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Article · July 2019

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Co-occurence of risky driving behaviours and associations with seatbelt and helmet use - a descriptive cross-sectional study among young adults

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DOI: ***10.2427/13041***
Accepted on 04 June, 2019

ABSTRACT

Background: Greece exhibits one of the highest rates of deaths and injuries due to motor vehicle crashes in young adults in Europe. The personal, social and financial cost is still very high as road traffic crashes account for 65.8% of all deaths among young people aged 10-24 years, with prominent gender differences that are not fully explained yet.
Methods: using a descriptive cross-sectional study design, we examined the associations of seatbelt and helmet use with the likelihood of manifesting multiple driving violations (fail to stop at STOP signs, running red traffic lights, driving towards the wrong direction, illegal overtaking, speeding, cellphone use while driving, driving under the influence of alcohol) in a sample of 536 1st year university students in Greece. A 'Risky Driving Index' score (RDI) was produced by summing the frequencies of all behaviours (range 0-28).
Results: only 8.8% of the students reported not performing any of the driving violations, whereas 8.6% engaged in all 7 of them when driving (male: 11.5%; female: 1.9%; score>8, male: 31.7%; female: 8.1%). Male, but not female participants, who never used seatbelts and helmets, reported significantly higher RDI scores with evidence of a dose-response effect in the increase. In adjusted logistic regression models, those who never used (vs regular use) seat belt 'as drivers' and 'as rear seat passengers' had increased odds of being in the higher score category of RDI (OR=5.239 95%CI=1.280-21.441 and OR=6.782 95%CI=1.891-24.324, respectively).
Conclusion: young male drivers and riders, but not their female counterparts, that do not take typical safety measures (seatbelt and helmet use), reported more illegal and risky driving behaviours. Preventive interventions using a gender-informed approach are needed to address co-occurring risk driving behaviours.

Key words: seatbelt, helmet, gender, driving violations, risky driving, Greece

BACKGROUND

Globally, risky driving behaviours among young adults have been associated to developmental, personality, lifestyle, demographic, instrumental social and environmental factors [1 - 6]. In addition to lower quality vehicles, inexperience, overestimation of driving skills and lower ability to estimate danger accurately, young drivers are more prone to risk-taking driving behaviours, such as speeding, keep unsafe distances and driving under the influence of alcohol or other drugs [7 - 10] with some prominent gender differences [11 - 13]. The fact that male and younger drivers outnumber their older and female counterparts in traffic incidents, injuries and fatalities has been well documented in many different contexts around the globe [14 - 15]. This may come as no surprise since male and teen drivers perceive as less risky and enjoy more risky driving behaviours than female and older individuals [16] In addition, gender norms about masculinity already formed during adolescence do not usually reward safe driving by males [17].

A significant body of research has concluded that risk-taking behaviours increase the probabilities of motor vehicle crashes and injuries [18 - 20]. Qu et al. [21] reported in a retrospective analysis that aggressive driving behaviours accounted for 94.36% of accidents. Not using helmet when riding and seatbelt when driving is also linked to increased occurrence of injury [14, 22]. However, a low compliance with the mandatory seatbelt and helmet use while driving and riding is still reported in Greece and internationally [5, 23]. In Greece, 74% of the motorcycle riders and 31% of the motorcycle passengers are reported to wear helmet and 77%, 72% and 21%, to wear seatbelts as drivers, front-seat passengers and rear-seat passengers respectively, based on 2009 data [24, 25].

Bogstrand et al. [26] reported very high odds of not using seatbelt and speeding when driving impaired by alcohol in relation to sober driving (8 and 5.2 respectively) and a similar effect was also noted for lack of helmet use in cases of alcohol consumption [5]. Zhao et al. [27] concluded that frequent cell phone users score higher on both self-reported and observed risky driving and driving violations. Donovan et al. [28], argued that some behaviours with similar characteristics may form a syndrome of health-compromising behaviours and Hsieh et al. [29] reported that regarding risky driving, risks in one domain will manifest as risks in the same and other domains across time.

The previous conclusions are quite important because in real world, most individuals follow complex behavioural patterns. That means that an individual may perform only one driving violation and another may perform concurrently many driving violations. Most of the current research focuses on a limited number of risky driving behaviours, without considering their co-occurence and most prevention programs employ a one-size-fits-all-approach, missing the opportunity to fully understand their co-occurrence and possible co-variance [30]. Additionally, the identification of these co-occurring behaviours is of paramount importance because they could lead to more sophisticated prevention interventions that address them concurrently in people with common behaviours [19, 30]. Although high violation score has been shown to be associated with traffic crash involvement [31 - 32], research is limited on the extent to which certain reckless driving behaviours, such as not using helmet when riding and seatbelt when driving are related to other intentional violations and risky driving behaviours that increase the crash risk. This conceptualization is largely based on the work made by Scott-Parker et al. [33] in relation to driving violations.

This study advances previous research by estimating the sex-stratified prevalence of co-occuring risky driving behaviours, and also examines the associations of seatbelt and helmet use with the likelihood of manifesting multiple driving violations.

METHODS

Study design and data collection

This cross-sectional analysis draws inferences from the results of the 1st year of the LATO prospective longitudinal study (Lifestyles and Attitudes in a Student Population), that was established in 2012, at TEI Crete, Greece (now Hellenic Mediterranean University), among the 1st year University students of the 11 academic departments located at the Heraklion campus. The students were approached during compulsory courses (in small groups of up to 24 persons) and were invited to respond to self-administered internet questionnaires (approximately 20-35 min for all variables in the study) during November-December of the academic year 2012-2013. Of the 1254 students that were present in the courses, 1213 agreed to participate (participation rate 96.7%). For more details on the study, the participants and data collection processes see Kritsotakis et al. [30, 34 - 35].

Study participants

Out of those who participated in the study, 667 met the inclusion criteria for this analysis (traditional 1st year college age, 18-20 years old and were eligible to complete questions on driving having stated that they were driving a car, riding a motorcycle, or both). Of them 536 had complete data in all risky driving variables for this analysis (80.4% of the eligible participants).

Ethical considerations

Research protocol was reviewed and approved by the relevant Research Board of the TEI of Crete. Students received written and oral information about the aim of

the study and signed informed consent forms before completing the questionnaire. their voluntary participation and the anonymity and confidentiality of their responses was extensively described and ensured.

Study variables

Participants provided information on their socio-demographic characteristics, driving status, seatbelt use (as driver, front-seat and rear-seat passenger) and helmet use (rider and passenger) and on seven risky driving behaviours (fail to stop at STOP signs, running red traffic lights, driving in the wrong direction, illegal overtaking, speeding, cellphone use while driving, driving under the influence of alcohol). The concept of violation as described in Reason et al. [36] and used in 'Driver Behaviour Questionnaire' (DBQ) informed the choice of these behaviours. The 5 response options for seatbelt and helmet use and the seven risky driving behaviours were scored as Never (0), Occasionally (1), sometimes (2), very often (3), regularly (4).

Co-occurence of driving violations

We created a score to evaluate the co-occurence of driving violations by summing every present risk driving behaviour (those with a score of ≥1, range 0-7).

Risky Driving Index

For evaluating more accurately the burden of violations for individuals we produced a Risky Driving Index (RDI) by summing the actual score (0, 1, 2, 3 or 4) of each driving violation for every student (range 0-28). Higher score is indicative of higher self-reported risk. The RDI score was further grouped in three categories to highlight the frequency of engaging in driving violations as Never (score=0), Occasionally (score=1-7), Very often, Regularly (score=8-28). The reliability of the 'Risky Driving Index' as measured by Cronbach's Alpha was 0.81 for this sample, well above the recommended 0.70 value, justifying calculating a total score [37].

Statistical analyses

Data were analyzed using the SPSS software (IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp). Categorical variables were summarized as relative frequencies (%), while continuous variables were presented as mean and standard deviation. Unadjusted associations between categorical variables were assessed using the chi-square test. 'The Risk Driving Index' score failed the normality test (Kolmogorov-Smirnov test) and log10 transformation was used to normalize the score. Thus, the method of analysis of variance was applied checking the differences between categories of seatbelt and helmet use within and between sexes (two-way analysis of variance). Crude and adjusted multivariable logistic regression models were performed to estimate the association (odds ratio (OR) and 95% confidence intervals (CI) of seatbelt and helmet use with the 'Risk Driving Index' score. For the regression analyses, seatbelt and helmet use were dichotomized as never use vs regularly use.

Confounders

Potential confounders related to the predictors or the outcome variables or both in bivariate associations with $p < 0.20$ were included in the multivariable models. These confounding variables were: gender (male, female); age (18, 19, 20 years old); maternal and paternal education (low level, ≤6 years of school; medium level, >6 years of school but ≤12 years that are typically needed prior to attending university; high level, university or technical college degree); place of birth (Greece, other country); current residence (on-campus dormitory, parent/guardian home, off-campus housing).

RESULTS

Demographic characteristics of study participants

The demographic characteristics of the 536 participants are presented in Table 1 (70% male; age range 18-20 years old). Most of the participating students come from Greece (92.9%), stay at off-campus housing (74.1%) and share diverse backgrounds regarding family composition, maternal and paternal education, and department of studies.

Sex-stratified rates of seven driving violations

Table 2 presents the sex-stratified rates of seven driving violations. Male drivers reported more traffic violations than female drivers in all seven violations. For both genders, illegal overtaking, speeding and cellphone use while driving were the most common self-reported violations.

Sex-stratified prevalence of seatbelt and helmet use

Sex-stratified prevalence of seatbelt and helmet use is shown in Table 3. A total of 47.3% and 72.2% of male and female participants use 'helmet as drivers' and 'seat belt as drivers', respectively. Similarly, 'Seat belt as front seat passengers' is regularly used by 72.2% of the respondents. The lowest percentage is reported for 'seat belt use as rear

TABLE 1. Demographic characteristics of the 536 participating students

	TOTAL	MALE	FEMALE
		n (%)	
Sex	536	375 (70.0)	161 (30.0)
Age in years			
18	378 (70.5)	262 (69.9)	116 (72.0)
19	111 (20.7)	78 (20.8)	33 (20.5)
20	47 (8.8)	35 (9.3)	12 (7.5)
Department of studies			
Nursing	30 (5.6)	12 (3.2)	18 (11.2)
Social Work	45 (8.4)	8 (2.1)	37 (23.0)
Tourism Management	9 (1.7)	6 (1.6)	3 (1.9)
Accounting & Finance	94 (17.5)	61 (16.3)	33 (20.5)
Business Administration	34 (6.3)	21 (5.6)	13 (8.1)
Informatics Engineering	66 (12.3)	55 (14.7)	11 (6.8)
Electrical Engineering	78 (14.6)	76 (20.3)	2 (1.2)
Mechanical Engineering	56 (10.4)	52 (13.9)	4 (2.5)
Civil Engineering	62 (11.6)	41 (10.9)	21 (13.0)
Agricultural Technology-Crop production	46 (8.6)	33 (8.8)	13 (8.1)
Agricultural Technology-Greenhouse production	16 (3.0)	10 (2.7)	6 (3.7)
Place of birth (n=532)			
Greece	494 (92.9)	347 (93.5)	147 (91.3)
Not in Greece	38 (7.1)	24 (6.5)	14 (8.7)
Current residence (n=533)			
Parent/guardian home	120 (22.5)	92 (24.7)	28 (17.4)
On-campus dormitory	18 (3.4)	11 (3.0)	7 (4.3)
Off-campus housing	395 (74.1)	269 (72.3)	126 (78.3)
Paternal level of education (n=514)			
Low	78 (15.2)	50 (13.9)	28 (18.1)
Medium	323 (62.8)	222 (61.8)	101 (65.2)
High	113 (22.0)	87 (24.2)	26 (16.8)
Maternal level of education (n=519)			
Low	61 (11.8)	35 (9.7)	26 (16.5)
Medium	329 (63.4)	226 (62.6)	103 (65.2)
High	129 (24.9)	100 (27.7)	29 (18.4)

seat passengers' (19.7% of the respondents). There were statistically significant differences between male and female participants in the rates of 'helmet use as passengers' and 'seat belt use as drivers', but not in the rates of 'seat belt use as front seat passengers', and 'seat belt use as rear seat passengers'. Additionally, male students were overrepresented in the higher-score categories of the 'Risk Driving Index' score (for score ≥8, male: 31.7%; female: 8.1%; mean for males: 6.47(4.80; females: 3.30(2.69, the latter presented in Table 4).

TABLE 2. Sex stratified rates of risky driving behaviours in 1st year university students

	TOTAL					MALE					FEMALE				
	Never	Occasionally	Sometimes	Very often	Regularly	Never	Occasionally	Sometimes	Very often	Regularly	Never	Occasionally	Sometimes	Very often	Regularly
Fail to stop at STOP signs															
N	370	143	9	10	4	242	111	9	10	3	128	32	0	0	1
%	69	27	1.7	1.9	0.7	64.5	29.6	2.4	2.7	0.8	79.5	19.9	0	0	0.6
Running red traffic lights															
N	354	136	33	7	6	226	109	29	5	6	128	27	4	2	0
%	66	25	6.2	1.3	1.1	60.3	29.1	7.7	1.3	1.6	79.5	16.8	2.5	1.2	0
Driving in the wrong direction															
N	331	173	21	7	4	211	137	17	6	4	120	36	4	1	0
%	61.8	32	3.9	1.3	0.7	56.3	36.5	4.5	1.6	1.1	74.5	22.4	2.5	0.6	0
Illegal overtaking															
N	169	223	72	52	20	88	163	58	48	18	81	60	14	4	2
%	31.5	42	13	9.7	3.7	23.5	43.5	15.5	12.8	4.8	50.3	37.3	8.7	2.5	1.2
Speeding															
N	119	199	86	70	62	58	128	71	62	56	61	71	15	8	6
%	22.2	37	16	13	12	15.5	34.1	18.9	16.5	14.9	37.9	44.1	9.3	5	3.7
Cellphone use while driving															
N	178	236	55	46	21	104	174	41	38	18	74	62	14	8	3
%	33.2	44	10	8.6	3.9	27.7	46.4	10.9	10.1	4.8	46	38.5	8.7	5	1.9
Driving under the influence of alcohol															
N	365	126	22	12	11	227	104	21	12	11	138	22	1	0	0
%	68.1	24	4.1	2.2	2.1	60.5	27.7	5.6	3.2	2.9	85.7	13.7	0.6	0	0

Sex-stratified associations of 'Risky Driving Index' score with seatbelt and helmet use

In Table 4 the sex-stratified associations of 'Risky Driving Index' score with seatbelt and helmet use are reported. In general, males in all categories reported the highest RDI scores and the highest RDI score mean related to female participants (4.1(2.6) is well below the lowest reported by male students (5.0(5.5). Male, but not female drivers, who never use seatbelts and helmets, reported significantly higher RDI scores in relation to those who regularly use, with evidence of a dose-response effect in the growth. Those who never use 'seat belt as drivers' and 'seat belt as front seat passengers' reported the highest RDI scores (9.8 (6.2) and 10.6 (7.1), respectively.

Co-occurence of the seven risky driving behaviours that comprise the RDI

Table 5 presents the co-occurence of the seven risky driving behaviours that comprise the RDI (fail to stop at STOP signs, running red traffic lights, driving in the wrong direction, illegal overtaking, speeding, cellphone use while driving, driving under the influence of alcohol). Only 8.8% of the students reported not performing any risk behaviour whereas 8.6% have engaged in all 7 behaviours when driving (male: 11.5%; female: 1.9%). There were statistically significant differences between male and female students when comparing the co-occurence of all 7 behaviours (male: 3.92; female: 2.47, $p<0.001$).

TABLE 3. Sex stratified rates of 'Risky Driving Index' score and prevalence of seatbelt and helmet use in 1st year university students

	Total n (%)	Male n(%)	Female n(%)	P-value
Risk Driving Index Score				
range	0-28	0-28	0-12	<0.001
Never (score=0)	47 (8.8)	26 (6.9)	21 (13.0)	
Occasionally (score=1-7)	357 (66.6)	230 (61.3)	127 (78.9)	
Very often, Regularly (score=8-28)	132 (24.6)	119 (31.7)	13 (8.1)	
Helmet use as driver (n= 457)				
Never	115 (25.2)	77 (23.3)	38 (30.2)	0.314
Occasionally	126 (27.6)	94 (28.4)	32 (25.4)	
Very often, Regularly	216 (47.3)	160 (48.3)	56 (44.4)	
Helmet use as passenger (n= 505)				
Never	247 (48.9)	193 (54.7)	54 (35.5)	<0.001
Occasionally	138 (27.3)	96 (27.2)	42 (27.6)	
Very often, Regularly	120 (23.8)	64 (18.1)	56 (36.8)	
Seat belt use as driver (n= 485)				
Never	60 (12.4)	37 (10.7)	23 (16.7)	0.023
Occasionally	75 (15.5)	62 (17.9)	13 (9.4)	
Very often, Regularly	350 (72.2)	248 (71.5)	102 (73.9)	
Seat belt use as front seat passenger (n= 532)				
Never	38 (7.1)	29 (7.8)	9 (5.6)	0.085
Occasionally	110 (20.7)	85 (22.8)	25 (15.6)	
Very often, Regularly	384 (72.2)	258 (69.4)	126 (78.8)	
Seat belt use as rear seat passenger (n= 532)				
Never	303 (57.0)	219 (58.9)	84 (52.5)	0.396
Occasionally	124 (23.3)	83 (22.3)	41 (25.6)	
Very often, Regularly	105 (19.7)	70 (18.8)	35 (21.9)	

Note: chi square tests

Crude and adjusted odds ratios on risky driving index

In logistic regression models adjusted for potential confounders (Table 6), those who never use vs those that regularly use 'seat belt as drivers' and 'seat belt as rear seat passengers' are at increased odds of being in the higher score category of RDI (OR=5.239 95%CI=1.280-21.441 and OR=6.782 95%CI=1.891-24.324 respectively). 'Helmet use as drivers', 'helmet use as passengers' and 'seat belt use as front seat passengers', were similarly associated with RDI scores, although not statistically significant in the adjusted regression models.

DISCUSSION

In this study, we estimated the prevalence of seatbelt and helmet use and their associations with risky driving behaviours, as well as their co-occurence by gender in young adults in Greece. Our results revealed that male drivers that do not take typical safety measures (seatbelt and helmet use), report more illegal and risky driving behaviours, thus providing further insights on why young males, in relation to their female counterparts, are over-represented in traffic incident injuries and fatalities.

Confirming the results of studies in developed and less developed countries, male drivers reported more traffic violations than female drivers [33, 38]. Consistent with other studies in Greece, the rates of compulsory seatbelt and helmet use as driver and as rider can be improved as 23.3% of the males and 30.2% of the females never wear a helmet as drivers (regular use: 48.3% for males and 44.4% for females) and 10.7% of the males and 16.7% of the females never wear a seatbelt when driving (regular use: 71.5% for males and 73.9% for females). The wearing rates in this study are comparable to those reported for Greece [24 - 25] and are generally higher than those reported for middle-income countries but usually

TABLE 4. Sex stratified mean of 'Risky Driving Index' score and associations with seatbelt and helmet use.

	Total		Male		Female		
	Mean (SD)		Mean (SD)	P-value[1]	Mean (SD)	P-value[1]	P-value[2]
Risk Driving Index	5.51 (4.51)	6.47 (4.80)	-	3.30 (2.69)	<0.001[a]		
Helmet use as driver							
Never			8.6 (5.8)		3.7 (2.8)		
Occasionally			6.8 (4.2)	0.001	3.8 (2.9)	0.651	<0.001
Very often, Regularly			5.8 (4.6)		3.2 (2.4)		
Helmet use as passenger							
Never			7.2 (4.8)		3.8 (2.9)		
Occasionally			6.4 (4.2)	<0.001	3.4 (2.6)	0.390	<0.001
Very often, Regularly			5.0 (5.5)		2.9 (2.4)		
Seat belt use as driver							
Never			9.8 (6.2)		3.9 (3.2)		
Occasionally			7.0 (4.4)	0.001	2.8 (1.9)	0.664	<0.001
Very often, Regularly			5.9 (4.4)		3.1 (2.7)		
Seat belt use as front seat passenger							
Never			10.6 (7.1)		3.4 (3.2)		
Occasionally			7.0 (4.1)	<0.001	4.1 (2.6)	0.128	<0.001
Very often, Regularly			5.7 (4.2)		3.1 (2.7)		
Seat belt use as rear seat passenger							
Never			6.9 (4.6)		3.5 (2.7)		
Occasionally			5.9 (4.2)	0.003	3.5 (2.9)	0.180	<0.001
Very often, Regularly			5.5 (5.5)		2.5 (2.3)		

Testing differences of Risky Driving Index score, log10 transformed values were used.
[1] *Analysis of variance.*
[2] *Between genders: two-way analysis of variance.*
[a] *Mann-Whitney test*

lower compared to high-income countries [11, 23]. The pattern of self-reported seatbelt use follows that of other reports in which rear-seat passengers present lower seatbelts wearing rates than the front seat passengers [23, 39] and their consistency across countries and gender may be indicative of the fact that not wearing a seatbelt in the rear seat is not considered a risky behaviour. The gender differences in seatbelt and helmet use are partially confirmed in the Greek context. Only 'Helmet use as passenger', and 'Seat belt use as driver' were significantly different between genders and female students outnumbered boys in the 'Never' category for 'Helmet' and 'Seat belt' use as driver. Although less common helmet use among females has been reported previously in western societies [40], it needs our consideration: changing societal norms may weaken the differences between male

TABLE 5. Sex-stratified co-occurence of risky driving behaviours in 1st year University Students

Number of risky driving behaviours	Total n (%)	Male n (%)	Female n (%)	P-value
0	47 (8.8)	26 (6.9)	21 (13.0)	<0.001[a]
1	53 (9.9)	26 (6.9)	27 (16.8)	
2	71 (13.2)	33 (8.8)	38 (23.6)	
3	107 (20.0)	71 (18.9)	36 (22.4)	
4	87 (16.2)	68 (18.1)	19 (11.8)	
5	70 (13.1)	57 (15.2)	13 (8.1)	
6	55 (10.3)	51 (13.6)	4 (2.5)	
7	46 (8.6)	43 (11.5)	3 (1.9)	
Mean (sd)	3.48 (2.02)	3.92 (2.00)	2.47 (1.67)	<0.001[b]
Median	3	4	2	
Mean Ranks		302.48	189.36	

Note: achi-square and bMann-Whitney test

TABLE 6. Crude and adjusted odds ratios (never use vs regularly use) for high score (≥7) on risky driving index

	CRUDE ODDS RATIOS (OR)			ADJUSTED ODDS RATIOS[a]		
	OR	95%CI		OR	95%CI	
Helmet use as driver (n = 80)	1.8	0.831	3.899	2.837	0.713	11.294
Helmet use as passenger (n = 98)	5.76	1.553	21.363	4.409	0.931	20.881
Seat belt use as driver (n =90)	4.787	1.479	15.497	5.239	1.280	21.441
Seat belt use as front seat passenger (n = 87)	4.703	1.262	17.523	2.865	0.637	12.884
Seat belt use as rear seat passenger (n = 120)	8.836	2.813	27.761	6.782	1.891	24.324

[a] *Logistic regression models adjusted for gender, age, country of birth, current residence, and maternal and paternal education*

and female drivers and riders. Alas, young female drivers have already been reported to follow the patterns of risk-taking driving behaviours and impaired driving crashes of their male peers [41 - 42], although this trend was not confirmed in this study. While legislation in Greece requires all passengers to wear seatbelt, this alone is not sufficient and media campaigns, health promotion programs and law enforcement are all warranted.

Male students who ride without wearing a helmet reported higher risk-driving score than those that regularly wear a helmet [8.6(5.8) vs 5.8(4.6), p<0.001, respectively]. However, such an association was not found for female participants, who reported lower risky driving score irrespective of helmet use [3.2(2.4) to 3.8(2.9), p=0.71] and this trend was stable across all seat-belt and helmet use variables examined in this study. Prominent differences in perceptions for threat for injuries among frequent adolescent helmet users and non-users have been reported in Greece, with non-users reporting lower threat [43]. These different perceptions may be reflected in this study but only for male riders. In an evolutionary perspective, risky driving behaviours co-occur because they clearly go against established norms and as risky behaviours help males accomplish short-term mating [44]. In a socio-ecological perspective, driving violations are legitimate behaviours that are accepted by current societal and cultural stereotypes and attitudes towards femininity and masculinity and the peers for the male population [17, 35, 45]. Obviously, we cannot exclude the possibility that the narrow range in the responses of female participants regarding driving violations did not provide the opportunity to reveal a possible association between seat-belt and helmet use and additional risk behaviours. However, if these

finding are confirmed in future research, this may be an indication of the different underlying reasons for not using helmet and not wearing a seatbelt between male and female drivers and riders and prevention programs and road safety initiatives may be more effective if using a gender-informed, gender-responsive, age-appropriate and cultural sensitive approach targeting individuals with common behavioural patterns. Unfortunately, even this approach has its own challenges, as many researchers [46] have shown that interventions may have inconsistent results and may only be effective on careful and not careless drivers.

A high co-occurrence of risky driving behaviours was also noted, as almost one in ten students (8.6%) reported to have been engaged in all seven behaviours and only 8.8% engaging in none of them. Male students reported more behaviours as a whole [3.92(2.00) vs 2.47(1.67), p<0.001] and were overrepresented in the high co-occurence categories. This is quite alarming because high violation score is associated with traffic crash involvement [31] and Antonopoulos et al. [32] reported that the crash risk increased by 35% for each one added behaviour in an 8-variable scale in university students, albeit the two studies did not measure exactly the same behaviours. Pickett et al [47] also reached similar conclusions for adolescents, confirming a stable and similar pattern across countries with diverse socio-economic characteristics. As noted in this study, students who never use vs those that regularly use 'seat belt as drivers' and 'seat belt as rear seat passengers' engage in more risk driving behaviours verifying Bina et al [13] in that risky driving is not an isolated behaviour. However, not all seatbelt and helmet wearing behaviours displayed statistically significant associations with the RDI score in the adjusted models, an indication that there may be different and diverse determinants and antecedents of each behaviour. As an example, people who usually wear helmets as drivers may not wear as riders, not because they do not want, but because there may be no available helmet. Anyhow, co-occurrence of risk behaviours is of paramount significance for preventive interventions because irrespective of their prevalence, their interrelationships remain strong [48].

Limitations

The results should be considered in light of some limitations. Study design was cross-sectional and shares the limitations of this type of analysis. Data were self-reported and may be prone to recall and social desirability bias [49]. However, previous research has shown that self-reported data can reliably document risk-driving behaviours and in any case archival data may be less accurate since many driving violations are not detected and properly documented [50-51]. Helmet and seat belt use seems to follow seasonal, hourly and additional patterns [5] that were not recorded in this study. Still, in accordance with current literature, the participants reported on their general and usual behaviours. Although the Risk Driving Index used in this study is based on previous studies and especially on the 'Driver Behaviour Questionnaire' (DBQ) proposed by Reason et al. [36] and has high internal reliability (Cronbach's Alpha = 0.81), driving violations were merged unweighted in the Index without knowing if they actually constitute equal risk. The sample consisted of 1st university year university students of only one University and although participants came from all over Greece and share diverse socioeconomic backgrounds, generalizability beyond this population should be made with caution. However, it should be noted that the rates of seatbelt and helmet use are comparable to those reported in other studies in Greece [5]. In addition to these limitations, future research should examine additional risky driving behaviours in more detail by including the driving context of the violations (e.g. time urgency, driving when fatigued e.t.c.).

CONCLUSIONS

In conclusion, young male drivers and riders, but not their female counterparts, not only abstain from using common safety precautions such as seatbelt and helmets, an independent risk factor for traffic injuries and fatalities by itself, but also engage more in risky driving behaviours that increase the possibilities of a traffic crash. Additionally, male participants reported more traffic violations than female, irrespective of seatbelt and helmet use. Preventive interventions using a gender-informed approach are needed to address co-occurring risk driving behaviours.

Acknowledgements

An earlier version of this article was presented during the 144th American Public Health Association Meeting, Denver, Colorado, USA, Oct. 29 - Nov. 2, 2016.

Funding

The study was funded through the Operational Program 'Education and Lifelong Learning' (Archimedes III) and was co-financed by the European Union (European Social Fund) and Greek national funds (NSRF 2007 - 2013). Mr Raymond Tumwesigye received a scholarship under the International Mobility in Erasmus+ of the European Union and spend four months at the Technological Educational Institute of Crete, Greece, in 2018.

Authors' contributions

GK is the PI of the LATO study, obtained the funding and contributed to the overall study concept and design. GK with additional researchers collected the data. GK, MP and RT conducted the analyses and interpreted the results. GK wrote the first draft. MP and RT were actively involved in the study and revised the manuscript critically, contributing to its final draft. GK provided supervised guidance and supervision at every stage. All authors edited the article and approved the final manuscript.

Ethics approval and consent to participate

Research protocol was reviewed and approved by the relevant Research Board of the TEI of Crete, and all students provided written informed consent after a thorough verbal and written description of the study.

Competing interests

The authors declare that they have no competing interests

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