TRA2020 – Rethinking transport
Towards clean and inclusive mobility • Helsinki 27–30 April 2020

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

Paper ID 1161

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Introduction

- An **important aspect** of road traffic injuries' problem is vulnerable road users such as pedestrians, cyclists and motorcyclists.
- Pedestrians suffer, due to their **vulnerability** to the speed of vehicles and increased exposure to multiple vehicles in high traffic volumes.
- In 2017 there were **5,220 pedestrian fatalities** due to road crashes in the EU (21% of all road fatalities).
- Pedestrian **actions and behaviour** may account for 15% of pedestrian fatalities.
- The **expansion of mobile phones** has caused a rising number of pedestrians who use mobile phones in their daily traffic activities by the roadside or even when crossing the street.

Objectives

- To investigate **traffic and safety behaviour** of pedestrians who are texting or web-surfing when passing through signalized pedestrian crossings.
- Examine the differences between the behavior of **distracted** and **non-distracted** pedestrians.
- **Analyze data** derived from an experimental process through video recording in real road conditions.

Data Collection (1/2)

- An **experimental process** through video recording was carried out in real road conditions, in three signalized intersections in the center of Athens in Greece (daylight, peak hours, good weather conditions).
- The selection of the pedestrian crossings was based on the **high pedestrian volumes** typically found in the area, ensuring sufficient sample size, and the **presence of a pedestrian traffic light** on each crossing.
- **Pedestrian crossings** chosen:

Akadimias Street (3 lane road) at intersection with Ippokratous Street
Ippokratous Street (2 lane road) at intersection with Akadimias Street
Skoufa Street (1 lane road) at intersection with Filikis Eterias Square

Data Collection (2/2)

- The **extracted data** used for this study were:
  - Pedestrian distraction
  - Pedestrian gender
  - Pedestrian age estimate 0-17 (child), 18-34 (young), 35-64 (middle) and 65+ (old)
  - Pedestrian crossing length and width
  - Crossing time
  - Pedestrian speed
  - Number of road lanes
  - Pedestrian volume

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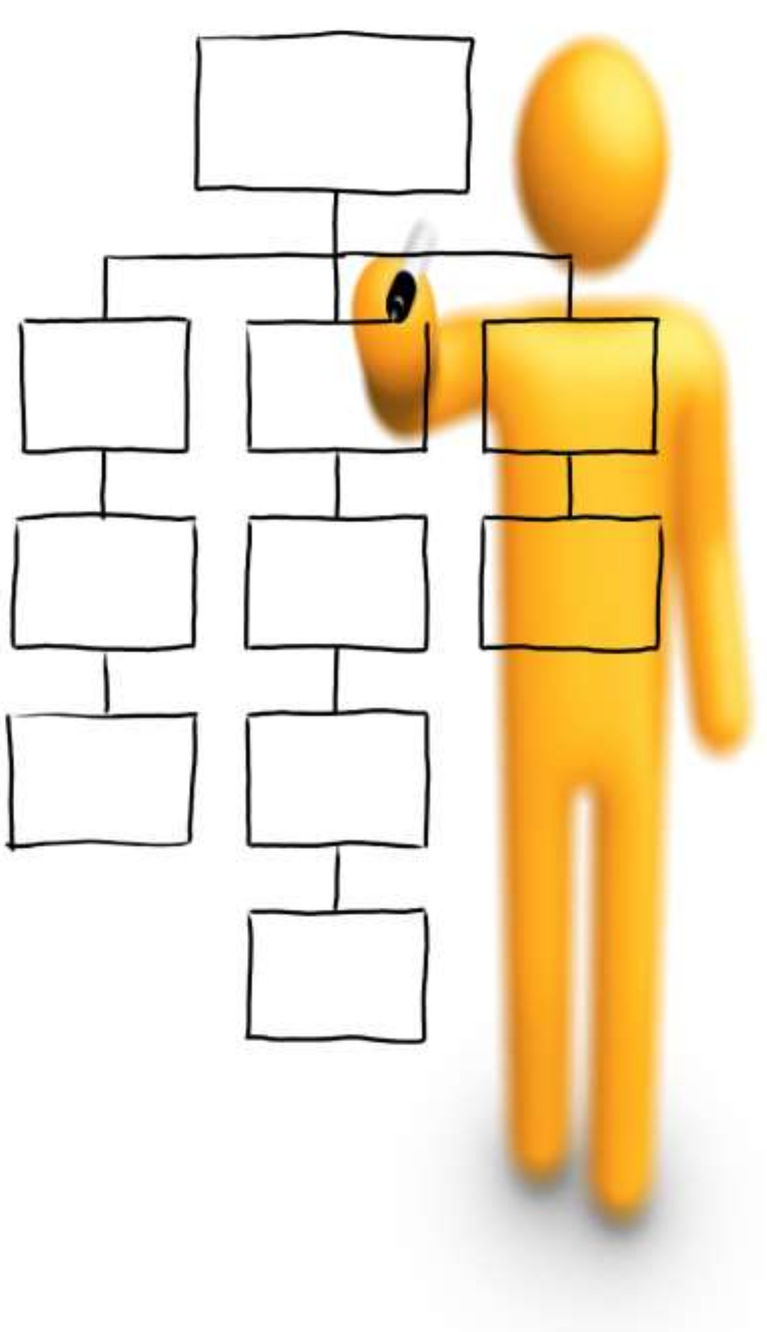
- The videos were examined frame by frame with the **ability to pause and rewind** all the pedestrian times and the calculation of pedestrian speed (m/s) was cross-checked by multiple researchers.

Distraction	Count	Percentage
Distracted Texting/Web-Surfing	142	6.2%
Distracted Music (headphones)	124	5.4%
Distracted Talking	113	5.0%
Non-Distracted	1,901	83.4%
Total	2,280	100.0%

Methodological Approach

- Statistical analyses were carried out using **two modelling approaches**; multiple linear regression and binary logistic regression models.
- The basic equation of the **multiple linear regression** model is: $Y_i = \beta_0 + \beta_1 * X_{1i} + \beta_2 * X_{2i} + \ldots + \beta_v * X_{vi} + \varepsilon_i$ and the accuracy of the model is assessed through the coefficient of determination R squared.
- Where the dependent variable is binary, **binary logistic regression** is the statistical technique used to predict the relationship between predictors and a predicted variable.
- If the **"utility function"** is given by $U=\beta_0+\beta_i * X_i$, then the **probability** P is given by $P=e^U/(e^U+1)$.
- The goodness of fit of the logistic regression model can be assessed with the **Hosmer & Lemeshow Test.**



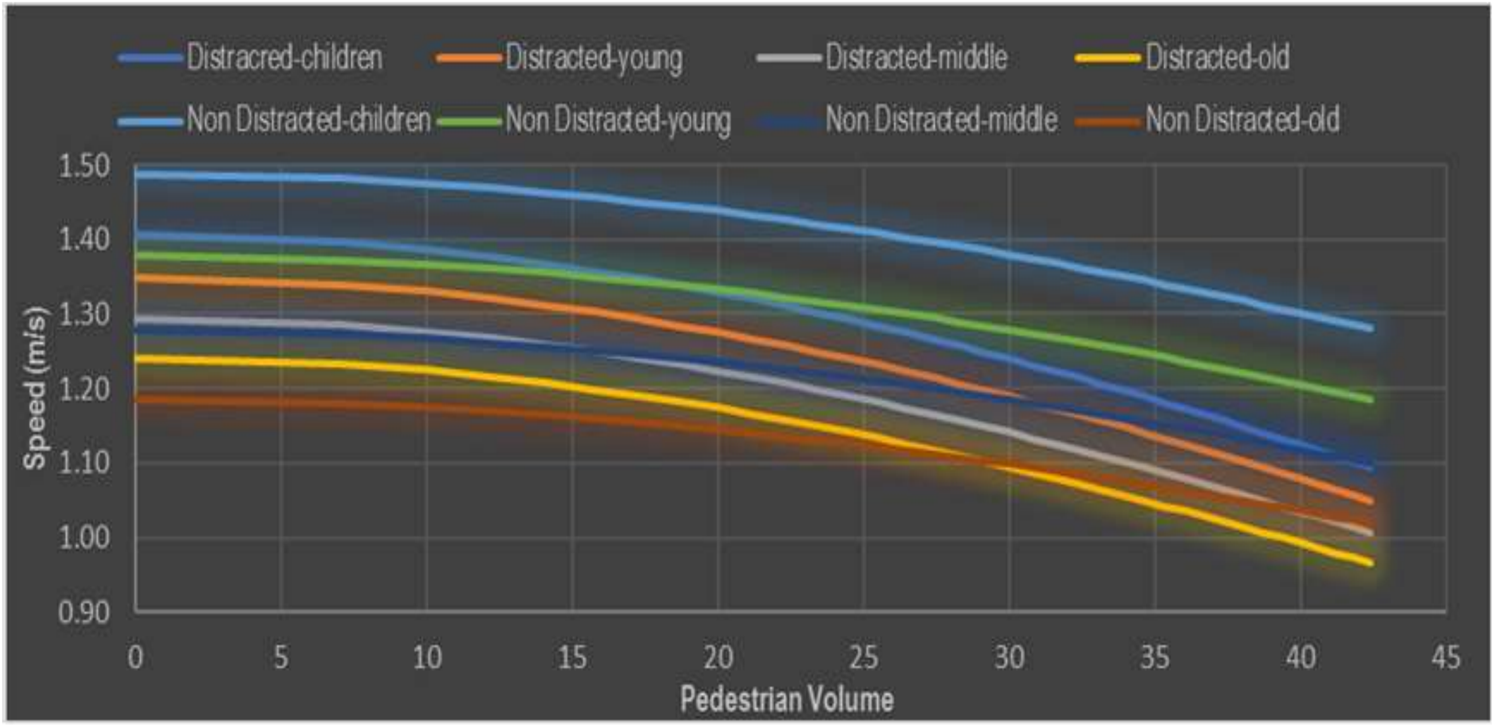
Models for Pedestrian Speed (1/2)

	Distracted Pedestrians			Non-Distracted Pedestrians		
Independent Variables	β_i	t	Sig.	β_i	t	Sig.
Age	-0.018	-1.781	0.077	-0.033	-6.562	0.000
Accompanied	-0.052	-2.093	0.038	-0.063	-6.194	0.000
Crossing length	0.021	7.676	0.000	0.026	15.231	0.000
(Pedestrian Volume)^2	-6.056E-005	-2.662	0.009	-3.627E-005	-3.200	0.001
Adjusted R^2		0.638			0.556	

- It can be observed that the independent variables **affect similarly** the speed of distracted and non-distracted pedestrians, as the signs of the β coefficients are the same in both cases.

Models for Pedestrian Speed (2/2)

- 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.



- At **low pedestrian volumes** distracted children move at higher speeds than non-distracted young pedestrians, as children are very familiar with the use of the mobile phone and their speed is not greatly affected.
- At **high pedestrian volumes**, distracted pedestrians who were texting or web-surfing on their mobile phone present lower speed than non-distracted pedestrians, regardless of their age, as they may be not aware of traffic conditions due to distraction and therefore they have higher crossing times.

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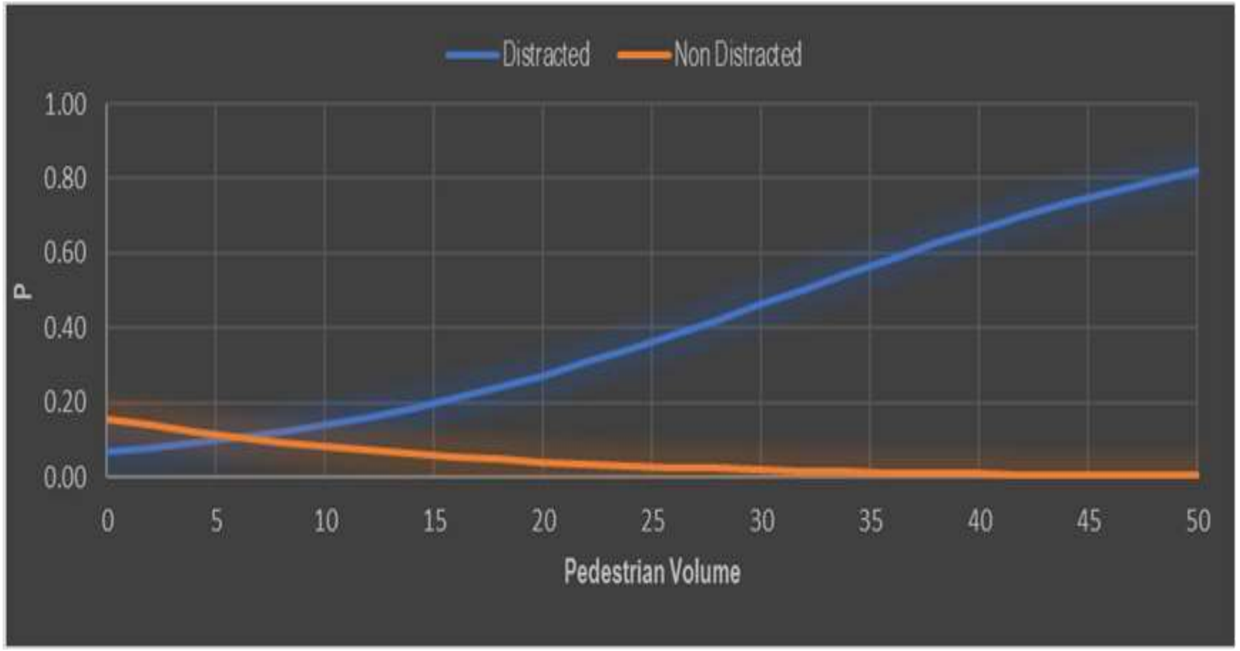
Models for Near Misses (1/2)

	Distracted Pedestrians				Non-Distracted Pedestrians			
Independent variables	β_i	Wald	Sig.	$Exp(\beta_i)$	β_i	Wald	Sig.	$Exp(\beta_i)$
Red Pedestrian Traffic light	3.287	11.399	0.001	26.756	2.269	8.095	0.004	9.671
Pedestrian Volume	0.083	3.711	0.054	1.086	-0.074	4.328	0.037	0.928
Log(Speed)	6.158	2.354	0.125	472.401	3.866	1.860	0.173	47.742
Crossing Length	-0.820	19.907	0.000	0.441	-0.543	25.724	0.000	0.581
Hosmer & Lemeshow Test	0.954				0.578			

- In these statistical models **the occurrence of a near miss** is the dependent variable; this variable takes two values (0: no near miss and 1: near miss observed).
- **Pedestrian volume** does not affect in the same way the probability of a near miss for distracted and non-distracted pedestrians. **The positive sign in the distracted pedestrians**' model shows that as pedestrian volume increases, the probability of a near miss for distracted pedestrians with a vehicle is higher. However, the sign of pedestrian volume **in the non-distracted pedestrians' model is negative** indicating that an increase in pedestrian volume leads to lower probabilities of a near miss.

Models for Near Misses (2/2)

- The following figure shows **the change in the probability of a near miss** depending on the pedestrian volume for both distracted and non-distracted pedestrians who started crossing the street with red pedestrian traffic light.



- **Distracted Pedestrians:** the probability of a near miss increases with increasing pedestrian volume as the more pedestrians who occupy the pedestrian crossing the more difficult is for them to observe carefully the rest traffic.
- **Non-Distracted Pedestrians:** the probability of a near miss decreases with increasing pedestrian volume. This may be attributed to the fact that they are fully aware of the traffic conditions and they can perceive the danger early by observing the behavior of other pedestrians.
- The probability of a near miss for non-distracted pedestrian **remains very low** and almost equal to zero when pedestrian volume increases, while for distracted pedestrians it presents an **increasing trend.**

Conclusions

- Distraction caused by texting or web-surfing on the mobile phone **affects negatively** pedestrians' main traffic and safety characteristics.
- At high pedestrian volumes, **distracted pedestrians** who were texting or web-surfing on their mobile phone present **lower speed** than non-distracted pedestrians, regardless of their age, and therefore they have **higher crossing times.**
- Moreover, at high pedestrian traffic, mobile use not only decreases pedestrians' speed but also **increases their probability** of being involved in a crash with an oncoming vehicle.

Recommendations

- **Educational campaigns** aiming to sensitize pedestrians to the risks of texting or web-surfing while crossing the street.
- A **type of restriction** on walking while using a mobile phone might also be foreseen in busy roads.
- **Mobile applications** warning pedestrians that they are moving towards a pedestrian crossing or that a vehicle is approaching them.
- Mobile phones' **GPS** could recognize that the pedestrians are moving and disable some specific features while walking.
- **Engineering solutions** in the design of road crossings and public places (e.g. green and red lights on the ground).

Future research

- More results could be obtained by observing the same variables on a **larger sample** of pedestrians.
- Expand the experiment in signalized intersections located in different areas and conduct a **comparative analysis** to identify which pedestrians incur higher risks.
- Carry out the same experiment during the **nighttime** in order to identify the differences in pedestrians' behavior between nighttime and daylight hours.
- Take into account **traffic volume.**

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