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Investigation of traffic and safety behaviour of pedestrians texting or web-surfing

Marilia Ropaka[a], Dimitrios Nikolaou[a]*, George Yannis[a]

[a]*National Technical University of Athens, Department of Transportation Planning and Engineering, Iroon Polytechniou 5 str., GR-15773, Athens, Greece*

Abstract

The objective of this research is the investigation of traffic and safety behaviour of pedestrians texting or web-surfing. To achieve this objective, a pedestrian outdoor-environment experiment was carried out at three signalized pedestrian crossings in the center of Athens in Greece. Data collected from 142 distracted pedestrians and 412 non-distracted pedestrians were analysed in order to examine the differences between their behaviour. Statistical analyses were carried out using multiple lognormal regression and binary logistic regression models. The results indicated that distracted pedestrians have lower speeds than non-distracted pedestrians. Moreover, the probability of a near miss (distance between pedestrian and vehicle less than two seconds) for non-distracted pedestrians remains very low and almost equal to zero when pedestrian volume or pedestrian speed increase, while for the distracted pedestrians it is much higher and presents an increasing trend.

Keywords: pedestrian; distraction; traffic behaviour; safety behaviour; lognormal regression; binary logistic regression

* Corresponding author. Tel.: +30-210-772-1155;
E-mail address: dnikolaou@mail.ntua.gr

1. Introduction

Despite important efforts and noteworthy progress, road safety remains a major issue that concerns the majority of the countries worldwide, as road traffic injuries are the eight leading cause of death for people of all ages. More specifically, it is estimated that about 1.35 million people lost their lives as a result of traffic accidents in 2016. (WHO, 2018). An important dimension of the problem is vulnerable road users such as pedestrians, cyclists and motorcyclists. Pedestrians, due to their vulnerability to the speed and traffic volume, are at increased risk of serious injury or even death when involved in road accidents. It is estimated that in 2017 there were 5,220 pedestrian fatalities due to road accidents in the EU, which account for 21% of all road fatalities. However, a significant decrease of 36% has been observed in pedestrians' road fatalities in the last decade (ERSO, 2018). It is also remarkable that pedestrian actions may account for 15% of pedestrian fatalities (Thompson et al., 2013).

Another factor that needs to be investigated is the association of pedestrian accidents with the use of mobile phone. Going through an era in which technology is evolving rapidly, it is now a fact that mobile phone is an integral part of people's lives. A recent survey conducted in six major European capitals found that a significant proportion of pedestrians crossing the street made use of their mobile phone (DEKRA Accident Reseach, 2016). Furthermore, many surveys have been conducted in order to analyse traffic and safety behaviour of distracted pedestrians with focus on texting or web-surfing distraction. Distraction activity is common among pedestrians and it was observed that technological and social distractions increase crossing times, with text messaging associated with the highest risk (Thompson et al., 2013). An outdoor-environment experiment was conducted among 28 college student pedestrians in China in order to examine how mobile phone distractions affect behaviour of pedestrians while they are crossing the street. The results showed that mobile phone distractions cause different levels of impairment to pedestrians' crossing performance, with the greatest effect from text distraction (Jiang et al., 2018). Another study tested how talking on the phone, texting, listening to music may influence pedestrian safety and it was observed that participants distracted by music or texting were more likely to be hit by a vehicle in the virtual pedestrian environment than were undistracted participants (Schwebel et al., 2012).

Based on the above, the objective of this paper is to investigate traffic and safety behaviour of pedestrians texting or web-surfing when passing through signalized pedestrian crossings. To that end, a pedestrian outdoor-environment experiment was carried out at signalized pedestrian crossings in the center of Athens in Greece, in order to examine the differences between the behaviour of distracted and non-distracted pedestrians.

2. Data collection

For the purpose of this research, a pedestrian outdoor-environment experiment was carried out at three signalized pedestrian crossings in Athens. The method chosen to collect the data on pedestrian behaviour was mobile phone video recording. The selection of the road sections for the experiment and consequently the selection of the pedestrian crossings were based on the number of lanes of the road, high pedestrian volume to ensure sufficient sample size and the existence of a traffic light on each crossing. The characteristics that were measured are presented in the following list:

- distraction, crossing length, crossing width, number of lanes, pedestrian gender, pedestrian age, pedestrian volume, pedestrian was accompanied by someone else (yes or no), pedestrian traffic light (green or red), trajectory (direct or not direct), pedestrians' conflicts, illegal vehicle passing, vehicle on crossing, near misses (distance between pedestrian and vehicle less than two seconds), weekday, waiting time before crossing, crossing time and pedestrian speed.

The analysis of the videos revealed that 142 pedestrians were texting or surfing the Internet, 113 were talking on the mobile phone, 124 were listening to music using headphones and 1901 pedestrians were non-distracted. Regarding the sample size for this research, all the pedestrians who were using their mobile phone for texting or web-surfing were included in the pedestrian sample. Concerning non-distracted pedestrians, a random sample was selected. More specifically, for each one non-distracted pedestrian who was added in the database, the average speed of the non-distracted pedestrians was calculated and at the point where the average speed stopped changing significantly, the recording of the non-distracted pedestrians sample was stopped. At that moment, the non-distracted pedestrians in the database were 412 and this number was considered representative of the behaviour of all non-distracted pedestrians.

3. Methodology

Data obtained from the videos were analysed using Microsoft Excel and SPSS. Afterwards, statistical analyses were carried out using two modelling approaches; multiple lognormal regression and binary logistic regression models. The basic equation of the multiple lognormal regression model is the following:

$$y_i^* = \log(y_i) = b_0 + b_1 * x_{1i} + b_2 * x_{2i} + \ldots + b_v * x_{vi} + e_i \qquad (1)$$

Regarding the logistic regression model, the typical relationship is the following:

$$Y = Logi(P) = Ln\left[\frac{\text{Pi}}{(1 - \text{Pi})}\right] = B_o + B_i X_i \qquad (2)$$

In this case, four statistical regression models were developed. More specifically, two lognormal models with pedestrian speed as independent variable and two binary logistic regression models with near misses as independent variable were developed.

4. Results

Initially, two multiple lognormal regression models were developed in order to investigate the association between distracted and non-distracted pedestrians' speed and explanatory variables. For both models, the dependent variable was the logarithm of pedestrian speed and explanatory variables include pedestrian age, if the pedestrian was accompanied by someone else (yes or no), crossing length and pedestrian volume. In Table 1, the results for these two lognormal regression models are presented.

Table 1: Lognormal regression models for pedestrian speed

	Distracted Pedestrians		Non-Distracted Pedestrians	
Independent variables	*βi*	*t*	*βi*	*t*
Age	-0.018	-1.781	-0.033	-6.562
Accompanied	-0.052	-2.093	-0.063	-6.194
Crossing length	0.021	7.676	0.026	15.231
$(\text{Pedestrian Volume})^2$	-6.056E-005	-2.662	-3.627E-005	-3.200
R^2	0.648		0.560	

From the results of the models, it is obvious that the independent variables affect in the same way the speed of distracted and non-distracted pedestrians, as the signs of the β coefficients are the same in both cases. Results indicate that elderly people have lower speeds. Moreover, if someone else accompanies the pedestrian, pedestrian speed decreases. Furthermore, it is observed that pedestrian speed is lower if pedestrian volume increases. Sensitivity analysis followed and figures based on sensitivity analysis were also developed to better understand the influence of the independent variables on the speed of the two types of pedestrians. A very interesting finding that came out from the sensitivity analysis was that distracted pedestrians have lower speeds than non-distracted pedestrians.

The association between independent variables and near misses was investigated by using logistic regression models. These statistical models examine near misses with the dependent variable taking two values (0-no near miss and 1-near miss) and traffic light, logarithm of pedestrian speed, pedestrian volume and crossing length as independent variables. The results of the binary logistic regression models are presented in Table 2.

Table 2. Binary logistic regression models for near misses

	Distracted Pedestrians		Non-Distracted Pedestrians	
Independent variables	*βi*	*Wald*	*βi*	*Wald*
Pedestrian Traffic Light (ref. green light)	3.287	11.399	2.269	8.095
Pedestrian Volume	0.083	3.711	-0.074	4.328
Log(speed)	6.158	2.354	3.866	1.860
Crossing length	-0.820	19.907	-0.543	25.724
Cox & Snell R^2	0.683		0.695	
Nagelkerke R^2	0.911		0.927	

It was found that pedestrians who started walking through the crossing when the light was red have higher probabilities of near miss. Moreover, there is an increase in the probability of near miss, if pedestrian speed increases. Finally, it can be observed that the probability of near miss is higher in pedestrian crossings with lower length. The only differentiation between distracted and non-distracted pedestrians model lies in the influence of pedestrian volume. The results showed that an increase in pedestrian volume leads to a reduction in the probability of near miss for non-distracted pedestrians, while an increase in pedestrian volume leads to an increase in the probability of near miss for distracted pedestrians. Another remarkable conclusion that derived from the sensitivity analysis is that the probability of a near miss for non-distracted pedestrian remains very low and almost equal to zero when pedestrian volume or pedestrian speed increase, while for distracted pedestrians it presents an increasing trend.

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