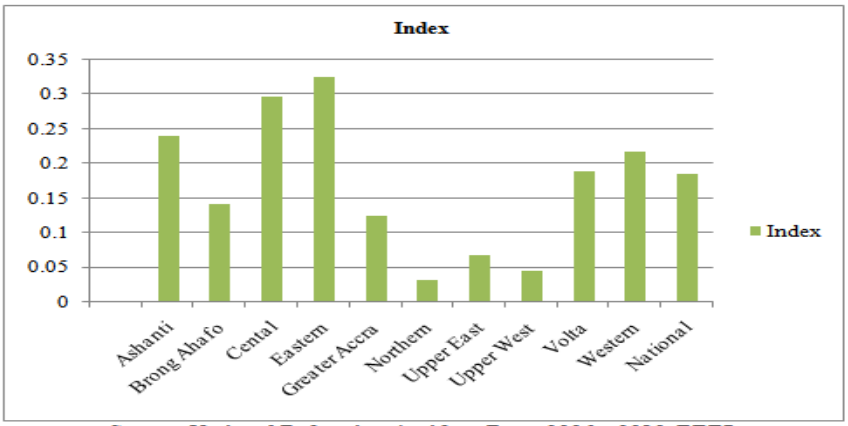
National	6,427	24,658,823	0.261

Source: National Pedestrian Accident Data, 2006 – 2010, BRRI

4.2.5 Accidents in Rural Settlements

The distribution of pedestrian accidents in rural settlements across the regions is presented in Fig. 4.5. Pedestrian accidents were over-represented in urban road corridors but in terms of casualties rural settlements recorded considerable numbers of road deaths and serious disabilities. Fig. 4.5 illustrates the scale of the problem in the regions. It is clear that the Northern, Upper East and Upper West regions do not have the problem of high incidence of pedestrian accidents in rural settlements. This may perhaps be due to the settlement pattern of rural communities in the three (3) northern regions. They are generally far from the road environment and roadside activities are not as intense as in the other regions. The Greater Accra regional index of 0.13 is below the national average of 0.19, suggesting that serious injury accidents may not necessarily be a problem in rural communities within the region.

It is not surprising the consequence of rural pedestrian accidents is severe in the Eastern, Central and Ashanti regions. This is due to the fact that most rural settlements along trunk roads in these regions are quite close to the roads. A situation which encourages roadside activity, thus, pedestrians in rural settlements are exposed to accident risk because of the proximity and interactions within the road environment. The high incidence of pedestrian accidents is attributed to inadequate provisions of pedestrian facilities and indiscriminate use of land within the road environment without due consideration to development controls.



Source: National Pedestrian Accident Data, 2006 – 2010, BRRI

Fig. 4.5 – Distribution of accidents in rural settlements by regions

4.2.6 Summary of Risk Indicators

An assessment of the regional pedestrian accident data provided another dimension to the study by revealing specific details to the general description of pedestrian accidents. The highlights of key findings have been presented.

- A pedestrian within the 15 – 45 age category in the Greater Accra region stands 100% risk of death or serious disability when hit by a vehicle than a pedestrian in the same age group in the Upper West region;
- The male pedestrian in the Ashanti, Central, Eastern and Greater Accra regions are more at risk but the male pedestrian in the Greater Accra region is most at risk;
- The dominant vehicle type in a region contributed significantly to the number of pedestrian accidents recorded as in four (4) regions motorcycles featured as one of the vehicle mostly involved in pedestrian accidents due to their high patronage;
- The size of the working population and the intensity of social and economic activities in the Ashanti, Central, Eastern and Greater Accra regions had some bearing on the degree of pedestrian vulnerability during the day; and
- The high numbers of rural pedestrian accidents in the Eastern, Central and Ashanti regions is due to the fact that most rural settlements are in close proximity with the trunk roads encouraging roadside social and economic activities.

V. CONCLUSION AND RECOMMENDATIONS

The objective of this study was to describe the characteristics of pedestrian accidents and to determine potential causal factors that pose risk to pedestrians on trunk roads. Apart from providing a general description, the regional perspectives of the pedestrian accident situation also revealed the complexity of the problem.

The extent of pedestrian risk on trunk roads was highlighted by the fact that three out of five male pedestrians risked dying when crossing a road in a rural settlement. Pedestrians between the ages of 14 and 46 were found as the most vulnerable and light vehicles (cars, pick-ups and minibuses) accounted for 76% of vehicles involved in pedestrian accidents. Considering the fact that pedestrian activity at night is less pronounced, it was not surprising that day time accidents dominated but in terms of fatality the risk of a pedestrian death when hit by a vehicle at night was higher than that of the day.

Another dimension to this study was an assessment of the regional differences in the pedestrian accident data. Findings from the investigation were quite revealing as pedestrians within the 15 – 45 age category in the Greater Accra region risk dying or having serious disability when hit by a vehicle than a pedestrian in the same age group in the Upper West region. Motorcycles featured as one of the vehicles mostly involved in pedestrian accidents in the Volta, Northern, Upper East and Upper West regions. This is to be expected because of the high patronage of motorcycles in these regions. The size of the working population and the intensity of social and economic activities had a bearing on degree of pedestrian vulnerability in the Ashanti, Central, Eastern and Greater Accra regions. Again, the increasing risk of pedestrians in rural communities on trunk roads in the Eastern, Central and Ashanti regions was due to the fact that most rural settlements feature roads with intense roadside social and economic activities.

The diversity of risk factors realized in the analysis of the regional accident data set gives an indication of the need to properly contextualize the accident problem for effective diagnosis. Therefore, data collected for the study variables, should be all inclusive and representative of the peculiarities of all segments of the study area. This study used rudimentary techniques to characterize pedestrian accidents. It has also shown the importance of situating the accident investigation to cover all relevant elements of the study domain for meaningful and effective diagnosis of the problem. The method of accident characterization should therefore precede any sophisticated accident investigation method in order to provide insight into the issues for analysis and make informed decisions on intervention strategies.

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