



Analysis of the State and Development of Road Safety Education in Spanish Higher Education Institutions

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Abstract: Traffic crashes are considered one of the major public health concerns, considering that this phenomenon explains a high number of deaths and injuries every year, and around all the world in different groups of population. The road safety education, (or traffic safety education), regarding the complexity of this process, and that it takes place during the complete process of life of individuals, is considered as a key determinant of road safety behaviors and a relatively lower road risk, essentially for road users with more and diverse high risk factors which may explain the occurrence of road accidents, such as young adults. The general objective of this study was to describe the associated factors to the Road Safety Education in the higher education institutions (universities) of Spain, and its relationship with road safety factors among young adults currently coursing a career in this kind of centers. Throughout this study, it was also assessed a set of indicators related with road safety education “outputs”, such as attitudes towards road safety, knowledge of traffic law and signals, risk perception and risky behaviors on the road. This cross-sectional study used a total sample of n=843 (357 (42.3%) men, and 486 (57.7%) women) university students, who answered a questionnaire designed to collect data about their psychosocial characteristics, factors associated with road safety education at Spanish higher education institutions and, finally, their attitudes, perceptions and self-reported behaviors as road users. Besides finding a very low participation of Spanish universities in road safety education, and of its students in these activities or programs, significant measures of association between individual factors and the employed road safety education indicators were found. Gender comparisons show substantial differences on road safety education indicators between men and women, being, in all cases, more adverse results corresponding to the male gender. Finally, it was built a multiple linear regression model, that allowed to establish the statistical influence of the road safety education on risky behaviors on the road of Spanish university students. This study shows that it is necessary to develop strategies to increase the presence of actions related to road safety education within universities, to improve the coverage and quality of the learning process of this subject among higher education students, and to include universities in the development of a multi-sectorial road safety education strategy.

Keywords: Road Safety Education, Universities, Young Adults, Road Users, Road Safety, Traffic Accidents

1. Introduction

Traffic accidents are, nowadays, characterized as a major public health concern, considering that this phenomenon are associated with a high number of deaths and injuries every year, around all the world and in different groups of population [1, 2]. The *road safety education* (or *traffic safety education*), regarding its breadth, and that it takes place during the complete process of life of individuals, is

considered as a key determinant of road safety behaviors and a relatively lower road risk [3, 4], essentially for road users with more and diverse high risk factors which may explain the occurrence of road accidents, such as young adults. Therefore, we can say that, around the world, there is a manifest need for the education and the prevention on health of the entire population [1, 5].

In other words, road safety education constitutes the best foundation and the greatest guarantee of future road safety, considering that most of the youth population is in a process

of constant exposure to risk [2], and is relevant educate them to strengthen road safety from their behavior. Educate the public on road safety issues represents one of the major current concerns of countries [6] due, among other factors, to the high rates of accidents of young road users [7, 8]. It is an express necessity of modern society to create, train, promote and build positive attitudes toward road safety [9], and often, the best suitable scenario for this task are the educational institutions.

In short, the lack of road safety education among road users may affect their performance, thus increasing the probability of being involved in traffic accidents [10, 11]. In this sense, a promising field of research has been able to study the institutional scenarios under those influence the impartation and improvement of road safety education takes place.

Through the past few decades, literature has progressively shown a not insignificant amount of risk factors that young adults, mostly between 16 and 25 years, present worldwide [12, 13]. Besides, this age period coincides in most countries with university studies [3]. In this regard, it has been determined that, in traffic and other potential disease sources, young people represent a highly vulnerable population with latent and manifest needs for receiving road safety education as a preventive and formative measure to improve their quality of life and health [14, 15].

One of the biggest challenges for road safety education in early adulthood is to achieve a positive impact on different elements (e.g. attitudes towards road safety, knowledge of the traffic laws and road signals, risk perception) and, subsequently, on the road behavior of this high-risk group [16, 17]. At this respect, recent studies have found strong relationships between positive and negative attitudes towards road safety and the involvement in road traffic in different groups of road users [18, 19]. Furthermore, the evidence reported by some of these studies shows that attitudes remain being, probably, the most significant factor in predicting the observed rate of road traffic accidents, above other variables also categorized as "relevant" in the scientific literature [20].

Other elements that have been characterized as essential for predicting traffic accidents, and which in turn are part of the spectrum of road safety education, are the knowledge and recognition of normative (traffic laws) and road signals [21, 22], and risk perception [23, 24], in addition to road safety behaviors, which are the desirable final output of road safety education in general.

Finally, it is worth emphasizing the importance of higher education institutions as agents of social change on issues involving public health of communities. According to some recent studies, it has been determined that these institutions have a broad potential, resources and skills that can potentiate the teaching of, in this case, relevant subjects such as road safety education on its members (i.e. professors, employees, students and extensive members), given the social and investigative emphasis which has, at the present, the higher education in general [3, 25].

Purpose of the Study

The general objective of this study was to describe the associated factors to the Road Safety Education in the higher education institutions (universities) of Spain, and its relationship with road safety factors among young adults currently coursing a career in this kind of centers. The specific objectives or purposes of this research were, concretely: *First*, to describe the frequency in which university students are covered by institutional actions to impart the road safety education issues. *Second*, to determine the level of knowledge, attitudes towards road safety and risky behaviors among university students. *Third*, to determine if there are statistical in the outputs of road safety education between students, according to gender. *Fourth*, to explain road risky behaviors reported by university students from relevant variables related to road safety education, and *fifth*, to provide a further understanding of the state of road safety education within the higher education institutions in Spain.

In general terms, and referring to the significance of this research, these aspects should be used to design better interventions and to increase road safety education in strategic groups of population.

2. Methods

2.1. Sample

Participants were part of a wide-ranging research on different aspects of health that affect driving. The sample used consisted of 843 university students, currently enrolled in Spanish universities, ranging from 17 to 58 years of age, 357 men (42.3%) and 486 women (57.7%), with a mean of $X=22.56$ ($SD=4.29$) years of age. The starting sample size was proportional by quota to the Spanish population segments of age and gender within this kind of institutions. The number of participants represents an error margin for the general data of ± 2.65 with a 95% confidence interval in the most unfavorable case of $p=q=50\%$.

Surveys were completed for 843 drivers and the response rate was approximately 95%; as it was a study dealing with a high impact social matter, the vast majority of people were willing to collaborate. There were approximately a 5% people who did not wish to participate in the research.

2.2. Procedure and Design

This cross-sectional national study used a structured survey. The sample was designed and applied through different universities of Spain. Approximately 80% of students responded to the survey through a virtual link (web-based) survey, and the remaining 20% answered through the live application of a paper version of the same questionnaire within the classroom.

The only selection criteria were to being studying a career in a Spanish higher education institution. The survey was conducted guaranteeing at all times the anonymity of the participants, and emphasizing on the existing data protection

laws and the fact that this information would only be used for statistical and research purposes. For this type of study, a consent statement is not required. The importance of answering honestly to all the arisen questions was emphasized, as well as the non-existence of wrong or right answers. For this purpose, it was designed a self-report questionnaire that evaluates the following variables:

Demographic variables: Gender (man/woman); age; Population size where live (Strata considered are as follows: in less than; Work Activity (Grouped in active, not active, housework, only studying); Profession and/or cursing career or academic program. Complementarily to these items, students were asked whether they had participated in road safety education actions at the center of studies, and other issues related to the promotion of road safety education from the university.

Knowledge of the traffic normative/laws: It was used a short questionnaire (sub-scale) with six statements relating to current traffic regulations in Spain was used. Each of the questions were answered with a "true" or "false" appreciation with a correction factor, adding 1 point if the answer is correct, or 0 if it is incorrect. The potential scores range from 0 (no correct answer) to 6 (all correct answers).

Knowledge and recognition of traffic signals: For this variable, it was employed a brief questionnaire presenting the image of six traffic signals along with a (true or false) description of the signal, asking the participant to respond if the signal corresponded to its description, adding 1 point if the answer is correct, or 0 if it is incorrect. The potential scores range from 0 (no correct answer) to 6 (all correct answers).

Road risk perception: In this case, it was used a scale composed by 12 items related with the risk perception in different situations potentially present in the road environment. Participants were requested to consider the dangerousness of a series of behaviors or situations (e.g. drive un adverse weather conditions, using the mobile phone while walking). The potential scores range from 0 (minimum risk perception) to 24 (high risk perception). *Positive attitudes towards road safety:* It has been used six statements related with road safety, on which students to declare if they believe they are not suitable or were asked were used (e.g. *although be not mandatory, I would use the seat belt*). The potential scores range from 0 (no favorable attitudes towards road safety) to 6 (highly favorable attitudes towards road safety).

Risky behaviors: The risk assumption was calculated by 6 items. The objective of this factor is to rate road users for certain risky behaviors. For each behavior considered, have applied the classification criteria of risk- no risk used in the study SARTRE 3 [26, 27], depending on how often they engaged in these behaviors. The potential scores range from 0 (minimum risky behaviors) to 24 (high risky behaviors).

2.3. Data Processing

In the case of this study, descriptive (frequencies and central tendency measures) and correlational analyzes were

initially conducted, in order to describe and characterize the prevalence of and obtain measures of factors associated with road safety education at Spanish higher education institutions. In addition, comparative analysis with One-way Analysis of Variance (ANOVA) were performed to discriminate the results according to specific characteristics of students who participated in the research. Furthermore, hierarchical multiple regressions were used to predict the participants' self-reported risky behaviors on the road, based on variables related with road safety education results.

Once the data was obtained, the relevant statistical analyses were performed using ©IBM SPSS (Statistical Package for Social Sciences), version 22.0.

2.4. Funding

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2.5. Ethics

For this type of study, ethical approval and formal consent are not required. The research type described in the manuscript did not required the official intervention of the Ethics Committee in Experimental Research (consultative and advisory body of the University of Valencia), as no personal data are used and the participation was anonymous. However, the *Research Ethics Committee for Social Science in Health* of the University Research Institute on Traffic and Road Safety at the University of Valencia was consulted, certifying that the research subject to analysis responds to the general ethical principles, currently relevant to research in Social Science, and issued a favorable opinion to carry out such research in Spain.

3. Results

Institutional coverage of Road Safety Education

Although it should be understood that road safety education is a holistic process and its learning takes place throughout the life (therefore, all individuals have some level of road safety education), the educational system is an essential stage for this learning. For this reason, the first question to answer in this study was "how many university students have received some form of driver education at Spanish higher education institutions?". In this regard, it has been found as a first important indicator of total $n=843$ participants in the study, only 5.21% of them (44 persons, 57% men and 43% women) had participated in any activity or intervention related to road safety in their respective universities.

Indicators of road safety education among university students

With respect to measurable output indicators of road safety

education for the population of university students, the assessment of the following variables was performed: Self-reported risky behaviors as road user [0-6]; favorable attitudes towards road safety [0-6]; knowledge of traffic

normative or laws [0-6]; knowledge of traffic signals [0-6], and road risk perception [0-24]. The obtained scores and its respective correlation coefficients (Pearson) are shown in Table 1.

Table 1. Final scores for the study variables among Spanish university students, and Pearson correlations among them.

Variable	Mean	SD	2	3	4	5	6
1 Age (years)	22.56	4.29	-.173**	0.066	-0.021	0.035	.148**
2 Risky behaviors	2.71	1.37	-	-.137**	.089*	-0.022	-.175**
3 Favorable attitudes towards road safety	4.85	1.16		-	.171**	.106**	.323**
4 Knowledge of traffic normative/law	4.59	0.94			-	0.051	.112**
5 Knowledge of traffic signals	5.33	0.71				-	0.057
6 Risk perception	11.87	2.07					-

** Correlation is significant at 0.01 level. and * at the 0.05 level.

Taking into account the mean scores found for this sample, it can be stated that descriptively, in terms of statistical relativity, the highest average corresponds to the traffic sign recognition, followed by the favorable attitudes towards road safety and the knowledge of the traffic normative. However, the scale of perceived road-risk presents a lower mean score than the aforementioned variables. Transforming proportionally this average to a scale of [0-6], the equivalent mean score would only be $X=2.96/6$, approximately.

As shown in Table 1, the correlational analysis allowed to establish significant measures of association between age and: self-reported risky behaviors (-), finding that with advancing age these behaviors tend to decrease, and risk perception (+), value that uses to increase along the age and experience of road users. In addition to the negative association with age, risky behaviors correlated significantly with: favorable attitudes towards road safety (-), the knowledge of traffic rules (+), and risk perception (-). Finally, favorable attitudes towards road safety were also

associated with: a greater knowledge of traffic regulations (+) and road signs (+), and a greater perception of road-risk (+).

Comparisons according to gender

When comparing indicators or components of road safety education by gender of the participants, significant differences were found in three of the variables of interest: First, with regard to the "positive" aspects associated with road safety education, we have found that women have a significantly higher score in terms of favorable attitudes towards road safety, knowledge of traffic law or normative, and road risk perception, as shown in Table 2. No significant differences in the traffic signal recognition between men and women were found. Concerning what relates to self-reported risky behaviors as road users, although no significant gender differences were found, it has been encountered a clear tendency for this scores, that is greater in the case of men, with an arithmetic mean of $X=2.77$ ($SD=1.40$), compared to the average of women, the latter being of $X=2.67$ ($SD=1.35$).

Table 2. ANOVA - comparisons for road safety education results according to gender.

Variables	Groups	Sum of Squares	df	Mean Square	F	Sig.
Reported risky behaviors	Between Groups	1.75	1	1.75	0.924	0.337
	Within Groups	1515.558	800	1.894		
Positive attitudes towards road safety	Between Groups	41.049	1	41.049	31.405	0.000
	Within Groups	1094.029	837	1.307		
Knowledge of traffic normative/law	Between Groups	4.46	1	4.46	5.008	0.026
	Within Groups	735.746	826	0.891		
Knowledge of traffic signals	Between Groups	0.822	1	0.822	1.607	0.205
	Within Groups	425.501	832	0.511		
Risk perception	Between Groups	69.8	1	69.8	16.491	0.000
	Within Groups	3508.903	829	4.233		

Multiple Regression analysis

The linear regression analysis showed the existence of a relationship between most of the study variables used and road behaviors, which is explained by the equation $Y= 4.55 - 0.039X_1 - 0.122X_2 + 0.186X_3 - 0.092X_4 - 0.205X_5$, being Y the self-reported risky behaviors; X_1 the years of age; X_2 the

positive attitudes towards road safety; X_3 the knowledge of traffic normative/law; X_4 the risk perception; and X_5 the fact of have been in a road training process before. The fixed coefficient of determination was $R^2=0.129$ and the mean square error of 1.7822. Table 3 shows the established typified coefficients and its probability values.

Table 3. Regression coefficients.

Model	Variables	Unstandardized coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3,916	0,256		15,304	0.000
	Age (years)	-0,054	0,011	-0,171	-4,832	0.000
	(Constant)	4,55	0,412		11,039	0.000
	Age (years)	-0,039	0,011	-0,124	-3,434	0.001
2	Attitudes tow. road safety	-0,122	0,044	-0,102	-2,76	0.006
	Knowledge - traffic law	0,186	0,052	0,127	3,597	0.000
	Risk perception	-0,092	0,025	-0,138	-3,721	0.000
	Have you taken road training?	-0,205	0,111	-0,046	-1,844	0.046

Dependent variable: Risky Behaviors for university students

In this model, based on the standardized beta coefficients, the variable the variables with the greatest statistical weight on the estimation of commission risky behavior are: the risk perception ($\beta=-0.138$), the knowledge of traffic law ($\beta=0.127$), the age ($\beta=-0.124$) and the favorable attitudes towards road safety ($\beta=-0.122$). Without being too high, the standardized beta of the previous driver training ($\beta=-0.046$) implies, in the same sense, the statistical significance of this variable in explaining risky road behaviors.

4. Discussion

The general results presented through this study represents, overall and consistently with earlier studies, a great void that afflicts road safety education in Spain in general [3, 28]. In the specific case of higher education institutions, the severity of the relatively poor state of road safety education at the level of coverage and participation is even greater than in the case of other relevant groups of the population [3, 21], taking into account that these kind of institutions use to have, worldwide, a broader spectrum of resources (i.e. economical, material and human) intended for research, formation and intervention on the problems that affect public health and the quality of life of the population, such as traffic accidents [25, 29].

First, the fact that coverage of road safety education within universities is very low implies that there is almost no link between some of the socially relevant issues scientifically addressed by these institutions and the paradigm of "promotion and prevention" to its users or beneficiaries, in this case, their students. Taking into account that only one of each twenty Spanish university students 5.2% have learned contents on road safety within the educational institution, it is worth mentioning the importance of students in this age group, i.e., usually young adults, to learn issues on traffic safety within the educational scenario [30, 31].

Within the annual records of traffic accidents, young adults are one of the population sectors with the highest rates in terms of morbidity and mortality [32, 33], often as a result of the commission of risky behaviors associated to serious accidents (e.g. speeding, driving under the influence of alcohol, deliberate omission of traffic signs) [34, 35, 36]. In this sense, this group constitutes itself as a focus of urgent attention to improve the mechanisms to prevent road

accidents based on the human factor [37, 38]. This is, in other words, generating traffic education oriented along life strategies, especially where it is possible to concentrate the largest possible number of potentially vulnerable subjects [39, 40]. Such is the case of university students.

The state of road safety education outputs among university students

Regarding the results found in this research, it has been found that the lowest average indicator in this sample corresponds to the perception of risk in common situations that occur on the road. In other words, this fact means that, despite knowledge of the rules and traffic signal recognition coefficients among university students have relatively good averages, there is no comprehensive translation of the theoretical content in the practice as road users. A factor which appears to support this assumption is that the average of risky behaviors is significantly higher for the case of participants with a less risk perception, as evidenced in the correlational analysis, describing a negative and significant association between these two variables, such as other studies have described the same direction for this relationship [24, 41].

Gender comparisons

The differences obtained according to the gender of university students in some indicators of road safety education (i.e. attitudes, knowledge and risk perception) show the influence of demographic variables on factors related to road behavior. In this regard, some studies have concluded that there are gender differences that highlight the need to intervene more emphasis on men (without disregarding the intervention in women), taking into account that evidence shows, also, major risk factors for road safety for men than for women in certain groups as young adults [42, 43]. In this respect, previous findings have demonstrated that males tend to have poorest positive attitudes towards road safety, commit riskier behaviors than females and, over time, have more accidents as a result [44].

Given that today the need to develop a "holistic" approach for road safety education is assumed [45, 46], differences in key variables such as gender, age groups and scholar level of beneficiaries are essential for the proper design and delivery of road safety education the population, or specific groups of it such as young adults.

Importance of road safety education indicators in explaining road risky behavior

The development of the multiple linear regression model allowed to identify the influence of age, favorable attitudes towards road safety, risk perception and driver training as protective factors against the commission of risky behaviors on the traffic.

Regarding the specific case of the influence of knowledge of traffic regulations in the estimation of risk behaviors in a positive way, it is worth mentioning that, according to some studies, in the case of road users has been observed that the normative knowledge does not imply by itself the desirable outputs, taking into account that safe behavior is based on the articulation of the knowledge with many elements, such as attitudes, risk perception and perceived existing control [41, 47]. Besides, risky behaviors may be adopted in a wide variety of situations and at different times, being, for example, some risky behaviors more hedonistic in nature for certain individuals or groups of them, such as in the case of young adults with speeding and alcohol consumption [48], even though the aforementioned transgressions are widely recognizable for almost the entire population [34, 35, 49]. Furthermore, the road users' intentions and behaviors use to be determined by attitudes and the interaction with existing norms, being the normative very limited in the case of pedestrians and drivers of vehicles (e.g. bicycles) that do not require license to be operated [50].

With this statistical model, it has been found not only that the intervention on these theoretically relevant variables, becomes necessary. Besides, it represents opportunity to intervene directly on reducing road risk of young adults starting from the evidence, taking into account that these indicators effectively predict an important part of the road behavior of this population group.

The role of higher educational institutions in the impartation of road safety education

Although historically the higher educational centers have never been branded for being extensive innovators in terms of road safety education [3], unlike the case of other type of institutions (i.e. elementary and secondary schools), this fact does not imply that the few existing interventions provide a poor quality or effectiveness. Possibly, the existing structural gap refers more to a lack of organization and articulation, rather to the absence of mechanisms for effective teaching/learning and efficient resources [3, 25]. Some previous analyzes have remarked that actions for road safety education at universities, and similar scenarios in which young adults use to be involved, tend to report acceptable effectiveness indicators [4], since these programs are normally designed combining theoretical and practical notions [51], that facilitates the managing of safety behaviors and attitudes towards road safety in young adults [17, 52], taking into account that in this age group the constructs relating to road safety are usually more stable than in young or children [3, 53, 54].

Regarding the challenge of participation of the social environment of the young adult on road safety education several studies have described the clear need to involve their parents [55, 56] and closest social circles [15] to improve

road safety education [30, 57, 58]. In other words, those programs that mostly address the social and psychological determinants of road behavior use to develop better attitudes, skills and behavioral outcomes in the beneficiary [15, 59]. For example, the techniques for behavioral change for young road users usually take into account the micro and macro social levels of interaction, since the traffic behavior does not occur in an isolated context [14, 60, 61]. The findings show that, mentioning the most successful strategies to improve road attitudes and behaviors among young adults, it is essential to integrate the greatest possible number of social and institutional actors in the learning process and consolidation of road safety education on this population group [45, 62, 63].

Furthermore, taking into account that young adulthood uses to be the age of novice driving, some studies have been dealing with the behavior of new drivers finding that, in absence of a good level of road safety education, road misbehaviors use to appear, or acquire a greater impact, along the time, especially when the driver does not have a constant monitoring or training [41, 62].

Finally, it is important to mention that road safety education should be developed not only in the curricular context (i.e. school and university), but optimally should be extended continuously throughout the life of individuals, within specific scenarios according to each stage of life development [64].

5. Conclusion

As a central conclusion, it is necessary to develop strategies to increase the presence of actions related to road safety education at university, and improve the coverage and learning process of this subject among higher education students.

In addition, it can be said that the assessed road safety education indicators allow to identify serious gaps in this area in young adults who are currently studying in Spanish universities.

Finally, it raises the general need to include universities in the development of a "road safety culture" within the universities and a multi-sectorial road safety education strategy, taking into account the multiple potentialities of teaching, research and development that have as institutions of higher education, potentially impacting not only on road safety education of their students, but also on their road health and welfare.

Limitations of the Study

Regarding the limitations of this study, the fact the data was obtained exclusively through self-report sources; aside from the clarification of the rules for participating, conditions of confidentiality, and the statistical treatment of the data, that we consider is proper, the study variables could present potential biases, that are often inherent in this type of data collection methodology.

The experienced data collection process has clear implications from a practical point of view. For instance, although the number of the total sample (843) was larger than the minimum target number of participants (statistically established), it would have been interesting the access to more participants who have been beneficiaries of actions of road safety education at university, so that could be given greater external validity of the statistical analysis of the variables related to coverage and appreciation of those interventions.

Further, apart from the socio-demographic data studied in this research (age and gender, principally), it would also be remarkable to include other variables that may also affect road users' perception of their behaviors in relation with road safety education obtained from their micro and macro social systems.

Finally, it should be mentioned that although students constitute the vast majority of potential beneficiaries of road safety education within universities, would have been relevant to collect and analyze, complementarily, information from other potential beneficiaries (minority ones), as administrative and professorial staff.

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