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The effect of road and environmental characteristics on pedestrian hit-and-run accidents in Ghana

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ABSTRACT

The number of pedestrians who have died as a result of being hit by vehicles has increased in recent years, in addition to vehicle passenger deaths. Many pedestrians who were involved in road traffic accident died as a result of the driver leaving the pedestrian who was struck unattended at the scene of the accident. This paper seeks to determine the effect of road and environmental characteristics on pedestrian hit-and-run accidents in Ghana. Using pedestrian accident data extracted from the National Road Traffic Accident Database at the Building and Road Research Institute (BRRI) of the Council for Scientific and Industrial Research (CSIR), Ghana, a binary logit model was employed in the analysis. The results from the estimated model indicate that fatal accidents, unclear weather, nighttime conditions, and straight and flat road sections without medians and junctions significantly increase the likelihood that the vehicle driver will leave the scene after hitting a pedestrian. Thus, integrating median separation and speed humps into road design and construction and installing street lights will help to curb the problem of pedestrian hit-and-run accidents in Ghana.

1. Introduction

Death and injury associated with road traffic accidents are global phenomena that require urgent attention (Tay et al., 2009). According to Peden et al. (2004), approximately 1.2 million people worldwide are killed each year as a result of road traffic accidents.

In addition to increases in death of passengers involved in road traffic accidents, pedestrian deaths that result from being knocked down by vehicles have also increased in recent years. Pedestrian accident has been found to be one of the single largest causes of injury, disability and death in the developed world (Sullman et al., 2011). Most accidents involving pedestrians are caused by the negligence of both the pedestrian and the driver. According to Hamed (2000), both drivers and pedestrians in developing countries ignore traffic regulations and thus take greater risks and exercise less caution. Rosenbloom et al. (2004) described pedestrians as a contributing factor to traffic accidents, and they constitute a large subgroup of those who are seriously and fatally injured. Pedestrians continue to be the road user with the highest risk of death in traffic in Ghana, and their actions predispose them to injury (Damsere-Derry et al., 2010; Afukaar et al., 2011). The number of people who are killed on the roads in Ghana is unacceptably high, and the death of pedestrians is the leading cause of fatalities among urban road users in Ghana (Ackaah and Adonteng, 2011; Damsere-Derry et al., 2010). Ackaah and Adonteng (2011) showed that pedestrian collision alone resulted in approximately 51.7% of all fatal accidents in Ghana during the period 2005–2007.

The death of many pedestrians who were involved in road traffic accidents resulted from the driver leaving the pedestrian who was struck at the scene of the accident. Pedestrians who did not die immediately after the collision later died as a result of poor trauma care (Mock et al., 1997; Peden et al., 2004). For example, most of these accident victims may not have died if they had been rushed to the hospital for medical treatment immediately following the accident. Hit-and-run drivers also increase the victim's exposure to being struck again by a subsequent vehicle (MacLeaod et al., 2012). Hit-and-run is described as the driver's decision to leave the scene after hitting a pedestrian without reporting to the police.

Reducing the number of drivers who flee after hitting a pedestrian will help to reduce deaths associated with pedestrian accidents. According to Tay et al. (2009), one way to reduce hit-and-run accidents is to increase the level of traffic enforcement. These authors further argue that educating drivers may change their attitudes and beliefs about hit-and-run accidents.

There are numerous diverse factors that contribute to hit-and-run accidents in general and in Ghana, in particular. This research considers factors such as traffic control, road characteristics and surface conditions, accident severity, light condition and day of the week. Previous research has confirmed that these factors are

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significant influences on the driver's decision to leave or stay on the scene after a pedestrian accident. For instance, light condition, day of the week and traffic condition have been found to be contributing factors in a driver's decision to leave the scene of the accident after striking a pedestrian (Solnick and Hemenway, 1994; Johnson, 1997; Tay et al., 2008, 2009). Solnick and Hemenway (1995) and MacLeaod et al. (2012) concluded in their research that pedestrian and environmental characteristics significantly influence the driver's decision to participate in a hit-and-run by leaving the scene of the accident. These researchers further found that drivers are less likely to flee the scene of the collision if younger or older pedestrians are involved.

This paper aims to contribute to the existing literature on road safety in Ghana by providing empirical results and identifying the effect of road and environmental characteristics on pedestrian hit-and-run accidents by drivers in Ghana. Identifying the effects of road and environmental characteristics on pedestrian hit-and-run accidents in Ghana is important for designing road safety policies and ensuring the successful implementation of road safety programs that will reduce pedestrian mortality due to hit-and-run accidents.

The remainder of the paper is organized as follows: Section 2 describes the methods employed in the study; Section 3 presents the data, empirical analysis and results; and Section 4 provide concluding remarks.

2. Methodology

To explain the effect of the road, environmental and weather conditions on the decision of the driver to leave or stay at the scene of pedestrian accidents, a binary logistic regression model was employed (Solnick and Hemenway, 1995; Tay et al., 2009). This type of model was used because of the dichotomous nature of the dependent variable (i.e., hit-and-run as opposed to not hit-and-run). This type of model makes it possible to estimate the probability of the driver leaving the accident scene based on the independent variables incorporated into the regression model. The independent variables incorporated into the regression model can be categorical or quantitative in nature. The binary logistic regression model is among the family of regression models in the generalized linear model framework (Nelder and Wedderburn, 1972; Agresti, 2007). The model assumes a binomial distribution for the binary dependent variable. A binary logistic regression model, also known as a logit model, is defined in the following manner:

$$\log\left[\frac{P(Y=1)}{1-P(Y=1)}\right] = \log\left(\frac{\pi}{1-\pi}\right) = logit(\pi)$$
$$= \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n, \quad (1)$$

where $P(Y=1)=\pi$ describes the probability of the driver leaving the scene after a pedestrian accident (hit-and-run), while $[1-P(Y=1)]$ represents the probability of the driver not leaving the scene (Agresti, 2007). The logit model predicts the probability (π) of the driver leaving the scene of the accident. This probability falls between 0 and 1 ($0 \le \pi \le 1$) for all possible independent variables. In Eq. (1), α is the intercept term in the model, β_i's ($i = 1, 2, \ldots, n$) are the regression coefficients for each covariate and x's are the set of covariates/independent variables. The parameters in the model can be estimated using a maximum likelihood approach. The estimated model can be evaluated by performing a likelihood ratio test to determine the significance of the covariates in the model. Because the dependent variable is modeled using a log transformation, $\log it(\pi)$, the interpretation of the estimated coefficient is based on the exponential transformation of the estimated coefficient, which is commonly known as the odds ratio. For this study, the odds ratio indicates the likelihood of the driver leaving the scene of the accident with respect to a change in the covariates being considered in the model. The data used in this research were extracted from the National Road Traffic Accident Database at the Building and Road Research Institute (BRRI) of the Council for Scientific and Industrial Research (CSIR), Ghana. The database is compiled from road traffic accident files from the Motor Traffic and Transport Unit (MTTU) of the Ghana Police Service. The database at the BRRI is subject to two shortfalls: non-reporting and under-recording.

Table 1
Descriptive statistics of pedestrian accidents (2004–2010).

Variable	No. of accidents	No. of hit-and-run	Hit-and-run (%)
Year			
2004	2704	236	8.7
2005	3024	217	7.2
2006	3208	257	8.0
2007	3297	222	6.7
2008	2982	243	8.1
2009	3323	259	7.8
2010	3040	234	7.7
Region			
Ashanti	3730	195	5.2
Brong Ahafo	1149	73	6.4
Central	2070	113	5.5
Eastern	2929	145	5.0
Greater Accra	8561	980	11.4
Northern	255	22	8.6
Upper East	224	17	7.6
Upper West	92	5	5.4
Volta	1140	64	5.6
Western	1428	54	3.8
Road environment			
Urban	13,940	1197	8.6
Non-urban	7625	471	6.2
Missing	13	0	
Day of week			
Weekdays	14,900	1124	7.5
Weekend	6678	544	8.1
Accident severity			
Fatal	5444	525	9.6
Non-fatal	16,134	1143	7.1
Weather condition			
Clear	20,088	1492	7.4
Others (rain, fog/ mist, etc.)	1490	176	11.8
Light condition			
Day	14,612	934	6.4
Night – no light	4186	451	10.8
Night – light on	2767	281	10.2
Road description			
Straight and flat	19,631	1568	8.0
Curve and inclined	1927	94	4.9
Road separation			
Median	4238	343	8.1
No median	17,312	1319	7.6
Road surface condition			
Dry	21,386	1652	7.7
Wet	143	5	3.5
Road surface repair			
Good	19,259	1520	7.9
Rough	2269	135	5.9
Location type			
Not at junction	17,173	1434	8.4
Junction	4360	228	5.2
Traffic condition			
None	12,055	944	7.8
Signage	9497	719	7.6

Note: Percentages for missing observations are not shown in the table.