Evaluating the impact of a school-based helmet promotion program on eligible adolescent drivers: different audiences, different needs?

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Abstract

The school environment has been often identified as a prosperous venue for public health improvement. This study is a cluster randomized controlled trial evaluating the impact of a school-based helmet promotion program on knowledge, attitudes and practices of eligible adolescent drivers. Four public, four private and four vocational high schools situated in Attica, Greece, were sorted by type and randomly assigned to receive a 1-month intervention, based on the concepts of the Health Belief Model, or serve as controls. Self-report data were collected at baseline from 741 second grade students (~16 years) and immediately after program completion. Linear mixed models with random student effects were used to estimate mean changes in scores for each treatment group and corresponding between groups differences of changes. Likelihood-based analysis showed that the intervention yielded a significant improvement in knowledge about helmet use. Yet, its impact on attitudes and practices appeared to vary across different school types. With current research offering ambiguous results on the appropriate timing of injury prevention efforts, this study suggests that educational programs targeting road safety can lead to positive changes if tailored to the needs of specific population groups and implemented during critical life periods, such as the transition to driving status.

Introduction

The school environment has been often identified as a prosperous venue for public health improvement; it provides a unique opportunity to address tailored health education messages to a ‘captive to learn’ audience, whereas there is increasing evidence that health-related behaviors adopted early in life may be sustained well into adulthood [1, 2]. Educational programs implemented in school settings have been frequently associated with positive changes in students’ health and well-being, such as enhancement of physical activity and fitness [3], prevention of smoking uptake and early drug use [4, 5], reduction of violent and aggressive behaviors [6, 7], as well as decrease of misconceptions regarding HIV/AIDS transmission and adoption of safer sex practices [8–10].

Although unintentional injuries represent the leading cause of death for children aged 10–19 years worldwide [11], there is a paucity of published research on well-articulated and rigorously evaluated school-based programs aiming to reduce risk-taking behaviors and promote use of safety
measures in this age group. In fact, the bulk of scientific interest has focused primarily on elementary school children [12–17]. By contrast, little is known about the effectiveness of such programs on the so-called ‘hard-core’ group of adolescents, who may be developmentally more competent to recognize and handle injury risks but may actively seek out risk [18]. Moreover, the injury prevention programs guided by constructs of theoretical models are still scarce, despite the widely accepted notion that the injury prevention field could benefit from greater collaboration with behavioral and social sciences [19].

Road crashes involving two-wheel motorized vehicles (TWMVs) pose a growing public health problem in the industrialized European Union (EU) Region. Each year, more than 6500 citizens die due to a TWMV crash, whereas the risk of dying of TWMV users is estimated to be 20 times higher than for car occupants [20]. Given the increasing popularity of TWMVs as a convenient means of transport, the proportion of TWMV-related fatalities has increased significantly in many EU countries. In Denmark, for instance, the proportion of traffic fatalities sustained by motorcycle and moped users rose from 11% in 1995 to 19% in 2004, while in Sweden from 7 to 15% [21]. In a Mediterranean country like Greece, where about 1 in 10 people owns a moped or a motorcycle, fatalities sustained by TWMV users represent about 25% of overall traffic fatalities, whereas approximately one-third of the victims are adolescents and young adults [21].

Routine helmet use is the single most effective way of reducing TWMV-related head injuries, currently contributing in European countries to around 75% of deaths among motorcycle and moped users [22]. Indeed, it has been suggested that an estimated 40% of TWMV deaths could have been averted every year in Greece if all riders were to use safety helmets [23]. Apart from theoretically based estimations, however, there is practical experience confirming that correct helmet use can result in large public health benefits. Hence, in the Romagna region, north-eastern Italy, a 66% decrease in admissions of traumatic brain injury for TWMV crashes was observed after the introduction of a revised mandatory helmet law; in addition, a fall to almost zero was noted in the number of blunt impact head injuries among injured moped users admitted to hospital [24].

Considering the limited compliance of adolescent TWMV users toward existing helmet wearing laws in Greece [25, 26], the ‘Stick it well on your head!’ program was developed by the Center for Research and Prevention of Injuries, Athens University Medical School, to promote helmet use among youngsters eligible to obtain a driving license for a moped (i.e., over 16 years of age). Specifically, guided by results obtained from a sizeable number of focus group discussions with young TWMV users [25], we opted to apply the key concepts of the Health Belief Model (HBM) in the development and implementation of a universal intervention targeting high-school students attending their second grade. This study reports the impact of the program on participants’ self-reported knowledge, attitudes and practices regarding TWMV helmet use.

Methods

Design and setting

A cluster randomized controlled trial was implemented, with schools as the unit of randomization. In September 2008, a list of all secondary schools in Attica, Greece, was provided by the Hellenic Ministry of Education. The Greek secondary education system is divided into two cycles: the ‘Lower High School’ or ‘Gymnasium’ (ages 12–15) and the ‘Upper High School’ or ‘Lyceum’ (ages 15–18), while the latter is distinguished into the ‘General Lyceum’, concentrating the bulk of student population, and the ‘Vocational Lyceum’, aiming to equip students with vocational skills and prepare them for the labor market. Although a standardized measure for classifying schools based on socio-economic status does not currently exist, type of school seems to be strongly associated with socio-economic status, with vocational high schools recruiting mainly students from lower socio-economic...
backgrounds, public general high schools (subsequently termed ‘public’) serving mostly students from middle-class families and private general high schools (subsequently termed ‘private’) attracting children from more privileged socio-economic backgrounds.

A total of 655 upper high schools were registered in the list. After excluding 62 schools offering evening classes, we stratified the remaining by type and used random numbers to select four public, four private and four vocational. Invitation letters were sent to the Directors of the schools, describing the objectives of the study and asking them for written permission to implement it. Two private schools refused to participate; subsequently, another two were randomly selected and successfully contacted. Schools consenting to study participation were sorted by type and assigned to receive the intervention or serve as controls using the toss of a coin. The allocating person was blind to the purpose of the study; yet, given the nature of the intervention, it was not possible to blind participants or researchers to group allocation. Intervention schools received the Stick it well on your head! program, while control schools followed the provisioned standard curriculum, namely normal school lessons without any systematic education on road traffic injury prevention. Self-report data were collected at baseline (mid-November 2008) and immediately after program completion (mid-December 2008). Ethical approval of the study was obtained from the Ethics Committee of the University Hospital of Crete, closely affiliated to the Faculty of Medicine, where the PhD thesis proposal of the principal investigator has been submitted.

**Participants**

All 813 students enrolled in the second grade were eligible to participate. Among them, 27 students did not consent to study participation, whereas another 45 were absent on the day of the survey, resulting in a total of 741 students (91.1%) completing the baseline assessment. At post-test, 513 of these students (69.2%) were contacted successfully (Fig. 1).

**Intervention**

The Stick it well on your head! program consisted of four 45-min sessions across a 4-week interval. Sessions were delivered by specially trained research staff in collaboration with the school teachers. Selected topics were designed to address the key concepts of the HBM [27, 28], namely ‘threat perception’ (i.e. perceived susceptibility to a negative health condition and perceived severity of its consequences), ‘behavioral evaluation’ (i.e. perceived benefits versus perceived barriers to undertaking a recommended health action), ‘self-efficacy’ (i.e. perceived ability of performing the recommended action) and ‘cues to action’ (i.e. bodily or environmental events raising individual’s awareness and triggering him/her to initiate change). Thus, the first session aimed to strengthen participants’ perceived susceptibility to a TWMV-related road crash and specify consequences of the risk through the use of a PowerPoint presentation describing the burden of TWMV-related injuries in Greece. The second session sought to provide guidance and training about correct helmet use by presenting a helmet instructional video and then giving students the opportunity to practice helmet fitting in class. The third session aimed to eliminate students’ perceived barriers and encourage routine helmet use through discussion on the advantages and disadvantages of helmet use, review of the decision-making process and role-playing activities. The objectives of the last session were to review lessons learned, as well as to identify strengths and limitations of the program. Cues to action were accomplished by using incentives and reminder messages, such as educational leaflets and posters. Table I provides a summary of educational material produced within the context of this program.

Program development was a multi-stage process lasting over a year and including several key steps: (i) formative research exploring factors contributing to adolescent decision making on helmet wearing, (ii) organization of learning sessions’ structure and objectives, (iii) development and pilot testing of educational materials to affirm age appropriateness and clarity of messages, (iv) training of staff to...
Approached to participate
12 schools (4 public, 4 private and 4 vocational)
2 schools refused and 2 other were successfully contacted (83.3% response rate)

Randomization
12 schools (4 public, 4 private and 4 vocational)
Total students: 813

Allocated to intervention group
6 schools (2 public, 2 private and 2 vocational)
Total students: 375

Baseline assessment
6 schools
Assessed: 332 (88.5%)
Not assessed: 43 (not consented, absent)

Intervention

Post-test
6 schools
Assessed: 240 (72.3%)
Not assessed: 92 (absent, failed to use personal identifying code)

Likelihood-based analysis (n=332)

Allocated to control group
6 schools (2 public, 2 private and 2 vocational)
Total students: 438

Baseline assessment
6 schools
Assessed: 409 (93.4%)
Not assessed: 29 (not consented, absent)

Post-test
6 schools
Assessed: 273 (66.7%)
Not assessed: 136 (absent, failed to use personal identifying code)

Likelihood-based analysis (n=409)

Fig. 1. Flow of schools and participants through the trial.
ensure standardized delivery of the program as well as (v) close collaboration with various stakeholders (i.e. health education directors, principals, teachers).

**Measures**

Participant self-report measures included (i) TWMV-related behavior, (ii) knowledge about TWMV helmet use, (iii) attitudes toward TWMV helmet use, (iv) practices regarding TWMV helmet use and (v) potential covariates, notably school performance and family financial status.

**TWMV-related behavior**

Frequency of TWMV use was examined on a five-point scale: ‘always (i.e. at least three times per week)’, ‘often (i.e. at least three times per month)’, ‘sometimes (i.e. at least three times per 6 months)’, ‘seldom (i.e. at least three times per year)’ and ‘never’. Self-report information on TWMV driving license availability was also obtained.

**Knowledge about TWMV helmet use**

Students were asked to rate the following statements as ‘true’ or ‘false’: (i) TWMV-related
fatalities comprise less than 10% of overall traffic fatalities in Greece (false); (ii) in Greece, the majority of TWMV users killed in road crashes are aged 35–44 years (false); (iii) correct helmet use can reduce the risk and severity of head injuries by up to 72% (true); (iv) a helmet can last 20 years if it has not sustained any serious damages from drops (false); (v) it is not mandated for a helmet to be stamped with an approval mark given that all helmets in the market have been previously quality controlled (false); (vi) irrespective of their price, all helmets offer the same degree of protection to the rider (false); (vii) the chin strap should be securely fastened to maintain the helmet in position on the head (true); (viii) frequent helmet use can cause permanent hearing damages (false); (ix) according to current legislation, helmet non-use is considered to be a traffic violation and is being punished with a fine of 350 € (true) and (x) TWMV passengers are not obliged to wear a helmet (false).

**Attitudes toward TWMV helmet use**

Given that human attitudes lie on a continuum [29], participants were asked to rate the following statements on a five-point Likert-type scale ranging from ‘strongly agree’ to ‘strongly disagree’: (i) it is not necessary to wear a helmet when traveling short distances; (ii) helmet use can protect me in case of a road traffic accident; (iii) helmet use is not needed if a rider is careful; (iv) wearing a helmet makes me feel ugly; (v) helmets are needed only when using motorcycles with powerful engines; (vi) if I owned a TWMV, I’d better buy a disc wheel or an exhaust pipe than a helmet; (vii) I would encourage a friend of mine who had just bought a TWMV to buy a helmet; (viii) both drivers and passengers of TWMVs should wear a helmet; (ix) I’d like to use a helmet but I cannot since I don’t want my parents to know that I am a TWMV user and (x) people wearing helmets do not enjoy the fascination of riding. The Cronbach alpha coefficient for the 10-item attitude scale was 0.75.

**Practices regarding TWMV helmet use**

For measuring practices regarding helmet use, students responding using TWMVs were asked to rate the following statements: (i) I always wear a helmet when using a TWMV; (ii) I often wear my friends’ helmet, even if it does not fit properly on my head; (iii) I advise my friends to wear a helmet when they use TWMVs; (iv) I wear a helmet only in areas usually subjected to Traffic Police inspection; (v) I rarely fasten the chin strap of my helmet; (vi) I usually carry a helmet with me but do not wear it; (vii) during summertime, I rarely wear a helmet; (viii) I wear a cheap helmet to avoid tickets from Traffic Police; (ix) I don’t wear a helmet because I use TWMVs only as a passenger and never as a driver and (x) I don’t wear a helmet because I don’t know where to keep it when getting off the TWMV. Again, response options ranged from strongly agree to strongly disagree, whereas internal consistency for these 10 items was $\alpha = 0.79$.

**Covariates**

Students were asked to evaluate their school performance based on recall of their last annual school report: ‘excellent (18.1–20.0)’, ‘very good (16.1–18.0)’, ‘good (13.1–16.0)’, ‘fairly good (9.5–13.0)’, ‘inadequate (5.1–9.4)’ and ‘bad (0.0–5.0)’. Family financial status was also assessed via report of the mean monthly income (‘over 5000 €’, ‘between 3000 and 5000 €’, ‘between 1500 and 3000 €’, ‘between 500 and 1500 €’ and ‘less than 500 €’).

**Statistical analyses**

Three individual scores were calculated for each one of the three measured variables as follows: each item of the knowledge section was graded with either ‘0’, if the corresponding response was wrong, or ‘1’, if it was correct, summing up to a score ranging from 0 to 10. The items of the attitudes and practices sections were graded according to the five-point Likert scale with ‘0’ indicating the worst answer and ‘4’ the best. Thus, two scores ranging from 0 to 40 were calculated by adding the corresponding items. Baseline equivalence between intervention and control schools by school type was assessed using standard statistical
procedures ($\chi^2$ for categorical data, $\chi^2$ for trend for ordered data, Fisher’s exact test for low frequencies and $t$-test for continuous data), whereas attrition between groups was checked with $\chi^2$. To estimate mean changes in scores for the intervention and the control group, as well as corresponding between groups differences of changes, linear mixed models with random student effects were employed. This analysis takes into account the clustering of students in schools and the baseline findings of each student. The derived results were adjusted for gender, family financial status, school performance and frequency of using TWMVs; since the majority of participants were the same age and very few among them possessed a driving license, we did not include these two variables in the multivariate analyses. Consistent with the intention-to-treat principle, the likelihood-based analysis included all available cases, with neither deleting nor imputing data. Rather than performing a complete case analysis or invoking simple imputation techniques (e.g. last observation carried forward), we chose the aforementioned maximum likelihood-based approach, in order to avoid bias and achieve robustness of our estimates against a wide range of plausible scenarios regarding the underlying missingness mechanism [30]. The SAS statistical package (Version 9.1, SAS Institute Inc, Cary, NC, USA) was used in all analyses.

Results

Sample characteristics
The baseline sample consisted of 741 students, of whom 29.7% attended public, 31.8% private and 38.5% vocational schools. The mean age was 16.3 years (SD = 0.7) and 53.7% were male. A high 40.8% reported using frequently a TWMV (either as a driver or as a passenger), whereas only 2.3% stated having already obtained a driving license for a moped.

Baseline equivalence
Baseline characteristics of participants by school type and treatment group are detailed in Table II; overall, study characteristics of students appeared to be well balanced at baseline. Despite randomization, however, it is worth noting the significant differences between the intervention and control groups of students attending public schools with respect to school performance and attitudes toward helmet use. Specifically, control students seemed to perform better at school ($P = 0.01$) and to have more positive attitudes toward helmet use ($P = 0.01$) than intervention students. A difference of borderline significance ($P = 0.05$) was also noted regarding the frequency of TWMV use among students enrolled in vocational schools, with intervention students reporting more frequent use than control students.

Attrition
At post-test, 30.8% of participating students were not assessed. Attrition occurred from participants either being absent on the day of the survey or failing to complete their unique identifying code; given that the questionnaires were anonymous, students had to fill in a four-digit individual code to allow linkage of information gathered at baseline and post-measurement. Attrition analyses were conducted to check: (i) whether students not completing the study differed from those completing it and (ii) whether there was a systematic group-specific dropout. Students not assessed at post-test were more likely to be male ($P = 0.002$), to attend vocational schools ($P = 0.001$), to use frequently TWMVs ($P = 0.001$) and to have a medium or bad performance at school ($P = 0.0001$). Nevertheless, dropout was not associated with condition ($P = 0.10$). Moreover, statistically significant attrition–condition interactions were found for none of the measured variables.

Intervention effects
Table III presents estimated mean (standard error) changes in scores for each treatment group, as well as corresponding between groups differences of changes, adjusted for gender, family financial status, school performance and frequency of using TWMVs.
Changes in TWMV helmet-related knowledge

After program completion, TWMV helmet-related knowledge was significantly improved for all intervention students. The adjusted mean changes from baseline to post-test were 1.71 for students attending public schools \((P = 0.0001)\), 2.31 for students attending private schools \((P = 0.0001)\) and 1.31 for students attending vocational schools \((P = 0.0001)\).

At the same time, control students attending public and private schools presented no significant changes in helmet-related knowledge. Yet, compared with baseline, control students enrolled in vocational schools scored significantly lower at post-test \((P = 0.001)\). The adjusted between groups difference of changes was estimated to be 1.87 for students attending public schools \((P = 0.0001)\), 2.58 for students attending private schools \((P = 0.0001)\) and 2.34 for students attending vocational schools \((P = 0.0001)\).

Changes in TWMV helmet-related attitudes

Within the intervention group, significant improvements in TWMV helmet-related attitudes were noted at post-test only for students attending public schools \((P = 0.001)\), while, within the control group, significant negative changes were observed for students attending vocational schools \((P = 0.003)\). Consequently, the adjusted between groups difference of changes was 1.87 for students attending public schools \((P = 0.02)\) and 1.91 for students attending vocational schools \((P = 0.01)\).

### Table II. Baseline characteristics of participants by school type and treatment group \((n = 741)\)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Public ((n = 220))</th>
<th>Control ((n = 236))</th>
<th>Private ((n = 236))</th>
<th>Control ((n = 236))</th>
<th>Vocational ((n = 285))</th>
<th>Control ((n = 285))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Male</td>
<td>48 (48.0)</td>
<td>49 (40.8)</td>
<td>33 (39.3)</td>
<td>75 (49.3)</td>
<td>103 (69.6)</td>
<td>90 (65.7)</td>
</tr>
<tr>
<td>Female</td>
<td>52 (52.0)</td>
<td>71 (59.2)</td>
<td>51 (60.7)</td>
<td>77 (50.7)</td>
<td>45 (30.4)</td>
<td>47 (34.3)</td>
</tr>
<tr>
<td>Frequency of TWMV use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Always/often</td>
<td>44 (44.0)</td>
<td>41 (34.2)</td>
<td>17 (20.2)</td>
<td>26 (17.1)</td>
<td>95 (64.2)</td>
<td>79 (57.7)</td>
</tr>
<tr>
<td>Sometimes/seldom</td>
<td>38 (38.0)</td>
<td>56 (46.6)</td>
<td>41 (48.8)</td>
<td>59 (38.8)</td>
<td>44 (29.7)</td>
<td>37 (27.0)</td>
</tr>
<tr>
<td>Never</td>
<td>18 (18.0)</td>
<td>23 (19.2)</td>
<td>26 (31.0)</td>
<td>67 (44.1)</td>
<td>9 (6.1)</td>
<td>21 (15.3)</td>
</tr>
<tr>
<td>TWMV driving license</td>
<td></td>
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<tr>
<td>Yes</td>
<td>2 (2.0)</td>
<td>1 (0.8)</td>
<td>0 (0.0)</td>
<td>2 (1.3)</td>
<td>7 (4.7)</td>
<td>5 (3.6)</td>
</tr>
<tr>
<td>No</td>
<td>98 (98.0)</td>
<td>119 (99.2)</td>
<td>84 (100.0)</td>
<td>150 (98.7)</td>
<td>141 (95.3)</td>
<td>132 (96.4)</td>
</tr>
<tr>
<td>School performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Good</td>
<td>50 (50.0)</td>
<td>76 (63.3)</td>
<td>53 (63.1)</td>
<td>108 (71.1)</td>
<td>23 (15.5)</td>
<td>26 (19.0)</td>
</tr>
<tr>
<td>Medium</td>
<td>36 (36.0)</td>
<td>41 (34.2)</td>
<td>23 (27.4)</td>
<td>37 (24.3)</td>
<td>78 (52.7)</td>
<td>59 (43.0)</td>
</tr>
<tr>
<td>Poor</td>
<td>14 (14.0)</td>
<td>3 (2.5)</td>
<td>8 (9.5)</td>
<td>7 (4.6)</td>
<td>47 (31.8)</td>
<td>52 (38.0)</td>
</tr>
<tr>
<td>Family financial status</td>
<td></td>
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</tr>
<tr>
<td>High</td>
<td>33 (33.0)</td>
<td>42 (35.0)</td>
<td>50 (59.5)</td>
<td>109 (71.7)</td>
<td>31 (21.0)</td>
<td>22 (16.1)</td>
</tr>
<tr>
<td>Medium</td>
<td>44 (44.0)</td>
<td>55 (45.8)</td>
<td>28 (33.3)</td>
<td>35 (23.0)</td>
<td>60 (40.5)</td>
<td>56 (40.8)</td>
</tr>
<tr>
<td>Low</td>
<td>23 (23.0)</td>
<td>23 (19.2)</td>
<td>6 (7.2)</td>
<td>8 (5.3)</td>
<td>57 (38.5)</td>
<td>59 (43.1)</td>
</tr>
</tbody>
</table>

\*Participants reporting use of TWMVs \((n = 577)\).
Changes in TWMV helmet-related practices

Regarding TWMV helmet-related practices, intervention students attending both public and vocational schools scored significantly higher at post-test, as compared with baseline. The adjusted mean changes were 3.87 for students attending public schools ($P = 0.0001$) and 1.44 for students attending vocational schools ($P = 0.03$). Again, although control students attending public and private schools presented no significant changes, helmet-related practices of control students attending vocational schools appeared to significantly worsen at post-measurement ($P = 0.02$). The adjusted between groups difference of changes was 2.41 for students attending public schools ($P = 0.03$) and 3.26 for students attending vocational schools ($P = 0.002$).

Discussion

This study investigated whether a theory-based intervention aiming to promote TWMV helmet use could induce positive changes in knowledge, attitudes and practices of 16-year-old Greek high-school students. Building on previous research suggesting that age should be integrated into the planning of helmet promotion efforts [31], we considered the age of 16 years as a cutoff point since it legally entitles adolescents to pass from a ‘pre-driver’ to a ‘driver’ status. Conceptualized in a broader context, this transition does not merely involve gaining access to a motor vehicle and having the ability to move from one place to another, but it is interwoven with a general sense of having the means and the opportunity to carry out a specific behavior, which could be vital in adolescence. In light of this perspective, we also sought to assess how the same intervention would affect different audiences, namely students attending public, private and vocational high schools, with the first representing the ‘average’ Greek adolescent audience, while the second and the third standing for the two ‘extremes’ in terms of socio-economic status and school performance.

The Stick it well on your head! program yielded a significant improvement in TWMV helmet-related knowledge, which was evident for students attending all types of secondary education. The proportion of individuals answering all knowledge questions correctly after the delivery of the program is quite worth noting; in public schools, it reached 34% as contrasted to 6% prior to the intervention;
in vocational schools, it was estimated at 17% compared with 3% before the intervention, whereas in private schools, it reached 42% as contrasted to 2%. Nevertheless, the impact of the program on participants’ attitudes and practices appeared to vary across different school types. Hence, although the intervention was associated with statistically significant positive changes among students attending public and vocational schools, no effects were found with respect to helmet-related attitudes and practices of students enrolled in private education. This could be attributed either to inherent characteristics of the specific population that the intervention failed to take into account or to a limited interest that this audience may have in messages related to TWMV safety. In fact, our data suggest that, compared with students attending public and vocational schools, individuals enrolled in private education had the lowest frequency of TWMV use. Only a 18.2% of participants attending private schools reported using a TWMV either ‘always’ or ‘often’, whereas the equivalent percentage in public schools was 38.6% and in vocational schools 61.1%. Therefore, it would not be exaggerated to assume that, for youngsters stemming from more privileged socio-economic backgrounds, TWMV use may have neither the same practical nor the same affective meaning that it has for middle- or low-income adolescents [32].

Our finding that TWMV helmet-related knowledge, attitudes and practices of control students attending vocational schools significantly worsened 1 month after the baseline assessment requires special attention. A cumulative body of research has documented that, during adolescence, risky behaviors tend to increase sharply with age [15, 31, 33, 34]. Specifically, Jonah [35] has suggested that drivers in their middle teenage years may display less reckless behavior than slightly older drivers, whereas Harré et al. [36] showed that a similar trend exists earlier in adolescence, with those aged 14–15 years displaying less risky attitudes toward driving than those aged 16–17 years. Although both socio-economic characteristics and school-related factors, such as going to a vocational school or having grades below average, have been found to correlate with many risky behaviors [33, 34], the contribution of these factors to a presumed ‘acceleration’ of the evolution of risky driving during adolescence has not yet been explored. Our study provides evidence toward this direction, while underlining an increased need for addressing road safety messages to such audiences.

The development, implementation and delivery of the Stick it well on your head! program constitute the main strengths of this study. Formative research exploring perceived barriers and facilitators to helmet use among the target population contributed to the socio-cultural background needed for designing age- and population-tailored educational interventions. Use of a widely applied psychological model that attempts to explain health behaviors by focusing on the attitudes and beliefs of individuals helped us in identifying key areas for action and, thus, organizing more efficiently the structure and objectives of the learning sessions. Moreover, involvement and active participation of various stakeholders, as well as recruitment of young personnel sharing a deep understanding of the school milieu, substantially facilitated program implementation and allowed us to investigate the effectiveness of a road safety intervention on 16-year-old students, a group often characterized as ‘hard core’ given its specific developmental characteristics.

Nevertheless, certain limitations need to be addressed. First, the study relied solely on self-report and, although there is evidence supporting the validity and reliability of adolescent self-report regarding risk behaviors [37–39], a degree of cautiousness is required when interpreting the data. Second, about 30% of participants were not assessed at post-test. In order to have an understanding of the impact that attrition had on our study, we sought to examine differences between completers and non-completers, as well as to identify whether there was a systematic group-specific dropout. Although no differential attrition was found between intervention and control conditions, students not completing the study were more likely to be male, to attend vocational schools, to use frequently TWMVs and to have a medium or bad performance at school. We addressed this issue by applying a maximum likelihood-based approach.
to the analysis of our data and including all available cases. Last but not least, an important drawback of this study is that, since the follow-up assessment was conducted immediately upon program completion, we are unaware of the long-term effects of the intervention. Initial positive effects, however, have been frequently associated with maintenance effects [40].

In conclusion, our results seem to have both theoretical and practical implications. With current research offering ambiguous results on the appropriate timing of health promotion efforts, this study suggests that educational programs targeting road safety can lead to significant positive changes if implemented during critical life periods, such as the transition to driving status. As Voas and Kelley-Baker [41] recently supported, the initiation of teen driving may be the most important period influencing development between puberty and emerging adulthood since parental control over social behavior is reduced and opportunities for risk taking are increased.

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**Conflict of interest statement**

None declared.

**References**


