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More Aware, More Protected: Do Road Safety Skills Predict the use of Passive Safety Elements among Teenagers?

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More Aware, More Protected: Do Road Safety Skills Predict the use of Passive Safety Elements among Teenagers?

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More Aware, More Protected: Do Road Safety Skills Predict the use of Passive Safety Elements among Teenagers?

Abstract

Objective. This study had two objectives: first, to test the effects of sociodemographic variables, and the effects of three key road safety skills (knowledge-risk perception-attitudes) on the use of passive safety elements (PSEs) among teenagers; and second, to assess the differential impact of the study variables on PSEs use from a gender-based perspective.

Setting and participants. This cross-sectional study was framed in the paradigm of primary care, and it involved students from several educational centers in Spain. A sample of 827 Spanish teenagers (52.4% females and 47.6% males) with a mean age of $M=14.4$ [12-19] years was used.

Results. Through SEM modeling, we found that the use of PSEs is largely explained by psychosocial variables through the mediation of three road safety skills: risk perception ($\beta=.103^{***}$), rule knowledge ($\beta=.095^*$), and attitudes towards road safety ($\beta=.186^{***}$). Furthermore, multi-group (MGSEM) analyses showed that, although most variables explain the use of PSEs among teenagers in a similar way, key gender-based differences exist in this regard.

Conclusions. Road safety skills have a significant effect on the use of passive safety elements among Spanish teenagers, and gender explains some differences in the mechanisms which predict them. Also, in the study we discuss the need for strengthening school-based interventions aimed at helping this vulnerable group of road users acquire and develop positive behavioral competences.

Keywords: Passive Safety; Seat Belt; Helmet; Teenagers; Education in Road Safety; Road Safety Skills.

Strengths and limitations of this study

Enhancing the use of passive safety elements is known to decrease the injury risk in traffic.

This study offers useful information on factors that strengthen the use of passive safety elements among adolescents.

These evidence-based findings could be addressed in interventions and multisectoral strategies aimed at improving the road safety competences of young population.

As a key limitation, findings of self-report-based studies are prone to be affected by common method bias. Although data collection and analysis were rigorously carried out, results should be carefully interpreted when generalizing to other populations.

Introduction

Daily transportation is an essential process for most population segments, and this fact implies both benefits and risks for road users [1,2]. To this date, the educational system can be considered a sphere closely related to the transport industry, since schooling typically implies the everyday commuting of children and teens to and from their educational centers, for which different means of transportation are used, some of them more proper and safer than others [1,3]. This implies, of course, a large set of risk factors that affect the health and welfare of young people, and traffic crashes are, perhaps, the most relevant one from the perspective of public health [2,4].

Passive Safety Elements or PSEs (also known as *secondary safety elements* in some countries) are the set of in-vehicle or wearable devices designed to minimize the physical injuries that can derive from a traffic crash. For instance, epidemiological studies have shown that in the United States, during the last few years, no more than 17% of fatally injured cyclists were using helmets at the moment of suffering cycling crashes and, globally, it is estimated that around 60% of deaths of cyclists are related to head injuries [5,6]. However, other studies have shown that 1) cyclists aged 10-20 are the least likely to wear a helmet while riding [7], and that 2) in other regions, such as Europe, only 68% of cyclists consider that helmets should be mandatory and just 38% of them use it regularly [8].

Regarding seat belts, a key PSE in the case of motor vehicles (although its ratio may vary between countries), the percentage of seat belt users fatally injured in traffic crashes is, in countries such as the United States, less than half in the case of both drivers (47%) and passengers (34%) [1]. Moreover, most deceased drivers and occupants of vehicles were not using the seat belt at the moment of the fatal crash. Furthermore, since a clear disparity

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3 in driver-versus-passenger belting is still evident, and different cultural, informational
4 and law-related barriers may enhance a scarce use of other elements such as helmets [2-
5 4], severe traffic injuries that could be prevented are still highly prevalent worldwide
6 among different risk groups of road users: such is the case of adolescents [4,9,10].
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13 *Passive safety in the school: Making the road for children and adolescents*
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16 Recent evidence points out that, in many countries, traffic crashes constitute the main
17 cause of death among adolescents [1]. However, although different strategies have been
18 adopted during the last fifty years, up to this date the proper use of passive safety elements
19 is not generalized, especially in countries with a weaker tradition of road safety education
20 and training [9,11]. In the field of school-based transportation, many advances in the
21 equipment of school vehicles with better passive safety systems/devices have been
22 reported [2,12], but, despite this fact, traffic injury rates involving school students are still
23 a considerably relevant issue in the field of road safety. Overall, it is evident that
24 technically improving the instruments (i.e., means of transportation) is not enough: it is
25 necessary to develop the behavioral resources of individuals, in order to increase their
26 likelihood of permanent and appropriate use of safety features [1,5].
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42 Recent studies have problematized the scarcity of both the frequency and the
43 appropriateness in the use of passive safety elements among adolescents. For instance, in
44 a school-based study conducted by [1], it was found that, in the case of the United States,
45 only half of teenagers (51%) use the seat belt as passengers. Even worse, this percentage
46 seems to drop systematically to 42% among high school students [2], implying their
47 increased risk of suffering severe injuries in traffic crashes. In this regard, apart from
48 accessibility, several studies have described the importance of the enforcement of
49 perceptual, representational, attitudinal, motivational and cognitive factors from school-
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3 related and microsocial environments for students to acquire safe habits since the early
4 stages of their lives. This is an effective strategy that can reduce the prevalence and
5 outcomes of risky road behaviors [5,13,14].
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10 *Relational factors influencing the use of PSEs: The role of parenting*

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13 Since the relationship between parents and children has a great influence in many spheres
14 of life, safety behaviors are also highly influenced by parental issues [15,16]. It is known
15 that observational learning and parental influence play a crucial role in the acquisition
16 and development of safety habits [17,18]. As evidence suggests that negative or risky
17 attitudes/behaviors could be learned from parents and translated into risky and
18 problematic behaviors that may compromise safety outcomes of children and adolescents
19 [18,19], we also know that observed positive behaviors could be transmitted from parents
20 to children, and the strengthening of parenting skills could enhance safe behavior. In other
21 words, parent-children relationships may also contribute to the learning of individual and
22 social skills in fields such as road safety [16]. Also, several empirical experiences
23 highlight parenting as a potential source of improvement for both healthy habits and road
24 safety behaviors, including the frequent and proper use of PSEs [5,17,19].
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45 **Objectives and hypotheses**

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48 The core objective of this study was to assess the effect of sociodemographic variables,
49 as well as the effect of three key road safety skills, on the use of passive safety elements
50 among Spanish teenagers. In this regard, and following the available theoretical and
51 empirical background described in the introduction, we hypothesized that the use of
52 passive safety elements would be higher if road users constantly received more
53 information about road safety issues, observed safer road behaviors in their parents,
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3 possessed a better psychological health and higher road safety skills (risk perception,
4 knowledge and positive attitudes). This theoretical-based framework is synthesized in
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8 Figure 1.
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14 **(FIGURE 1 HERE)**
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17 *Figure 1.* Hypothesized mediated path model for predicting the use of PSEs. Rectangles are the
18 observed variables, and lines with arrows indicate the predicted paths.
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23 The second objective of the study was to evaluate the differential impact of these variables
24 on the use of PSEs from a gender-based perspective (*how similarly or differently do they*
25 *work across genders?*). The evidence has shown that, although several similarities exist
26 between males and females in road safety-related issues, gender explains substantial
27 differences in the decision-making within the behavioral context, such as the use of seat
28 belts and helmets. Thus, it has been assumed that, if we apply the model to both genders
29 keeping a similar structure, key differences between male and female teenagers will be
30 observed in the variables affecting the use of PSEs.
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51 **Methods**

52 **Participants**

53 For this cross-sectional study, a sample of 827 Spanish teenagers, 433 females (52.4%)
54 and 394 males (47.6%) was used. The participants were between 12 and 19 years old, and
55 their mean age was $M=14.39$ ($SD=1.60$) years, with $M=14.45$ ($SD=1.65$) for females and
56 $M=14.33$ ($SD=1.64$) for males.
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Study Design - Setting

In this school-based research, participants were invited to take part in the study through the mediation of their educational centers. As for the sampling technique, we employed a convenience (non-probabilistic) method, based on the accessibility to the study population and on their will to participate in the study.

Regarding the application of the questionnaire, it was completed in the classroom, with previous approval and assistance from the educational staff. Also, key factors such as the age range and the academic level of the study sample were taken into account for the selection of items and scales that composed the instrument. In the case of children and adolescents, some sources contained in the literature suggest the use of short forms synthesizing the most relevant aspects of each variable, written in a clear and simple language [20], aspects that enhance an adequate understanding of the questions. Additionally: (a) we used instruments and items that had been previously tested in similar populations; (b) a researcher was always accessible to assist participants; and (c) the anonymity of participation was continuously highlighted, emphasizing the data protection principles and the fact that the information would only be used for research purposes, thus minimizing biased responses. We also kept in mind that most of participants were under-aged. Thus, permissions signed by schools and associations of parents were obtained beforehand (including Informed Consent forms). All participants were initially informed about the importance of answering honestly to all the questions, as well as about the absence of right or wrong answers.

Study variables and description of the questionnaire

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3 For this study, a paper-based questionnaire composed of four sections was designed, in
4 order to measure each set of study variables (described below): the first section aimed at
5 collecting demographic data (e.g. age, gender, current academic year). In the second
6 section, participants were asked about: *a*) their exposure (received information) to road
7 safety education from different sources (e.g. mass-media, advertising campaigns, school-
8 based interventions and their teachers/relatives), through a 5-item ($\alpha=0.73$) Likert scale
9 (0=total disagreement; 4=total agreement) (*example item: I remember seeing some*
10 *campaigns on road safety*); and *b*) safe road behaviors observed in their parents, on a 5-
11 item ($\alpha=0.62$) Likert scale (0=never; 4=always), in which they were asked about how
12 often their parents performed three different key safe behaviors on the road: using seat
13 belts, avoiding the cellphone while driving, and speeding (*example item: "in the car, my*
14 *parents always wear the seat belt"*). Thirdly, the questionnaire included the 12-item
15 version of the General Health Questionnaire [21] ($\alpha=0.72$), which provides a single
16 psychological health measure, and has been previously applied to similar populations in
17 Spanish-speaking countries [22,23]. Finally, in the fourth section of the questionnaire we
18 measured: *a*) the use of PSEs, through a frequency-based Likert scale on the use of seat
19 belts and helmets in cars, bicycles and motorcycles (0=never; 4=always), and *b*) three
20 core-skills related to Road Safety Education (RSE), through an 18-item questionnaire
21 with two possible options for answer (yes/no), in which each one of the three factors was
22 composed of six items: knowledge of traffic rules ($\alpha=0.68$), road risk perception ($\alpha=0.67$)
23 and positive attitudes towards road safety ($\alpha=0.73$). The scale had already been adapted
24 for the Spanish population in previous applications [16]. The questionnaire (researcher
25 form) is available as a supplementary file of this paper.

56 **Patient and Public Involvement**

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59 This study did not involve any clinical trial and/or patients.
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Ethics

To perform this study, the Committee of Ethics in Social Science in Health Research of the University of Valencia was consulted, certifying that it responded to the ethical principles and that it complied with the Declaration of Helsinki, thus granting it a positive guesstimate (IRB approval number H1535548125595).

Data processing

Basic descriptive analyses were performed to calculate scores for the different variables measured in the questionnaire. Pearson' correlational analyses were used to establish associations among the variables of the study, and once the basic parameters were tested, mean scores in the study variables were compared through ANOVA. The explanatory association between age, exposure to road safety education, psychological health, and the statistical mediation of road safety skills in the use of passive safety elements, were tested using SEM analysis with maximum likelihood estimations (MLA) and data imputation for missing data; the significance levels were $p<0.05$, $p<0.01$ and $p<0.001$ (*Model A*). The statistical mediation specifies a chain of relations in which an antecedent variable affects a mediating variable, that in turn affects a dependent variable [24]. Finally, the same model was tested for the second time, using a gender-based multi-group analysis (MGSEM with MLA) with differential criteria - significance levels of $p<0.05$, $p<0.01$, $p<0.001$ (*Model B*). All statistical analyses were performed using ©IBM SPSS 23.0, and AMOS 24.0, specifically employed for structural and invariance analyses.

Results

The descriptive statistics of the study are summarized in Table 1. Apart from previously reported basic data on age and gender distribution, mean comparisons were carried out, in order to determine potential differences in the study variables between male and female subjects. The analysis of variance revealed a significantly higher mean value for two road safety skills among female teenagers (i.e., traffic rule knowledge and attitudes towards road safety) when compared to males, and a lower mean value for females in the indicator of psychological health [21]. Correlational analysis allowed us to establish association measures between variables, all coherent to what had been theoretically hypothesized, and the use of PSEs was significantly associated with all the other study factors.

Table 1.

Descriptive results, gender-based mean comparisons and Pearson bivariate correlations of study variables.

Variable	Descriptive			Mean comparisons		Bivariate correlations (2-tailed)						
	Mean (SD)			<i>F</i>	Sig.	2	3	4	5	6	7	8
	Full Sample	Females	Males									
1 Age	14.39(1.61)	14.45(1.57)	14.33(1.64)	1.17	.281	0.061	0.001	-.086*	.099**	0.014	.097**	.076*
2 Exposure to RSE Observed Safe Behaviors (Parents)	10.21(3.79)	10.37(3.36)	10.06(4.22)	1.38	.240	--	0.033	0.042	.115**	.135**	.252**	.103**
3 Psychological Health (GHQ-12)	5.08(1.77)	5.13(1.67)	5.01(1.88)	.96	.328	--	-0.015	.077*	.109**	.178**	.470**	
4 Road Risk Perception	28.27(6.13)	26.88(6.39)	29.82(5.45)	49.71	.000**	--	0.067	0.063	.099**	.096**		
5 Knowledge of Traffic Norms	4.30(1.09)	4.37(1.01)	4.23(1.18)	2.98	.085	--	.294**	.280**	.227**			
6 Positive Attitudes Towards Road Safety	4.14(1.20)	4.28(1.09)	3.97(1.28)	13.98	.000**	--	.374**	.248**				
7 Use of Passive Safety Elements	4.51(1.40)	4.74(1.26)	4.26(1.50)	25.24	.000**	--	.341**					
8	8.52(2.95)	8.65(2.72)	8.38(3.14)	1.69	.193	--						--

Notes: *Significant at 0.05 level. **Significant at 0.01 level.

Structural Equation Modelling

With the aim of testing the background-based hypothesis about the effect of different factors on the use of PSEs, a Structural Equation Model (SEM) was built. Considering that the initial model did not fit the data relatively well ($\chi^2(18)=200.97$, $p < .001$; NFI=.700; CFI=.701; RMSEA=.161; CMIN/DF=11.329), some key modifications and constraints were performed. First of all, nonsignificant and very low paths between endogenous-exogenous variables were set to zero, and modification indexes were applied to the model structure, always following the theoretical basis of the unconstrained model. Thus, a more parsimonious and reasonable model was obtained, with better fit coefficients and theoretical sense ($\chi^2(9)=18.598$, $p < .05$; NFI=.972; CFI=.985; RMSEA=.036; CMIN/DF=2.066). The model is presented in Table 2, and Figure 2.

The model fit was established based on the cut-off criteria suggested by the specialized literature [25]. The cut-off point of RMSEA is <0.08 , and CFI/NFI values are ideal when >0.9 . The standardized path coefficients or SPCs of the SEM model suggest positive relations between risk perception ($\beta=.103^{***}$), traffic rule knowledge ($\beta=.095^*$), positive attitudes towards road safety ($\beta=.186^{***}$) and the use of passive safety elements. A direct effect was spotted in the paths between the safe behaviors observed in parents ($\beta=.420^{***}$), the psychological health indicator ($\beta=.075^{**}$) and the use of PSEs (dependent variable). No significant direct effects were found between the exposure to RSE, the age and the use of passive safety elements, the first two being fully mediated by road safety skills, as shown in Table 2 and in the values next to solid lines in Figure 2.

Table 2.

Structural Equation Model (SEM) for predicting the use of PSEs (Model A).

SEM Paths (Full Sample)		Std. Estimate	S.E.	C.R.	P	Sig.
Positive Attitudes	← Observed Safe Behaviors	.172	.026	5.214	<.001	***
Rule Knowledge	← Observed Safe Behaviors	.106	.023	3.094	.002	**
Risk Perception	← Exposure to RSE	.104	.010	3.027	.002	**
Risk Perception	← Observed Safe Behaviors	.075	.021	2.181	.029	*
Rule Knowledge	← Exposure to RSE	.129	.011	3.753	<.001	***
Positive Attitudes	← Exposure to RSE	.237	.012	7.192	<.001	***
Risk Perception	← Age	.099	.023	2.887	.004	**
Positive Attitudes	← Age	.091	.029	2.763	.006	**
Rule Knowledge	← Age	.011	.026	.334	.738	N/S
Positive Attitudes	← Psychological Health	.100	.008	3.023	.003	**
Rule Knowledge	← Psychological Health	.060	.007	1.748	.080	N/S
Risk Perception	← Psychological Health	.072	.006	2.115	.034	*
Use of Passive Safety Elements	← Age	.052	.053	1.788	.074	N/S
Use of Passive Safety Elements	← Exposure to RSE	.012	.023	.401	.688	N/S
Use of Passive Safety Elements	← Observed Safe Behaviors	.420	.048	14.377	<.001	***
Use of Passive Safety Elements	← Risk Perception	.103	.083	3.365	<.001	***
Use of Passive Safety Elements	← Rule Knowledge	.095	.078	2.992	.003	**
Use of Passive Safety Elements	← Positive Attitudes	.186	.069	5.686	<.001	***
Use of Passive Safety Elements	← Psychological Health	.075	.014	2.586	.010	*

Notes: ¹SPC = Standardized Path Coefficients (can be interpreted as linear regression weights). ²S.E. = Standard Error. ³C.R. = Critical Ratio. ⁴p-values. ***Significant at level 0.001. **Significant at level 0.01. *Significant at level 0.05.

(FIGURE 2 HERE)

Figure 2. Graphic presentation of the Structural Equation Model (SEM) for predicting the use of PSEs. Solid lines represent significant paths. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Effect of gender on the use of PSEs: Multi-Group analysis

Based on the theoretical assumptions presented in the introduction, the effect of gender on the use of PSEs was assessed using a MGSEM approach: this is extensively different from modeling gender groups within the variables included in the general structural model. In this sense, the data were split into two groups (*Group 1*: female; *Group 2*: male), presenting an acceptable sample size and optimal conditions for comparability. Using the AMOS multi-group comparison analysis, the hypothesized structural model was adjusted following a multi-group invariance-testing strategy.

Same as *Model A*, the MGSEM model was specified in a sequence similar to the one recommended in expert literature [25]. As baseline model did not optimally fit the data ($\chi^2(18)=190.05$, $p < .001$; NFI=.727; CFI=.732; RMSEA=.109; CMIN/DF=10.559), and therefore structural modifications were applied to constrain the model. The resulting SEM reported better fit coefficients ($\chi^2(18)=63.214$, $p < .001$; NFI=.909; CFI=.929; RMSEA=.055; CMIN/DF=3.512), and it is presented in Table 3, and Figure 3. In addition to the multi-group invariance test, indicating that the model works similarly well for both of them, the RMSEA (<.08), NFI/CFI (>.90) coefficients suggested an optimal fit for the final model [25-27], showing that factor loadings, intercepts and residual covariances, were operating equivalently in both groups.

Table 3.

Gender-based Multi-Group (MGSEM) model for predicting the use of PSEs (Model B).

MGSEM (1/2): Female Teenagers			Std. Estimate ¹	S.E. ²	C.R. ³	P ⁴	Sig.
Positive Attitudes	←	Observed Safe Behaviors	.167	.034	3.691	<.001	***
Rule Knowledge	←	Observed Safe Behaviors	-.028	.031	-.583	.560	N/S
Risk Perception	←	Exposure to RSE	.136	.014	2.880	.004	**
Risk Perception	←	Observed Safe Behaviors	.070	.028	1.490	.136	N/S
Rule Knowledge	←	Exposure to RSE	.159	.015	3.357	<.001	***
Positive Attitudes	←	Exposure to RSE	.227	.017	5.010	<.001	***
Risk Perception	←	Age	.131	.030	2.784	.005	**
Positive Attitudes	←	Age	.150	.036	3.311	<.001	***
Rule Knowledge	←	Age	.027	.033	.564	.573	N/S
Positive Attitudes	←	Psychological Health	.119	.009	2.624	.009	**
Rule Knowledge	←	Psychological Health	.086	.008	1.810	.070	N/S
Risk Perception	←	Psychological Health	.013	.007	.284	.776	N/S
Use of Passive Safety Elements	←	Age	.062	.070	1.534	.125	N/S
Use of Passive Safety Elements	←	Exposure to RSE	-.050	.033	-1.216	.224	N/S
Use of Passive Safety Elements	←	Observed Safe Behaviors	.383	.066	9.462	<.001	***
Use of Passive Safety Elements	←	Risk Perception	.121	.112	2.903	.004	**
Use of Passive Safety Elements	←	Rule Knowledge	.104	.109	2.399	.016	*
Use of Passive Safety Elements	←	Positive Attitudes	.244	.098	5.381	<.001	***
Use of Passive Safety Elements	←	Psychological Health	.086	.017	2.157	.031	*
MGSEM (2/2): Male Teenagers			Std. Estimate	S.E.	C.R.	P	Sig.
Positive Attitudes	←	Observed Safe Behaviors	.169	.038	3.533	<.001	***
Rule Knowledge	←	Observed Safe Behaviors	.204	.034	4.154	<.001	***
Risk Perception	←	Exposure to RSE	.068	.014	1.369	.171	N/S
Risk Perception	←	Observed Safe Behaviors	.076	.031	1.528	.127	N/S
Rule Knowledge	←	Exposure to RSE	.104	.015	2.111	.035	*
Positive Attitudes	←	Exposure to RSE	.230	.017	4.807	<.001	***
Risk Perception	←	Age	.065	.036	1.305	.192	N/S
Positive Attitudes	←	Age	.034	.044	.715	.475	N/S
Rule Knowledge	←	Age	-.002	.038	-.035	.972	N/S
Positive Attitudes	←	Psychological Health	.174	.013	3.631	<.001	***
Rule Knowledge	←	Psychological Health	.102	.012	2.077	.038	*
Risk Perception	←	Psychological Health	.172	.011	3.465	<.001	***
Use of Passive Safety Elements	←	Age	.038	.080	.915	.360	N/S
Use of Passive Safety Elements	←	Exposure to RSE	.056	.032	1.314	.189	N/S
Use of Passive Safety Elements	←	Observed Safe Behaviors	.455	.072	1.618	<.001	***
Use of Passive Safety Elements	←	Risk Perception	.106	.122	2.323	.020	*
Use of Passive Safety Elements	←	Rule Knowledge	.076	.115	1.614	.106	N/S
Use of Passive Safety Elements	←	Positive Attitudes	.138	.099	2.922	.003	**
Use of Passive Safety Elements	←	Psychological Health	.058	.025	1.369	.171	N/S

Notes: ¹SPC = Standardized Path Coefficients (can be interpreted as linear regression weights). ²S.E. = Standard Error.

³C.R. = Critical Ratio. ⁴p-values. ***Significant at level 0.001. **Significant at level 0.01. *Significant at level 0.05.

(FIGURE 3 HERE)

Figure 3. Two-group (MGSEM) structural model showing standardized path coefficients and significant paths (solid lines). Categories: females (above) and males (below). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Gender differences and similarities

The MGSEM model shows that, although both groups keep similar characteristics, there are some key structural gender differences in what concerns the differential effect of the study variables on the use of passive safety elements. First, and regarding the observed similarities, we see how (for both genders): exposure to RSE has a significant effect on rule knowledge ($\beta=.159^{***}$ females; $\beta=.104^*$ males) and attitudes towards road safety ($\beta=.227^{***}$ females; $\beta=.230^{***}$ males). Also, the observed safe behaviors significantly influence the positive attitudes of subjects towards road safety ($\beta=.167^{***}$ females; $\beta=.169^{***}$ males) and the use of PSEs ($\beta=.383^{***}$ females; $\beta=.455^{***}$ males). Furthermore, psychological health has an effect on positive attitudes towards road safety in both groups ($\beta=.119^{**}$ females; $\beta=.174^{***}$ males). Finally, risk perception ($\beta=.121^{**}$ females; $\beta=.106^*$ males) and positive attitudes towards road safety ($\beta=.244^{***}$ females; $\beta=.138^{**}$ males) has a similar and significant effect on the use of passive safety elements.

Secondly, and regarding gender differences, it was found that: unlike male teenagers, in the case of females age has a significant effect on risk perception ($\beta=.131^{**}$) and positive attitudes towards road safety ($\beta=.150^{***}$). Also, the exposure to RSE influence risk perception ($\beta=.136^{***}$), and psychological health has a positive effect on the use of passive safety elements ($\beta=.086^*$). All these paths were non-statistically significant for

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3 male teenagers. On the other hand, there is a set of significant effects that were only
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5 observed in males: the safe behaviors observed in parents were linked to the knowledge
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7 of traffic rules ($\beta=.204^{***}$), and psychological health had a significant effect on both risk
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9 perception ($\beta=.172^{***}$) and the traffic rule knowledge ($\beta=.102^*$), paths that were non-
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11 significant for females.
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18 **Discussion and conclusion**

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21 The main objectives of this study were, first, to test the effects of sociodemographic
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23 variables, and the effects of three key road safety skills (*knowledge—risk perception—*
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25 *attitudes*) on the use of passive safety elements (PSEs) among teenagers; and second, to
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27 assess the differential impact of the study variables on PSEs use from a gender-based
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29 perspective.
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33 Regarding the first objective of the study, the results of this study allowed us to establish
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35 that the use of such elements in teenagers is not only correlated, but also largely explained
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37 by several variables related to age, psychological health, and road safety education,
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39 through the mediation of road safety skills: risk perception, knowledge of traffic rules and
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41 positive attitudes towards road safety. In short, the directionality of the significant
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43 bivariate correlations between demographic variables, road safety skills and the use of
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45 PSEs, suggests that these factors are associated between themselves; however, the
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47 predictive mechanism needed to be tested through a theoretically-supported model, which
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49 in turn had to be tested in this population. In this regard, the SEM modeling was
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51 performed, and a parsimonious model with an adequate fit was obtained. In this *Model A*,
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53 built in accordance with the revised literature, it was interesting to observe how the
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55 directions and significance of the associations between study variables suggest the need
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3 for strengthening road safety-related skills as a way of improving safe behaviors [16], in
4 accordance to what was already stated by other researches dealing with Spanish-speaking
5 populations [16,28,29]. Most of these conclusions support that systematic exposure to
6 enough information/education in road safety settings is, perhaps, the most effective
7 measure for minimizing road risks and traffic injuries among teenagers [1,28].
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15 *“Similar, but different”: a summary of gender similarities and disparities*
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18 As for the second objective of the study, we found that, although several similarities can
19 be observed across male and female teenagers, some key differences are noticeable.
20 Accordingly, previous studies on road safety behavior have shown that, even though great
21 similarities and uniform patterns may be observed across genders, key differences in the
22 role of demographic factors, mental health and educational aspects might explain
23 differential outcomes in both risky and protective road behaviors of individuals [30-32].
24 Also, several studies have already suggested that risky road behaviors can be more
25 frequent and dangerous, and protective behaviors less prevalent in the case of male road
26 users [11,13,32].
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39 Furthermore, local studies have stated that there is a gender disparity in the injury
40 protection through PSEs [33] of people, although differences in this regard have been
41 reported as nonsignificant in some other studies performed on adult samples [34,35]: this
42 implies a differential state-of-affairs based on factors such as the law enforcement and
43 the road safety culture of each country [31]. In this regard, it is worth mentioning that,
44 although non-significant differences were found in the extent to which subjects of both
45 genders use PSEs, the mean score was tendentially higher for females. Furthermore,
46 significant mean differences were found in the case of two road safety skills: rule
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3 knowledge and positive attitudes towards road safety (both higher for females), while the
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5 only study variable significantly higher for males was psychological health [21].
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8 Bearing in mind the second objective of our research study (that is, to evaluate the
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10 differential impact of the study variables on the use of PSEs from a gender-based
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12 perspective through MGSEM), while at the same time comparing the structural models
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14 presented in Figure 3 with the hypothesized assumption that there are key structural
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16 similarities (but also differences) between males and females, we discovered an
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18 interesting set of outcomes. First of all, age has a significant effect on risk perception and
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20 positive attitudes in females, but, in the case of males, it does not have a significant effect
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22 on any of the dependent variables. Apart from the mere gender difference, it is attention-
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24 worthy how, from a gender-based perspective, age may play a critical role in the
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26 perception of road risk situations and the production of safer behaviors within the set of
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28 problematic road safety behaviors observed in female road users [16,36]. Also, we found
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30 that exposure to RSE, both in males and females, had a significant effect on the
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32 knowledge of traffic norms and on positive attitudes; however, RSE exposure only
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34 influenced the road risk perception of females. Regarding the observed safe behaviors of
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36 parents, while showing an effect on positive attitudes and (directly) on the use of passive
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38 safety elements for both genders, it exerted a significant influence on the knowledge of
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40 traffic rules only in male teenagers. Another differential outcome was found for what
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42 concerns the psychological health indicator: speaking of similarities, it influenced
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44 positive attitudes in both genders. As for particularities, the GHQ-12 score had a direct
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46 effect on females' use of PSEs, and on males' risk perception and traffic rules'
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48 knowledge. In this regard, the evidence has suggested that mental health may have a
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50 differential role in health-compromising behaviors that are also related to traffic,
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52 especially in the case of young male subjects, whose competences in decision making
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3 concerning safety issues could be highly influenced by their mental health condition
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5 [23,37].
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8 Regarding road safety skills, it was found that risk perception and positive attitudes,
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10 although differentially affected by independent study variables, had a significant effect
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12 on the use of passive safety elements for both male and female teenagers. However,
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14 positive attitudes towards road safety remain significantly higher for females, as it has
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16 been seen in some other studies involving young road users [38]. Finally, and although
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18 knowledge of traffic rules had a direct effect on the use of PSEs in female teenagers, it
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20 was not significant for males. This could be supported by the gender differences found in
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22 mean comparisons (shown in Table 1), in which males tend to report a significantly lower
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24 knowledge of traffic rules than females; similar studies focusing on gender differences
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26 such as the ones performed by Yahia et al. [39] and Eiskund [40] confirm this. In fact, it
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28 constitutes the only assessed road safety skill that reported a structural gender-based
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30 difference.
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35 36 *Enforcing the use of PSEs: law, parenting & RSE* 37 38

39 Even though the self-reported frequency of the use of passive safety elements was overall
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41 high among Spanish teenagers (with an average score of 8.52/12), the discussion is still
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43 open for the complementary factors that strengthen the use of protective elements. The
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45 first element to be highlighted is law enforcement, since it directly involves both parents
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47 and educational institutions. In this regard, the evidence has demonstrated that, in the case
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49 of motor-vehicle users, policies on primary enforcement laws (and unbelted
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51 driver/passengers are a sufficient reason for imposing a traffic fine) have positive effects
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53 on the use of PSEs in teenagers [41], especially considering that the use of PSEs is highly
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3 enhanced by institutional stakeholders. Also, other studies [42] have prospectively
4 demonstrated that the use of PSEs is significantly increased by law improvements.
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8 The second point to be highlighted is the parental influence on the safe habits of young
9 road users. As it has been previously addressed [15,19,43], the implications of
10 strengthening the parent-child relationship in the field of road safety carry an undisputable
11 practical implication for the outcomes of our research. In fact, the results have not only
12 shown that the observed safe behaviors have an effect on the use of PSEs, but also that
13 they influence the positive attitudes of teenagers towards road safety and, in the particular
14 case of males, towards the learning of traffic norms by means of the behaviors observed
15 in parents and relatives [43,44].
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27 The third point that needs to be highlighted is the role of road safety education. Studies
28 suggest that, with an increased set of skills, such as the knowledge of traffic norms (that
29 might also be enforced by policymakers), road risk perception and favorable attitudes, it
30 is possible to predict the safe road behaviors of people and, consequently, to foster fewer
31 injuries derived from traffic crashes [14,28,29]. Other studies have highlighted that
32 increasing the use of PSEs is an urgent need for road safety [1,13,16], and the increase of
33 RSE (Road Safety Education), especially during early life stages, is of key importance
34 for developing both the present and future safe behaviors of children and adolescents.
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46 Finally, it is worth mentioning the importance of the multi-level efforts made in the
47 enforcement of both RSE and the available human and structural resources, with the aim
48 of guaranteeing injury prevention among teenagers: more than 30 years ago, Spital, Spital
49 & Spital [12] claimed for a superior professional involvement (especially by part of
50 physician pediatricians), in order to optimize the quality standards of passive safety in
51 school transportation; furthermore, they advocated for the presence of more education
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3 within the community. Nowadays, it is worth highlighting that, as of yet: developed
4 countries have successfully policed minimum standards and guidelines in this regard
5 while developing ones are “on their way” —and this, up until now, has already saved
6 many lives —; yet it is not enough, since the ultimate objective is *zero* lives lost. This
7 type of task has acquired a multidisciplinary approach [45] which is currently and
8 predominantly framed within the Road Safety Education approach, a fact that maximizes
9 the articulation and potentiality of multilevel researches, interventions and policies aimed
10 at filling out pending issues in community health.
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22 **Limitations of the study and further research**

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24 Although basic methodological considerations were formulated, and core statistical
25 parameters needed for the analyses were satisfactorily tested, some issues should be listed
26 as potential biasing sources. Firstly, this was a self-report-based study, and it was
27 therefore prone to present the common method bias, that may influence the results derived
28 from the answers provided by the participants, especially when gathering information on
29 issues that may be sensitive for them [46]. This entails the need of being cautious when
30 interpreting behavioral models based on self-reports [47]. Also, topics related to the
31 participants’ behavior may elicit social desirability: for this reason, we actively
32 emphasized on the anonymity of the survey. Also, 23 incomplete data (not fully
33 completed surveys) and acquiescent questionnaires (whose responses presented an
34 atypical unilateral trend) were excluded during the data processing. Finally, although
35 different standards exist in the educational system and the instruments were previously
36 tested during a pilot phase, some additional assistance from the researcher was required
37 by specific participants. This supports the need of having staff members being physically
38 present during surveying, in order to clarify doubts and strengthen the correct completion
39 of self-report-based questionnaires.
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3 Furthermore, regarding the obtained bivariate correlations (oscillating between .076 and
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5 .248), it is worth saying that, although procedural parameters were followed during the
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7 data analysis, some relatively small correlations were found. This could be related to the
8
9 effect of having a large sample size that might lead to the finding of significant variable
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11 associations, even when their relationship could be very small or moderate. In other
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13 words, huge sample sizes can amplify the bias associated with inferential errors, reason
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15 why it is important to be cautious with this kind of sample size-related issues [48,49].
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19 This study offers useful information for researchers, practitioners and policymakers on
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21 factors that strengthen the use of passive safety elements among adolescents and, thus,
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23 can decrease their injury risk in traffic crashes. These evidence-based findings could be
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25 addressed in interventions and multisectoral strategies aimed at improving the road safety
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27 competences of young population.
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42
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50 **Competing Interests**

51
52 The authors declare no competing interests.
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60 **Author contribution statement**

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3 For this study, S.U. conceived and designed the research; S.U. and L.G. performed the
4 data collection; S.U. and F.A. analyzed the data; F.A. contributed
5 reagents/materials/analysis tools; S.U. and L.M. wrote and revised the paper.
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14
15
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17 commercial, or not-for-profit sectors.
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24 **Data availability statement**

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26 The datasets generated for this study are available on request to the corresponding author.
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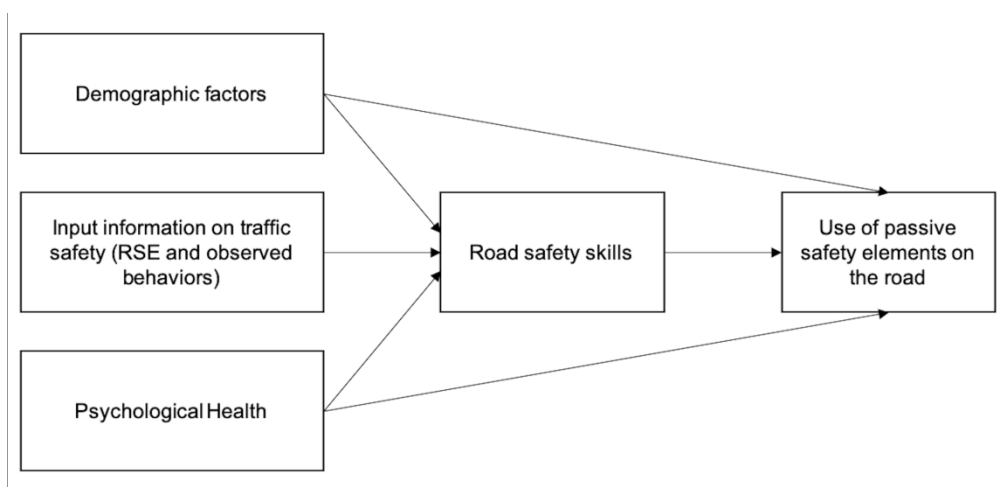


Figure 1. Hypothesized mediated path model for predicting the use of PSEs. Rectangles are the observed variables, and lines with arrows indicate the predicted paths.

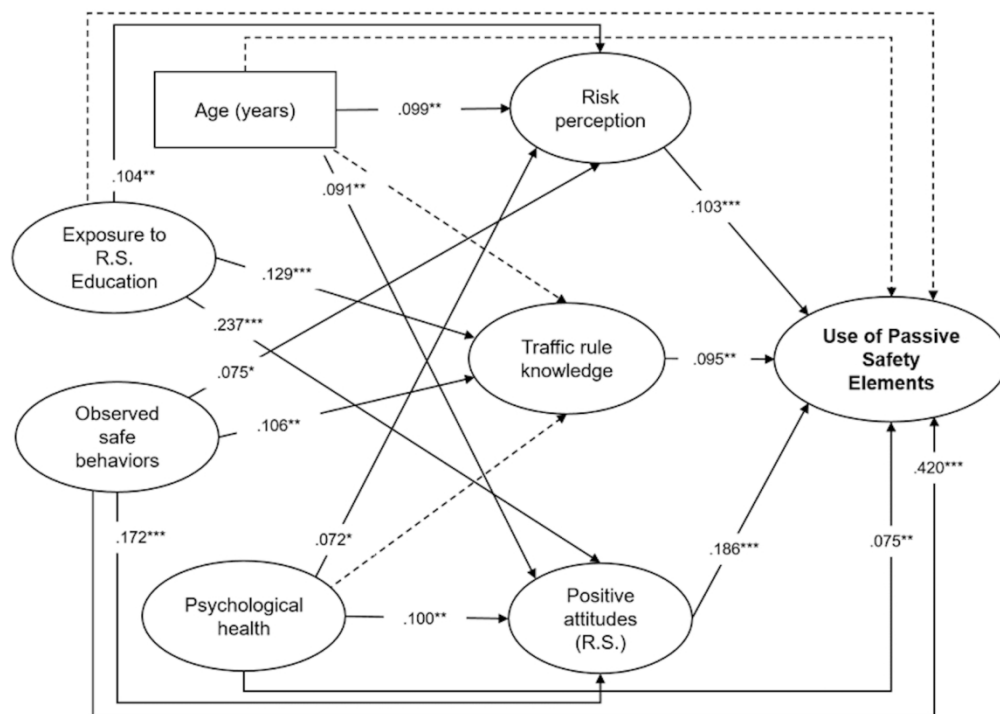


Figure 2. Graphic presentation of the Structural Equation Model (SEM) for predicting the use of PSEs. Solid lines represent significant paths. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

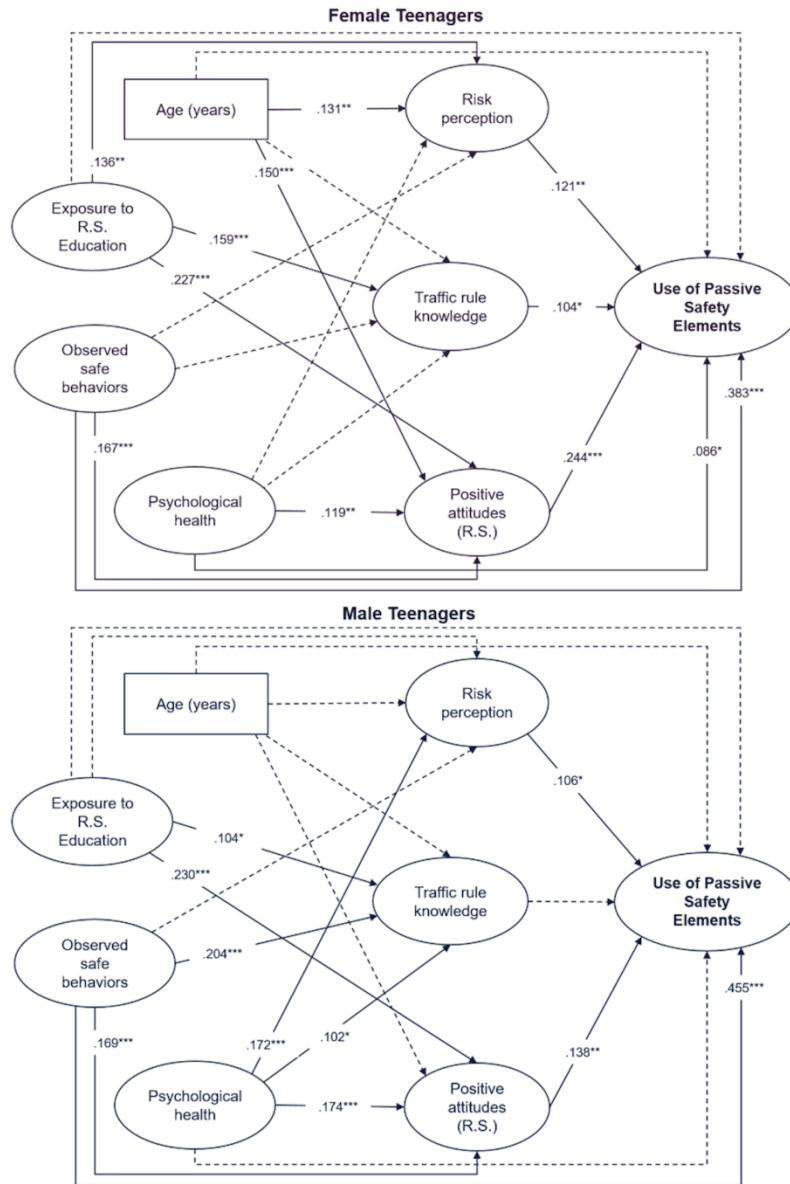


Figure 3. Two-group (MGSEM) structural model showing standardized path coefficients and significant paths (solid lines). Categories: females (above) and males (below). *p < 0.05; **p < 0.01; ***p < 0.001.

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	22
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	N/A
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	8
		(c) Explain how missing data were addressed	8
		(d) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(e) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6, 9-10
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-10
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	N/A
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-17

		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	21, 22
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17-21
Generalisability	21	Discuss the generalisability (external validity) of the study results	22
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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More Aware, More Protected: A cross-sectional study on Road Safety Skills Predicting the use of Passive Safety Elements among Spanish Teenagers

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More Aware, More Protected: A cross-sectional study on Road Safety Skills Predicting the use of Passive Safety Elements among Spanish Teenagers

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More Aware, More Protected: A cross-sectional study on Road Safety Skills Predicting the use of Passive Safety Elements among Spanish Teenagers

Abstract

Objective. This study had two objectives: first, to test the effects of sociodemographic variables, and the effects of three key road safety skills (knowledge-risk perception-attitudes) on the use of passive safety elements (PSEs) among teenagers; and second, to assess the differential impact of the study variables on PSEs use from a gender-based perspective.

Setting and participants. This cross-sectional study was framed in the paradigm of primary care, and it involved students from several educational centers in Spain. A sample of 827 Spanish teenagers (52.4% females and 47.6% males) with a mean age of $M=14.4$ [12-19] years was used.

Results. Through SEM modeling, we found that the use of PSEs is largely explained by psychosocial variables through the mediation of three road safety skills: risk perception ($\beta=.103^{***}$), rule knowledge ($\beta=.095^*$), and attitudes towards road safety ($\beta=.186^{***}$). Furthermore, multi-group (MGSEM) analyses showed that, although most variables explain the use of PSEs among teenagers in a similar way, key gender-based differences exist in this regard.

Conclusions. Road safety skills have a significant effect on the use of passive safety elements among Spanish teenagers, and gender explains some differences in the mechanisms which predict them. Also, in the study we discuss the need for strengthening school-based interventions aimed at helping this vulnerable group of road users acquire and develop positive behavioral competences.

Keywords: Passive Safety; Seat Belt; Helmet; Teenagers; Education in Road Safety; Road Safety Skills.

Strengths and limitations of this study

Enhancing the use of passive safety elements is known to decrease the injury risk in traffic.

This study offers useful information on factors that strengthen the use of passive safety elements among adolescents.

These evidence-based findings could be addressed in interventions and multisectoral strategies aimed at improving the road safety competences of young population.

As a key limitation, findings of self-report-based studies are prone to be affected by common method bias. Although data collection and analysis were rigorously carried out, results should be carefully interpreted when generalizing to other populations.

For peer review only

Introduction

Daily transportation is an essential process for most population segments, and this fact implies both benefits and risks for road users [1,2]. To this date, the educational system can be considered a sphere closely related to the transport industry, since schooling typically implies the everyday commuting of children and teens to and from their educational centers, for which different means of transportation are used, some of them more proper and safer than others [1,3]. This implies, of course, a large set of risk factors that affect the health and welfare of young people, and traffic crashes are, perhaps, the most relevant one from the perspective of public health [2,4].

Passive Safety Elements or PSEs (also known as *secondary safety elements* in some countries) are the set of in-vehicle or wearable devices designed to minimize the physical injuries that can derive from a traffic crash. For instance, epidemiological studies have shown that in the United States, during the last few years, no more than 17% of fatally injured cyclists were using helmets at the moment of suffering cycling crashes and, globally, it is estimated that around 60% of deaths of cyclists are related to head injuries [5,6]. However, other studies have shown that 1) cyclists aged 10-20 are the least likely to wear a helmet while riding [7], and that 2) in other regions, such as Europe, only 68% of cyclists consider that helmets should be mandatory and just 38% of them use it regularly [8].

Regarding seat belts, a key PSE in the case of motor vehicles (although its ratio may vary between countries), the percentage of seat belt users fatally injured in traffic crashes is, in countries such as the United States, less than half in the case of both drivers (47%) and passengers (34%) [1]. Moreover, most deceased drivers and occupants of vehicles were not using the seat belt at the moment of the fatal crash. Furthermore, since a clear disparity

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3 in driver-versus-passenger belting is still evident, and different cultural, informational
4 and law-related barriers may enhance a scarce use of other elements such as helmets [2-
5 4], severe traffic injuries that could be prevented are still highly prevalent worldwide
6 among different risk groups of road users: such is the case of adolescents [4,9,10].
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13 *Passive safety in the school: Making the road for children and adolescents*
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16 Recent evidence points out that, in many countries, traffic crashes constitute the main
17 cause of death among adolescents [1]. However, although different strategies have been
18 adopted during the last fifty years, up to this date the proper use of passive safety elements
19 is not generalized, especially in countries with a weaker tradition of road safety education
20 and training [9,11]. In the field of school-based transportation, many advances in the
21 equipment of school vehicles with better passive safety systems/devices have been
22 reported [2,12], but, despite this fact, traffic injury rates involving school students are still
23 a considerably relevant issue in the field of road safety. Overall, it is evident that
24 technically improving the instruments (i.e., means of transportation) is not enough: it is
25 necessary to develop the behavioral resources of individuals, in order to increase their
26 likelihood of permanent and appropriate use of safety features [1,5].
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42 Recent studies have problematized the scarcity of both the frequency and the
43 appropriateness in the use of passive safety elements among adolescents. For instance, in
44 a school-based study conducted by [1], it was found that, in the case of the United States,
45 only half of teenagers (51%) use the seat belt as passengers. Even worse, this percentage
46 seems to drop systematically to 42% among high school students [2], implying their
47 increased risk of suffering severe injuries in traffic crashes. In this regard, apart from
48 accessibility, several studies have described the importance of the enforcement of
49 perceptual, representational, attitudinal, motivational and cognitive factors from school-
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3 related and microsocial environments for students to acquire safe habits since the early
4 stages of their lives. This is an effective strategy that can reduce the prevalence and
5 outcomes of risky road behaviors [5,13,14].
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10 *Relational factors influencing the use of PSEs: The role of parenting*

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13 Since the relationship between parents and children has a great influence in many spheres
14 of life, safety behaviors are also highly influenced by parental issues [15,16]. It is known
15 that observational learning and parental influence play a crucial role in the acquisition
16 and development of safety habits [17,18]. As evidence suggests that negative or risky
17 attitudes/behaviors could be learned from parents and translated into risky and
18 problematic behaviors that may compromise safety outcomes of children and adolescents
19 [18,19], we also know that observed positive behaviors could be transmitted from parents
20 to children, and the strengthening of parenting skills could enhance safe behavior. In other
21 words, parent-children relationships may also contribute to the learning of individual and
22 social skills in fields such as road safety [16]. Also, several empirical experiences
23 highlight parenting as a potential source of improvement for both healthy habits and road
24 safety behaviors, including the frequent and proper use of PSEs [5,17,19].
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45 **Objectives and hypotheses**

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48 The core objective of this study was to assess the effect of sociodemographic variables,
49 as well as the effect of three key road safety skills, on the use of passive safety elements
50 among Spanish teenagers. In this regard, and following the available theoretical and
51 empirical background described in the introduction, we hypothesized that the use of
52 passive safety elements would be higher if road users constantly received more
53 information about road safety issues, observed safer road behaviors in their parents,
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3 possessed a better psychological health and higher road safety skills (risk perception,
4 knowledge and positive attitudes). This theoretical-based framework is synthesized in
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8 Figure 1.
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14 **(FIGURE 1 HERE)**
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17 *Figure 1.* Hypothesized mediated path model for predicting the use of PSEs. Rectangles are the
18 observed variables, and lines with arrows indicate the predicted paths.
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23 The second objective of the study was to evaluate the differential impact of these variables
24 on the use of PSEs from a gender-based perspective (*how similarly or differently do they*
25 *work across genders?*). The evidence has shown that, although several similarities exist
26 between males and females in road safety-related issues, gender explains substantial
27 differences in the decision-making within the behavioral context, such as the use of seat
28 belts and helmets. Thus, it has been assumed that, if we apply the model to both genders
29 keeping a similar structure, key differences between male and female teenagers will be
30 observed in the variables affecting the use of PSEs.
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51 **Methods**

52 **Participants**

53 For this cross-sectional study, a sample of 827 Spanish teenagers, 433 females (52.4%)
54 and 394 males (47.6%) was used. The participants were between 12 and 19 years old, and
55 their mean age was $M=14.39$ ($SD=1.60$) years, with $M=14.45$ ($SD=1.65$) for females and
56 $M=14.33$ ($SD=1.64$) for males.
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Study Design - Setting

In this school-based research, participants were invited to take part in the study through the mediation of their educational centers. As for the sampling technique, we employed a convenience (non-probabilistic) method, based on the accessibility to the study population and on their will to participate in the study.

Regarding the application of the questionnaire, it was completed in the classroom, with previous approval and assistance from the educational staff. Also, key factors such as the age range and the academic level of the study sample were taken into account for the selection of items and scales that composed the instrument. In the case of children and adolescents, some sources contained in the literature suggest the use of short forms synthesizing the most relevant aspects of each variable, written in a clear and simple language [20], aspects that enhance an adequate understanding of the questions. Additionally: (a) we used instruments and items that had been previously tested in similar populations; (b) a researcher was always accessible to assist participants; and (c) the anonymity of participation was continuously highlighted, emphasizing the data protection principles and the fact that the information would only be used for research purposes, thus minimizing biased responses. We also kept in mind that most of participants were under-aged. Thus, permissions signed by schools and associations of parents were obtained beforehand (including Informed Consent forms). All participants were initially informed about the importance of answering honestly to all the questions, as well as about the absence of right or wrong answers.

Study variables and description of the questionnaire

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3 For this study, a paper-based questionnaire composed of four sections was designed, in
4 order to measure each set of study variables (described below): the first section aimed at
5 collecting demographic data (e.g. age, gender, current academic year). In the second
6 section, participants were asked about: *a*) their exposure (received information) to road
7 safety education from different sources (e.g. mass-media, advertising campaigns, school-
8 based interventions and their teachers/relatives), through a 5-item ($\alpha=0.73$) Likert scale
9 (0=total disagreement; 4=total agreement) (*example item: I remember seeing some*
10 *campaigns on road safety*); and *b*) safe road behaviors observed in their parents, on a 5-
11 item ($\alpha=0.62$) Likert scale (0=never; 4=always), in which they were asked about how
12 often their parents performed three different key safe behaviors on the road: using seat
13 belts, avoiding the cellphone while driving, and speeding (*example item: "in the car, my*
14 *parents always wear the seat belt"*). Thirdly, the questionnaire included the 12-item
15 version of the General Health Questionnaire [21] ($\alpha=0.72$), which provides a single
16 psychological health measure, and has been previously applied to similar populations in
17 Spanish-speaking countries [22,23]. Finally, in the fourth section of the questionnaire we
18 measured: *a*) the use of PSEs, through a frequency-based Likert scale on the use of seat
19 belts and helmets in cars, bicycles and motorcycles (0=never; 4=always), and *b*) three
20 core-skills related to Road Safety Education (RSE), through an 18-item questionnaire
21 with two possible options for answer (yes/no), in which each one of the three factors was
22 composed of six items: knowledge of traffic rules ($\alpha=0.68$), road risk perception ($\alpha=0.67$)
23 and positive attitudes towards road safety ($\alpha=0.73$). The scale had already been adapted
24 for the Spanish population in previous applications [16]. The questionnaire (researcher
25 form) is available as a supplementary file of this paper.

56 **Patient and Public Involvement**

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59 This study did not involve any clinical trial and/or patients.
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Ethics

To perform this study, the Committee of Ethics in Social Science in Health Research of the University of Valencia was consulted, certifying that it responded to the ethical principles and that it complied with the Declaration of Helsinki, thus granting it a positive guesstimate (IRB approval number H1535548125595).

Data processing

Basic descriptive analyses were performed to calculate scores for the different variables measured in the questionnaire. Pearson' correlational analyses were used to establish associations among the variables of the study, and once the basic parameters were tested, mean scores in the study variables were compared through ANOVA. The explanatory association between age, exposure to road safety education, psychological health, and the statistical mediation of road safety skills in the use of passive safety elements, were tested using SEM analysis with maximum likelihood estimations (MLA) and data imputation for missing data; the significance levels were $p<0.05$, $p<0.01$ and $p<0.001$ (*Model A*). The statistical mediation specifies a chain of relations in which an antecedent variable affects a mediating variable, that in turn affects a dependent variable [24]. Finally, the same model was tested for the second time, using a gender-based multi-group analysis (MGSEM with MLA) with differential criteria - significance levels of $p<0.05$, $p<0.01$, $p<0.001$ (*Model B*). All statistical analyses were performed using ©IBM SPSS 23.0, and AMOS 24.0, specifically employed for structural and invariance analyses.

Results

The descriptive statistics of the study are summarized in Table 1. Apart from previously reported basic data on age and gender distribution, mean comparisons were carried out, in order to determine potential differences in the study variables between male and female subjects. The analysis of variance revealed a significantly higher mean value for two road safety skills among female teenagers (i.e., traffic rule knowledge and attitudes towards road safety) when compared to males, and a lower mean value for females in the indicator of psychological health [21]. Correlational analysis allowed us to establish association measures between variables, all coherent to what had been theoretically hypothesized, and the use of PSEs was significantly associated with all the other study factors.

Table 1.

Descriptive results, gender-based mean comparisons and Pearson bivariate correlations of study variables.

Variable	Descriptive			Mean comparisons		Bivariate correlations (2-tailed)						
	Mean (SD)			<i>F</i>	Sig.	2	3	4	5	6	7	8
	Full Sample	Females	Males									
1 Age	14.39(1.61)	14.45(1.57)	14.33(1.64)	1.17	.281	0.061	0.001	-.086*	.099**	0.014	.097**	.076*
2 Exposure to RSE	10.21(3.79)	10.37(3.36)	10.06(4.22)	1.38	.240	--	0.033	0.042	.115**	.135**	.252**	.103**
3 Observed Safe Behaviors (Parents)	5.08(1.77)	5.13(1.67)	5.01(1.88)	.96	.328	--	-0.015	.077*	.109**	.178**	.470**	
4 Psychological Health (GHQ-12)	28.27(6.13)	26.88(6.39)	29.82(5.45)	49.71	.000**	--	0.067	0.063	.099**	.096**		
5 Road Risk Perception	4.30(1.09)	4.37(1.01)	4.23(1.18)	2.98	.085	--	.294**	.280**	.227**			
6 Knowledge of Traffic Norms	4.14(1.20)	4.28(1.09)	3.97(1.28)	13.98	.000**	--	.374**	.248**				
7 Positive Attitudes Towards Road Safety	4.51(1.40)	4.74(1.26)	4.26(1.50)	25.24	.000**	--	.341**					
8 Use of Passive Safety Elements	8.52(2.95)	8.65(2.72)	8.38(3.14)	1.69	.193	--						

Notes: *Significant at 0.05 level. **Significant at 0.01 level.

Structural Equation Modelling

With the aim of testing the background-based hypothesis about the effect of different factors on the use of PSEs, a Structural Equation Model (SEM) was built. Considering that the initial model did not fit the data relatively well ($\chi^2(18)=200.97$, $p < .001$; NFI=.700; CFI=.701; RMSEA=.161; CMIN/DF=11.329), some key modifications and constraints were performed. First of all, nonsignificant and very low paths between endogenous-exogenous variables were set to zero, and modification indexes were applied to the model structure, always following the theoretical basis of the unconstrained model. Thus, a more parsimonious and reasonable model was obtained, with better fit coefficients and theoretical sense ($\chi^2(9)=18.598$, $p < .05$; NFI=.972; CFI=.985; RMSEA=.036; CMIN/DF=2.066). The model is presented in Table 2, and Figure 2.

The model fit was established based on the cut-off criteria suggested by the specialized literature [25]. The cut-off point of RMSEA is <0.08 , and CFI/NFI values are ideal when >0.9 . The standardized path coefficients or SPCs of the SEM model suggest positive relations between risk perception ($\beta=.103^{***}$), traffic rule knowledge ($\beta=.095^*$), positive attitudes towards road safety ($\beta=.186^{***}$) and the use of passive safety elements. A direct effect was spotted in the paths between the safe behaviors observed in parents ($\beta=.420^{***}$), the psychological health indicator ($\beta=.075^{**}$) and the use of PSEs (dependent variable). No significant direct effects were found between the exposure to RSE, the age and the use of passive safety elements, the first two being fully mediated by road safety skills, as shown in Table 2 and in the values next to solid lines in Figure 2.

Table 2.

Structural Equation Model (SEM) for predicting the use of PSEs (Model A).

SEM Paths (Full Sample)		Std. Estimate	S.E.	C.R.	P	Sig.
Positive Attitudes	← Observed Safe Behaviors	.172	.026	5.214	<.001	***
Rule Knowledge	← Observed Safe Behaviors	.106	.023	3.094	.002	**
Risk Perception	← Exposure to RSE	.104	.010	3.027	.002	**
Risk Perception	← Observed Safe Behaviors	.075	.021	2.181	.029	*
Rule Knowledge	← Exposure to RSE	.129	.011	3.753	<.001	***
Positive Attitudes	← Exposure to RSE	.237	.012	7.192	<.001	***
Risk Perception	← Age	.099	.023	2.887	.004	**
Positive Attitudes	← Age	.091	.029	2.763	.006	**
Rule Knowledge	← Age	.011	.026	.334	.738	N/S
Positive Attitudes	← Psychological Health	.100	.008	3.023	.003	**
Rule Knowledge	← Psychological Health	.060	.007	1.748	.080	N/S
Risk Perception	← Psychological Health	.072	.006	2.115	.034	*
Use of Passive Safety Elements	← Age	.052	.053	1.788	.074	N/S
Use of Passive Safety Elements	← Exposure to RSE	.012	.023	.401	.688	N/S
Use of Passive Safety Elements	← Observed Safe Behaviors	.420	.048	14.377	<.001	***
Use of Passive Safety Elements	← Risk Perception	.103	.083	3.365	<.001	***
Use of Passive Safety Elements	← Rule Knowledge	.095	.078	2.992	.003	**
Use of Passive Safety Elements	← Positive Attitudes	.186	.069	5.686	<.001	***
Use of Passive Safety Elements	← Psychological Health	.075	.014	2.586	.010	*

Notes: ¹SPC = Standardized Path Coefficients (can be interpreted as linear regression weights). ²S.E. = Standard Error. ³C.R. = Critical Ratio. ⁴p-values. ***Significant at level 0.001. **Significant at level 0.01. *Significant at level 0.05.

(FIGURE 2 HERE)

Figure 2. Graphic presentation of the Structural Equation Model (SEM) for predicting the use of PSEs. Solid lines represent significant paths. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Effect of gender on the use of PSEs: Multi-Group analysis

Based on the theoretical assumptions presented in the introduction, the effect of gender on the use of PSEs was assessed using a MGSEM approach: this is extensively different from modeling gender groups within the variables included in the general structural model. In this sense, the data were split into two groups (*Group 1*: female; *Group 2*: male), presenting an acceptable sample size and optimal conditions for comparability. Using the AMOS multi-group comparison analysis, the hypothesized structural model was adjusted following a multi-group invariance-testing strategy.

Same as *Model A*, the MGSEM model was specified in a sequence similar to the one recommended in expert literature [25]. As baseline model did not optimally fit the data ($\chi^2(18)=190.05$, $p < .001$; NFI=.727; CFI=.732; RMSEA=.109; CMIN/DF=10.559), and therefore structural modifications were applied to constrain the model. The resulting SEM reported better fit coefficients ($\chi^2(18)=63.214$, $p < .001$; NFI=.909; CFI=.929; RMSEA=.055; CMIN/DF=3.512), and it is presented in Table 3, and Figure 3. In addition to the multi-group invariance test, indicating that the model works similarly well for both of them, the RMSEA (<.08), NFI/CFI (>.90) coefficients suggested an optimal fit for the final model [25-27], showing that factor loadings, intercepts and residual covariances, were operating equivalently in both groups.

Table 3.

Gender-based Multi-Group (MGSEM) model for predicting the use of PSEs (Model B).

MGSEM (1/2): Female Teenagers			Std. Estimate ¹	S.E. ²	C.R. ³	P ⁴	Sig.
Positive Attitudes	←	Observed Safe Behaviors	.167	.034	3.691	<.001	***
Rule Knowledge	←	Observed Safe Behaviors	-.028	.031	-.583	.560	N/S
Risk Perception	←	Exposure to RSE	.136	.014	2.880	.004	**
Risk Perception	←	Observed Safe Behaviors	.070	.028	1.490	.136	N/S
Rule Knowledge	←	Exposure to RSE	.159	.015	3.357	<.001	***
Positive Attitudes	←	Exposure to RSE	.227	.017	5.010	<.001	***
Risk Perception	←	Age	.131	.030	2.784	.005	**
Positive Attitudes	←	Age	.150	.036	3.311	<.001	***
Rule Knowledge	←	Age	.027	.033	.564	.573	N/S
Positive Attitudes	←	Psychological Health	.119	.009	2.624	.009	**
Rule Knowledge	←	Psychological Health	.086	.008	1.810	.070	N/S
Risk Perception	←	Psychological Health	.013	.007	.284	.776	N/S
Use of Passive Safety Elements	←	Age	.062	.070	1.534	.125	N/S
Use of Passive Safety Elements	←	Exposure to RSE	-.050	.033	-1.216	.224	N/S
Use of Passive Safety Elements	←	Observed Safe Behaviors	.383	.066	9.462	<.001	***
Use of Passive Safety Elements	←	Risk Perception	.121	.112	2.903	.004	**
Use of Passive Safety Elements	←	Rule Knowledge	.104	.109	2.399	.016	*
Use of Passive Safety Elements	←	Positive Attitudes	.244	.098	5.381	<.001	***
Use of Passive Safety Elements	←	Psychological Health	.086	.017	2.157	.031	*
MGSEM (2/2): Male Teenagers			Std. Estimate	S.E.	C.R.	P	Sig.
Positive Attitudes	←	Observed Safe Behaviors	.169	.038	3.533	<.001	***
Rule Knowledge	←	Observed Safe Behaviors	.204	.034	4.154	<.001	***
Risk Perception	←	Exposure to RSE	.068	.014	1.369	.171	N/S
Risk Perception	←	Observed Safe Behaviors	.076	.031	1.528	.127	N/S
Rule Knowledge	←	Exposure to RSE	.104	.015	2.111	.035	*
Positive Attitudes	←	Exposure to RSE	.230	.017	4.807	<.001	***
Risk Perception	←	Age	.065	.036	1.305	.192	N/S
Positive Attitudes	←	Age	.034	.044	.715	.475	N/S
Rule Knowledge	←	Age	-.002	.038	-.035	.972	N/S
Positive Attitudes	←	Psychological Health	.174	.013	3.631	<.001	***
Rule Knowledge	←	Psychological Health	.102	.012	2.077	.038	*
Risk Perception	←	Psychological Health	.172	.011	3.465	<.001	***
Use of Passive Safety Elements	←	Age	.038	.080	.915	.360	N/S
Use of Passive Safety Elements	←	Exposure to RSE	.056	.032	1.314	.189	N/S
Use of Passive Safety Elements	←	Observed Safe Behaviors	.455	.072	1.618	<.001	***
Use of Passive Safety Elements	←	Risk Perception	.106	.122	2.323	.020	*
Use of Passive Safety Elements	←	Rule Knowledge	.076	.115	1.614	.106	N/S
Use of Passive Safety Elements	←	Positive Attitudes	.138	.099	2.922	.003	**
Use of Passive Safety Elements	←	Psychological Health	.058	.025	1.369	.171	N/S

Notes: ¹SPC = Standardized Path Coefficients (can be interpreted as linear regression weights). ²S.E. = Standard Error.

³C.R. = Critical Ratio. ⁴p-values. ***Significant at level 0.001. **Significant at level 0.01. *Significant at level 0.05.

(FIGURE 3 HERE)

Figure 3. Two-group (MGSEM) structural model showing standardized path coefficients and significant paths (solid lines). Categories: females (above) and males (below). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Gender differences and similarities

The MGSEM model shows that, although both groups keep similar characteristics, there are some key structural gender differences in what concerns the differential effect of the study variables on the use of passive safety elements. First, and regarding the observed similarities, we see how (for both genders): exposure to RSE has a significant effect on rule knowledge ($\beta=.159^{***}$ females; $\beta=.104^*$ males) and attitudes towards road safety ($\beta=.227^{***}$ females; $\beta=.230^{***}$ males). Also, the observed safe behaviors significantly influence the positive attitudes of subjects towards road safety ($\beta=.167^{***}$ females; $\beta=.169^{***}$ males) and the use of PSEs ($\beta=.383^{***}$ females; $\beta=.455^{***}$ males). Furthermore, psychological health has an effect on positive attitudes towards road safety in both groups ($\beta=.119^{**}$ females; $\beta=.174^{***}$ males). Finally, risk perception ($\beta=.121^{**}$ females; $\beta=.106^*$ males) and positive attitudes towards road safety ($\beta=.244^{***}$ females; $\beta=.138^{**}$ males) has a similar and significant effect on the use of passive safety elements.

Secondly, and regarding gender differences, it was found that: unlike male teenagers, in the case of females age has a significant effect on risk perception ($\beta=.131^{**}$) and positive attitudes towards road safety ($\beta=.150^{***}$). Also, the exposure to RSE influence risk perception ($\beta=.136^{***}$), and psychological health has a positive effect on the use of passive safety elements ($\beta=.086^*$). All these paths were non-statistically significant for

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3 male teenagers. On the other hand, there is a set of significant effects that were only
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5 observed in males: the safe behaviors observed in parents were linked to the knowledge
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7 of traffic rules ($\beta=.204^{***}$), and psychological health had a significant effect on both risk
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9 perception ($\beta=.172^{***}$) and the traffic rule knowledge ($\beta=.102^*$), paths that were non-
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11 significant for females.
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18 **Discussion and conclusion**

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21 The main objectives of this study were, first, to test the effects of sociodemographic
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23 variables, and the effects of three key road safety skills (*knowledge—risk perception—*
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25 *attitudes*) on the use of passive safety elements (PSEs) among teenagers; and second, to
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27 assess the differential impact of the study variables on PSEs use from a gender-based
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29 perspective.
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33 Regarding the first objective of the study, the results of this study allowed us to establish
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35 that the use of such elements in teenagers is not only correlated, but also largely explained
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37 by several variables related to age, psychological health, and road safety education,
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39 through the mediation of road safety skills: risk perception, knowledge of traffic rules and
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41 positive attitudes towards road safety. In short, the directionality of the significant
42
43 bivariate correlations between demographic variables, road safety skills and the use of
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45 PSEs, suggests that these factors are associated between themselves; however, the
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47 predictive mechanism needed to be tested through a theoretically-supported model, which
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49 in turn had to be tested in this population. In this regard, the SEM modeling was
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51 performed, and a parsimonious model with an adequate fit was obtained. In this *Model A*,
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53 built in accordance with the revised literature, it was interesting to observe how the
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55 directions and significance of the associations between study variables suggest the need
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3 for strengthening road safety-related skills as a way of improving safe behaviors [16], in
4 accordance to what was already stated by other researches dealing with Spanish-speaking
5 populations [16,28,29]. Most of these conclusions support that systematic exposure to
6 enough information/education in road safety settings is, perhaps, the most effective
7 measure for minimizing road risks and traffic injuries among teenagers [1,28].
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15 *“Similar, but different”: a summary of gender similarities and disparities*
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18 As for the second objective of the study, we found that, although several similarities can
19 be observed across male and female teenagers, some key differences are noticeable.
20 Accordingly, previous studies on road safety behavior have shown that, even though great
21 similarities and uniform patterns may be observed across genders, key differences in the
22 role of demographic factors, mental health and educational aspects might explain
23 differential outcomes in both risky and protective road behaviors of individuals [30-32].
24 Also, several studies have already suggested that risky road behaviors can be more
25 frequent and dangerous, and protective behaviors less prevalent in the case of male road
26 users [11,13,32].
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39 Furthermore, local studies have stated that there is a gender disparity in the injury
40 protection through PSEs [33] of people, although differences in this regard have been
41 reported as nonsignificant in some other studies performed on adult samples [34,35]: this
42 implies a differential state-of-affairs based on factors such as the law enforcement and
43 the road safety culture of each country [31]. In this regard, it is worth mentioning that,
44 although non-significant differences were found in the extent to which subjects of both
45 genders use PSEs, the mean score was tendentially higher for females. Furthermore,
46 significant mean differences were found in the case of two road safety skills: rule
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3 knowledge and positive attitudes towards road safety (both higher for females), while the
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5 only study variable significantly higher for males was psychological health [21].
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9 Bearing in mind the second objective of our research study (that is, to evaluate the
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11 differential impact of the study variables on the use of PSEs from a gender-based
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13 perspective through MGSEM), while at the same time comparing the structural models
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15 presented in Figure 3 with the hypothesized assumption that there are key structural
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17 similarities (but also differences) between males and females, we discovered an
18
19 interesting set of outcomes. First of all, age has a significant effect on risk perception and
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21 positive attitudes in females, but, in the case of males, it does not have a significant effect
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23 on any of the dependent variables. Apart from the mere gender difference, it is attention-
24
25 worthy how, from a gender-based perspective, age may play a critical role in the
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27 perception of road risk situations and the production of safer behaviors within the set of
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29 problematic road safety behaviors observed in female road users [16,36]. Also, we found
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31 that exposure to RSE, both in males and females, had a significant effect on the
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33 knowledge of traffic norms and on positive attitudes; however, RSE exposure only
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35 influenced the road risk perception of females. Regarding the observed safe behaviors of
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37 parents, while showing an effect on positive attitudes and (directly) on the use of passive
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39 safety elements for both genders, it exerted a significant influence on the knowledge of
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41 traffic rules only in male teenagers. Another differential outcome was found for what
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43 concerns the psychological health indicator: speaking of similarities, it influenced
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45 positive attitudes in both genders. As for particularities, the GHQ-12 score had a direct
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47 effect on females' use of PSEs, and on males' risk perception and traffic rules'
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49 knowledge. In this regard, the evidence has suggested that mental health may have a
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51 differential role in health-compromising behaviors that are also related to traffic,
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53 especially in the case of young male subjects, whose competences in decision making
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3 concerning safety issues could be highly influenced by their mental health condition
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5 [23,37].
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8 Regarding road safety skills, it was found that risk perception and positive attitudes,
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10 although differentially affected by independent study variables, had a significant effect
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12 on the use of passive safety elements for both male and female teenagers. However,
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14 positive attitudes towards road safety remain significantly higher for females, as it has
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16 been seen in some other studies involving young road users [38]. Finally, and although
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18 knowledge of traffic rules had a direct effect on the use of PSEs in female teenagers, it
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20 was not significant for males. This could be supported by the gender differences found in
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22 mean comparisons (shown in Table 1), in which males tend to report a significantly lower
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24 knowledge of traffic rules than females; similar studies focusing on gender differences
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26 such as the ones performed by Yahia et al. [39] and Eiskund [40] confirm this. In fact, it
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28 constitutes the only assessed road safety skill that reported a structural gender-based
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30 difference.
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36 *Enforcing the use of PSEs: law, parenting & RSE*

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39 Even though the self-reported frequency of the use of passive safety elements was overall
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41 high among Spanish teenagers (with an average score of 8.52/12), the discussion is still
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43 open for the complementary factors that strengthen the use of protective elements. The
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45 first element to be highlighted is law enforcement, since it directly involves both parents
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47 and educational institutions. In this regard, the evidence has demonstrated that, in the case
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49 of motor-vehicle users, policies on primary enforcement laws (and unbelted
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51 driver/passengers are a sufficient reason for imposing a traffic fine) have positive effects
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53 on the use of PSEs in teenagers [41], especially considering that the use of PSEs is highly
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3 enhanced by institutional stakeholders. Also, other studies [42] have prospectively
4 demonstrated that the use of PSEs is significantly increased by law improvements.
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8 The second point to be highlighted is the parental influence on the safe habits of young
9 road users. As it has been previously addressed [15,19,43], the implications of
10 strengthening the parent-child relationship in the field of road safety carry an undisputable
11 practical implication for the outcomes of our research. In fact, the results have not only
12 shown that the observed safe behaviors have an effect on the use of PSEs, but also that
13 they influence the positive attitudes of teenagers towards road safety and, in the particular
14 case of males, towards the learning of traffic norms by means of the behaviors observed
15 in parents and relatives [43,44].
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19 The third point that needs to be highlighted is the role of road safety education. Studies
20 suggest that, with an increased set of skills, such as the knowledge of traffic norms (that
21 might also be enforced by policymakers), road risk perception and favorable attitudes, it
22 is possible to predict the safe road behaviors of people and, consequently, to foster fewer
23 injuries derived from traffic crashes [14,28,29]. Other studies have highlighted that
24 increasing the use of PSEs is an urgent need for road safety [1,13,16], and the increase of
25 RSE (Road Safety Education), especially during early life stages, is of key importance
26 for developing both the present and future safe behaviors of children and adolescents.
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30 Finally, it is worth mentioning the importance of the multi-level efforts made in the
31 enforcement of both RSE and the available human and structural resources, with the aim
32 of guaranteeing injury prevention among teenagers: more than 30 years ago, Spital, Spital
33 & Spital [12] claimed for a superior professional involvement (especially by part of
34 physician pediatricians), in order to optimize the quality standards of passive safety in
35 school transportation; furthermore, they advocated for the presence of more education
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3 within the community. Nowadays, it is worth highlighting that, as of yet: developed
4 countries have successfully policed minimum standards and guidelines in this regard
5 while developing ones are “on their way” —and this, up until now, has already saved
6 many lives —; yet it is not enough, since the ultimate objective is *zero* lives lost. This
7 type of task has acquired a multidisciplinary approach [45] which is currently and
8 predominantly framed within the Road Safety Education approach, a fact that maximizes
9 the articulation and potentiality of multilevel researches, interventions and policies aimed
10 at filling out pending issues in community health.
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22 **Limitations of the study and further research**

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24 Although basic methodological considerations were formulated, and core statistical
25 parameters needed for the analyses were satisfactorily tested, some issues should be listed
26 as potential biasing sources. Firstly, this was a self-report-based study, and it was
27 therefore prone to present the common method bias, that may influence the results derived
28 from the answers provided by the participants, especially when gathering information on
29 issues that may be sensitive for them [46]. This entails the need of being cautious when
30 interpreting behavioral models based on self-reports [47]. Also, topics related to the
31 participants’ behavior may elicit social desirability: for this reason, we actively
32 emphasized on the anonymity of the survey. Also, 23 incomplete data (not fully
33 completed surveys) and acquiescent questionnaires (whose responses presented an
34 atypical unilateral trend) were excluded during the data processing. Finally, although
35 different standards exist in the educational system and the instruments were previously
36 tested during a pilot phase, some additional assistance from the researcher was required
37 by specific participants. This supports the need of having staff members being physically
38 present during surveying, in order to clarify doubts and strengthen the correct completion
39 of self-report-based questionnaires.
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3 Furthermore, regarding the obtained bivariate correlations (oscillating between .076 and
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5 .248), it is worth saying that, although procedural parameters were followed during the
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7 data analysis, some relatively small correlations were found. This could be related to the
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9 effect of having a large sample size that might lead to the finding of significant variable
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11 associations, even when their relationship could be very small or moderate. In other
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13 words, huge sample sizes can amplify the bias associated with inferential errors, reason
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15 why it is important to be cautious with this kind of sample size-related issues [48,49].
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19 This study offers useful information for researchers, practitioners and policymakers on
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21 factors that strengthen the use of passive safety elements among adolescents and, thus,
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23 can decrease their injury risk in traffic crashes. These evidence-based findings could be
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25 addressed in interventions and multisectoral strategies aimed at improving the road safety
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27 competences of young population.
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42
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50 **Competing Interests**

51
52 The authors declare no competing interests.
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60 **Author contribution statement**

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3 For this study, S.U. conceived and designed the research; S.U. and L.G. performed the
4 data collection; S.U. and F.A. analyzed the data; F.A. contributed
5 reagents/materials/analysis tools; S.U. and L.M. wrote and revised the paper.
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14
15
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17 commercial, or not-for-profit sectors.
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24 **Data availability statement**

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27 The datasets generated for this study are available on request to the corresponding author.
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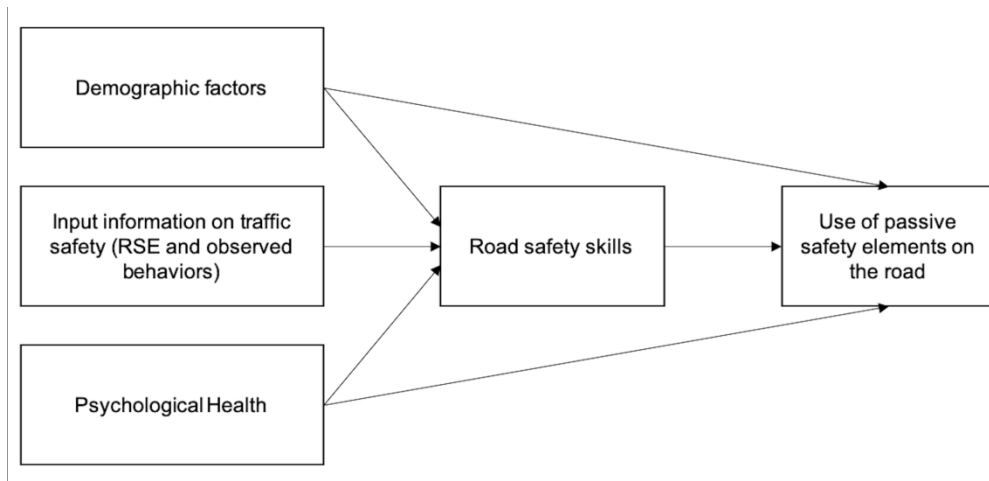


Figure 1. Hypothesized mediated path model for predicting the use of PSEs. Rectangles are the observed variables, and lines with arrows indicate the predicted paths.

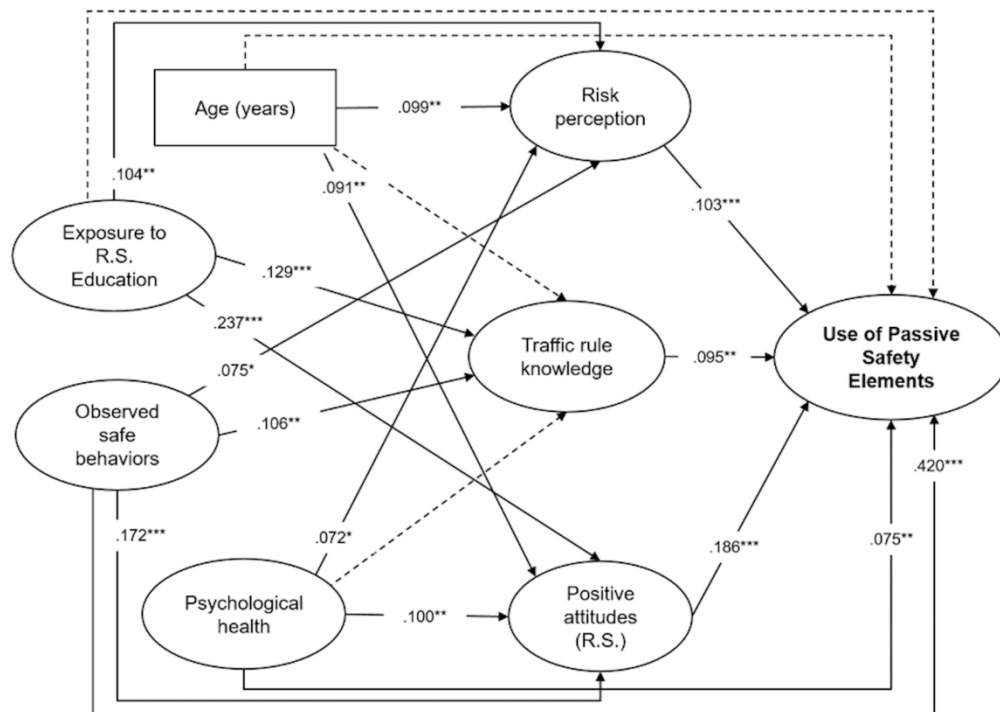


Figure 2. Graphic presentation of the Structural Equation Model (SEM) for predicting the use of PSEs. Solid lines represent significant paths. *p<0.05; **p<0.01; ***p<0.001.

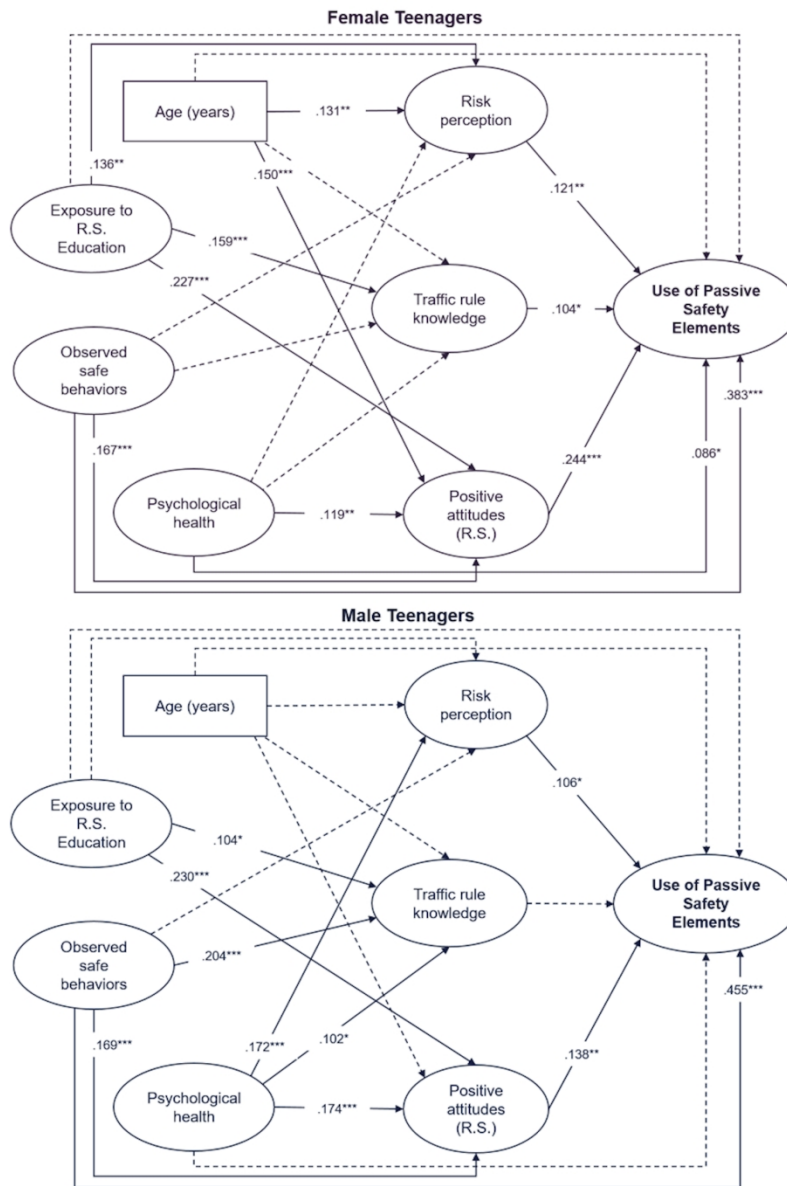


Figure 3. Two-group (MGSEM) structural model showing standardized path coefficients and significant paths (solid lines). Categories: females (above) and males (below). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

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Supplementary File

Paper Questionnaire (researcher form)

Questionnaire code: _____ Date: _____

Age: _____ Gender: _____

City or town of residence: _____

Academic year (current): _____

Exposure to information on road safety

In this section, we will discuss some issues related to the information you receive on road safety topics from different sources (such as the media, the news, and content you go through at school).

Please, state to what extent you agree with the following statements:

Totally disagree – Disagree – Neutral – Agree – Totally agree

1. Advertising campaigns on traffic influence my behavior
2. Advertising campaigns on traffic should be more present
3. Advertising campaigns are adequately transmitted to young people and children
4. Traffic campaigns are truly effective
5. I can remember the last campaigns on traffic and road safety

Observed Road Safety Behaviors in Parents

We will now discuss some behaviors observed in your parents (or tutors) when they drive (if they do not own a car, please leave this section blank).

How frequently do you observe the following behaviors in your parents?

Never – Rarely – Sometimes – Frequently – Always/almost always

1. My parents use the seatbelt while driving or accompanying someone in the car
2. My parents avoid using their cellphones in the car when they are driving
3. My parents respect the speed limits when they drive

General Health Questionnaire (GHQ)

We would like to know how your health has been over the past few weeks. Below, we will present a brief set of issues that may (or not) apply to you during this period. Have you recently:

Less than usual – No more than usual – Rather more than usual – Much more than usual

1. Been able to concentrate on whatever you are doing?
2. Lost much sleep over worry?
3. Felt that you were playing a useful part in things?

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- 4 Felt capable of making decisions about things?
- 5
- 6 Felt constantly under strain?
- 7
- 8 Felt that you couldn't overcome your difficulties?
- 9
- 10 Been able to enjoy day-to-day activities?
- 11
- 12 Been able to face problems?
- 13
- 14 Been feeling unhappy and depressed?
- 15
- 16 Been losing confidence in yourself?
- 17
- 18 Been thinking of yourself as a worthless person?
- 19
- 20 Feeling reasonably happy, all things considered?
- 21

Attitudes towards road safety

22 *Do you agree with the following statements?*

23 Agree - Disagree

- 24 1. Even if it were not mandatory, I would still use the safety seatbelt
- 25
- 26 2. The use of helmets should be voluntary, they should be used only by those who want to
- 27
- 28 3. Traffic norms and rules are only good for writing us tickets
- 29
- 30 4. People who do not comply with the norms should be fined more
- 31
- 32 5. It is annoying to use the road and pay attention to every road safety norm
- 33
- 34 6. When I travel by car I like overtaking others, as if we were doing a race
- 35
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Risk Perception

40 *Do you agree with the following statements?*

41 Agree – Disagree

- 42 1. Traveling by bus is safer than traveling by car
- 43
- 44 2. When the roads or vehicles we are using for traveling are very safe, we can take more
- 45 risks
- 46
- 47 3. Sometimes, wearing a seatbelt could be more dangerous than not wearing it
- 48
- 49 4. When the vehicle has an airbag, it is not necessary to use a seatbelt
- 50
- 51 5. Wearing a helmet when using a skateboard is more important than when riding a bike
- 52
- 53 6. Driving for more than four hours in a row increases the risk of suffering accidents
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Knowledge of Traffic Rules

Please, indicate whether the following statements regarding Spanish traffic norms are true or false

True - False

1. On a crosswalk, you can cross the road without looking around you, since pedestrians always have the priority
2. You must always wear a helmet when you ride a bike
3. Passengers in the backseat of a vehicle do not have to use seatbelts
4. Kids older than 12 can already sit on the passenger side
5. The maximum blood alcohol limit allowed for driving a motorbike is 0,5 g/l
6. A driver who is waiting at a traffic light is allowed to answer phone calls

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	22
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	N/A
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	8
		(c) Explain how missing data were addressed	8
		(d) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(e) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6, 9-10
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-10
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	N/A
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-17

		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	21, 22
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17-21
Generalisability	21	Discuss the generalisability (external validity) of the study results	22
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.