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Original Article

Preventing Traffic Accidents in Adolescents: A Theory of Planned Behavior Intervention in High Schools

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ABSTRACT

Traffic accidents are a major cause of death and disability for adolescents in developing countries. This study explores how education, based on the Theory of Planned Behavior, can reduce risky driving by changing influencing factors in male high school students and promote road safety. This quasi-experimental study utilized a randomized controlled trial design with 60 male high school students selected randomly from first-level high schools under the Mashhad Health Center's area. Participants were split into experimental and control groups. After conducting a needs assessment using the Theory of Planned Behavior, a targeted educational intervention was designed and implemented for the experimental group. Follow-up assessments were conducted three months later, and data were analyzed with SPSS version 24, utilizing statistical tests including Mann-Whitney, chi-square, and Fisher's exact tests. At the pre-intervention phase, there were no statistically significant differences between the experimental and control groups concerning the Theory of Planned Behavior constructs (attitude, subjective norm, perceived behavioral control, and behavioral intention). However, immediately after the intervention and at the three-month follow-up, the experimental group showed significant improvements in their average scores for these constructs ($p < 0.0001$). The study results demonstrate that educational programs for students significantly improve their attitudes, subjective norms, perceived behavioral control, and behavioral intentions related to safe traffic behaviors. Additionally, interventions aimed at preventing traffic accidents can considerably lower their occurrence.

Keywords: Theory of planned behavior, Traffic accidents, Health education, High school students.

Introduction

The continual advancement of technology, along with rapid urban growth, the frequent use of automobiles, and resource limitations in communication network development, has intensified traffic congestion, particularly in large cities. As a result, this situation has led to an increase in traffic accidents and the associated damage(1).Conversely, among the various systems and social factors that individuals encounter daily, communication and road transportation are among the most intricate and hazardous social systems. With the evolution of communication and transportation, the injuries resulting from related accidents have become so prevalent that they are commonly described as "road wars." (2). According to the World Health Organization's report, traffic accident fatalities moved from being the 10th leading cause of death in 1990 to the 5th leading cause of death in 2010. Furthermore, a striking 46% of the deaths recorded during this period were attributed to traffic accidents. Unfortunately, the trend of increasing fatalities due to road accidents continues unabated, with a staggering figure of approximately 1.3 million people losing their lives annually worldwide(3, 4). It's important to note that 90% of these traffic accidents occur in developing countries (5). It was predicted that by the year 2020, deaths caused by traffic

accidents would increase by 66%. Additionally, the burden of disability and physical impairment due to injuries from traffic accidents was expected to rise, moving from the ninth position in 2009 to the third position in global health concerns. This alarming trend highlights the urgent need for enhanced road safety measures, public awareness campaigns, and improved infrastructure in order to mitigate the rising toll of traffic-related injuries and fatalities(6). More than a third of road traffic accident deaths in low- and middle-income countries involve pedestrians and cyclists. Despite this significant risk, less than 35% of these countries have implemented policies aimed at protecting these vulnerable road users. This gap in safety measures underscores the need for urgent policy reforms and the establishment of protective regulations to enhance the safety of pedestrians and cyclists, ultimately aiming to reduce fatalities and injuries on the roads(7) Only 28 countries, representing about 449 million people (or 7% of the world's population), have implemented sufficient laws to effectively address five key risk factors associated with road traffic safety: speed limits, driving under the influence of alcohol, the use of helmets for motorcyclists, seat belts for passengers, and child restraints. This highlights a significant global disparity in road safety regulations, suggesting that many regions still lack the necessary legal frameworks to protect road users and minimize traffic-related injuries and fatalities. Immediate efforts are needed to expand and enforce such laws globally to improve public safety on the roads(7).In Iran, injuries from accidents are the leading cause of death for individuals aged 1 month to 49 years, with traffic accidents contributing the largest share, accounting for approximately 25% of these fatalities. It is estimated that around 400,000 people are hospitalized annually due to traffic-related injuries, and an additional 2 million individuals suffer minor injuries. Moreover, the rate of death and the years of life lost, as measured by the disability-adjusted life years (DALY) index, due to road accidents in Iran is higher than the global average. This situation emphasizes the urgent need for enhanced traffic safety measures and interventions in Iran to reduce the devastating impact of road traffic injuries on public health (8). Traffic accidents not only represent a significant cause of death and disability in Iran, but they also rank as the foremost contributor to the overall disease burden in the country. Currently, they are the second leading cause of death, surpassed only by fatalities resulting from heart-related diseases. This highlights the critical public health challenge posed by road traffic incidents, necessitating urgent attention to road safety measures, enforcement of traffic regulations, and public awareness campaigns aimed at reducing accidents and their devastating consequences on the community's health and well-being (9). Numerous research studies indicate that adolescence is among the most critical periods in human development(10). Conversely, traffic accidents are the leading cause of fatalities in developing nations and play a significant role in deaths and disabilities, particularly affecting adolescents(11). Literature reviews consistently demonstrate that health education programs can significantly influence beliefs, attitudes, and decision-making skills. This empowerment can lead to positive individual and societal changes (12).The theory of planned behavior consists of attitude structures, abstract norms, perceived control, intention, and behavior. According to this model, a person intends to perform a behavior (for example, observing the speed limit or wearing a seat belt) if that behavior is evaluated as a useful behavior from his point of view, that is, the person's attitude towards performing the behavior is positive, and on the other hand, the person feels the need to do it. It is under pressure through other social factors such as the police (abstract norms). Finally, a person feels that there are factors that are effective in preventing risky driving behaviors and complying with traffic rules and regulations, but despite these factors, the person can perform the behavior. Which in fact will have the same perceived behavioral control (13). Due to the diverse circumstances and limited resources faced by many health educators, it is indeed feasible to develop interventions that promote positive changes by understanding behavioral patterns and theories. Health professionals like educators, psychologists, nutritionists, and nurses who concentrate on behavior change need to identify the role of individuals in adopting healthy behaviors. This understanding is crucial for implementing effective interventions and accurately assessing their impact. The theory of planned behavior, which encompasses various individual theories, plays a significant role in health research, behavioral performance, and health education (14).

Materials and Methods

This research was a semi-experimental study. In order to conduct this study, after getting the basic approvals for the research plan from the Faculty of Health and presenting it to Mashhad Health Center No. 1, an introduction letter and permission to enter Mashhad schools were obtained. After carrying out the guide study and determining the sample size and sampling by random sampling method to determine the samples of the test and control groups, in order to implement the educational intervention, two schools were randomly selected from among the boys' high schools under the coverage of Mashhad Health Center No. 1 by lottery as a group. The test and control were considered. These schools were geographically and culturally similar. The trainings were held at Azmoun High School and group discussions, brainstorming, lectures, questions and answers, and role-playing were used. The students were divided into 2 groups of 30 people and training was done for the test group(Figure 1). Participants in the intervention group received educational sessions based on the TPB constructs. The training content was developed based on the analysis of pre-intervention questionnaires and included topics such as risky behaviors leading to traffic accidents assessment, prevention and control of Use of protective equipment such as helmets and safety belts. Due to time

constraints and the participants' work commitments, the educational program was delivered in 6 sessions, each lasting 45 minutes over 4 weeks, using a lecture format with Q&A. The control group did not receive any education during the study period. After a 3-month follow-up, the initial questionnaire was re-administered to both groups. To ensure ethical standards, the control group received the educational content after the study concluded. A summary of the educational activities is provided in (Table 1)At the end of each training session, an assignment was given to the students depending on the topics discussed in the session, and an educational CD was given at the end of the training session, which included ways to prevent accidents. It was a traffic accident and was given to students. After three months of training, the questionnaires were completed again by the students of both groups and finally, after collecting the desired data, the information was analyzed by SPSS24 software

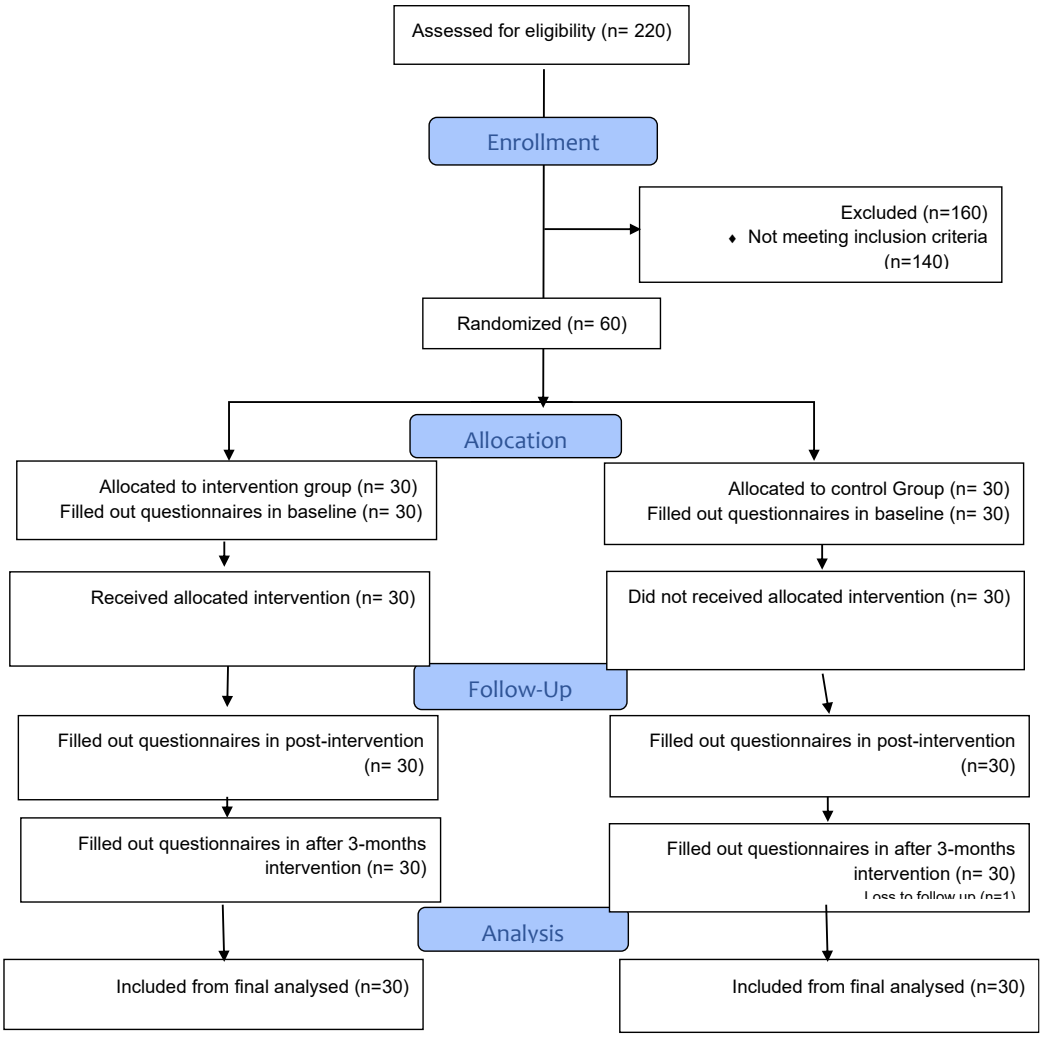

Figure 1.Flow of participants through each stage of the program

Table 1. Educational Content and Activities Conducted in Intervention Sessions Based on the Theory of Planned Behavior

Session	TPB Constructs	Intervention Method	Intervention's Instruction	Objectives	Time
1' 2	Attitudes	Speech, text message, pamphlet, question and answer	High school students discussed the benefits on traffic accidents preventive behaviors , health educators encouraged participants to share their personal experiences and beliefs.	Introduction and getting to know the group members, completing the questionnaire, Educate about the benefits of traffic accidents preventive behaviors , increase awareness, and create a positive attitude towards Preventive	90 minutes

3	Subjective Norms	Presenting the clip ,Group discussions and role-playing led by high school students	The impact of peers, family, and community on traffic accidents preventive behaviors was examined through group discussions and role-playing, and positive social influences were reinforced.	Behaviors, Educate risky behaviors leading to traffic accidents assessment, Identify and strengthen positive social influences on traffic accidents preventive behaviors , enhance social support, and increase motivation through health ambassadors and family interactions. Prevention and control of high school students	45 minutes
4	Perceived Behavioral Control	Speech, presentation of clip and PowerPoint, Discussions and goal-setting led by high school students	Health educators led discussions on overcoming barriers to on traffic accidents preventive behaviors and assisted participants in setting realistic and achievable goals for traffic accidents preventive behaviors routines.	Identify and overcome barriers to traffic accidents preventive behaviors, increase self-efficacy, and set achievable goals. Use of protective equipment such as helmets and safety belts	45 minutes
5	Behavioral Intention	Text message, educational image, pamphlet	Behavioral intentions I n participants were reinforced through setting specific, realistic, and achievable goals for traffic accidents preventive behaviors	Strengthen the intention to maintain an active lifestyle, set specific and realistic goals for traffic accidents preventive behaviors . Use of protective equipment such as helmets and safety belts	45 minutes
6	Traffic Accidents Preventive Behaviors	Progress review, feedback, and follow-up	Health educators reviewed participants' progress, provided feedback, and offered resources to support continued of traffic accidents preventive behaviors after the program. Follow-up was conducted via phone and online messaging..	Review progress, provide feedback and support, and offer resources and guidance for maintaining traffic accidents preventive behaviors levels after the intervention.	45 minutes

Results and Discussion

The average age of the studied students in the control and test groups was 14.73 and 14.67 years, respectively, in the control and test groups, 60% and 70% of their fathers had a bachelor's degree or higher, in the control and test groups, all fathers had a car. Most of the parents of the students in the control and test groups were fined by 53.3 and 70% respectively, also most of the students in the control and test groups had a history of accidents in the family by 73.3 and 69% respectively. All variables were homogeneous in both control and test groups. More information is reported in Table 2.

Table 2. Examination of demographic variables in two groups

Test result	Test	Control		Variable
	2(6/7)	3(10/00)	diploma	
fisher =0/76	7 (23/3)	9(30/00)	Associate Degree	Father's education
P-value=0/71	21 (70/00)	18(60/00)	Bachelor's degree and higher	
	2(6/7)	6(20/00)	diploma	
fisher=2/68	8 (26/7)	9(30/00)	Associate Degree	mother's education
P-value=0/25	20 (66/7)	15(50/00)	Bachelor's degree and higher	
X^2=0	20(66/7)	20(66/7)	Employee	Father's job
P-value>0/99	10 (33/3)	10(33/3)	free	
X^2=0/28	12(40/00)	10(33/3)	Employee	mother's job
P-value=0/59	18 (60/00)	20(66/7)	housewife	
-	30(100/00)	30(100/00)	Yes	father's car
	0 (0/00)	0 (0/00)	no	
X^2=0/06	17(56/7)	16(53/3)	Yes	mother car
P-value=0/79	13(43/3)	14(46/7)	no	
X^2=3/48	21(70/00)	16(53/3)	Yes	The father or mother is fined for not following the driving rules
P-value=0/14	9(30/00)	11(36/7)	no	
X^2=2/65	17(81/00)	9(56/3)	Yes	The effect of fines on compliance
P-value=0/16	4(19/00)	7(43/8)	no	
X^2=0/13	20(69/00)	22(73/3)	Yes	A history of accidents in the family
P-value=0/71	9(31/00)	8(26/7)	no	

X^2=0/28	14(70/00)	17(77/3)	Yes	Being with you during an accident
P-value=0/59	6(30/00)	5(22/7)	no	
	7(38/9)	5(25/00)	Unauthorized speed	
	1(5/6)	2(10/00)	The role of the car	The cause of the accident
X^2=4/13	8(44/4)	7(35/00)	Deviation	Variable
P-value=0/59	2(11/1)	2(10/00)	Mobile	Father's education
	0(0/00)	2(10/00)	No belt	mother's education
	0(0/00)	2(10/00)	Eating and drinking	

The average change of control belief before and immediately after the intervention in the test group (9.06±1.81) and the control group (0.03±0.31). The difference between these two averages was statistically significant (p-value > 0.0001). The average change of control belief before and three months after the intervention in the test group was (9.06±1.81) and in the control group (-0.63±1.35). The difference between these two averages was statistically significant (P-value>0.0001). The average changes in attitude before and immediately after the intervention in the test group (25.4±3.95) and the control group (0.06±1.41) and the difference between these two averages was statistically significant (P-value > 0.0001). The average changes in attitude before and three months after the intervention in the test group (25.56±4.11) and the control group (0.23±3.3), the difference between these two averages was statistically significant. (P-value > 0.0001).

The average changes in mental norms before and immediately after the intervention in the test group (23.33±2.18) and the control group (0.3±2.16), the difference between these two averages was statistically significant. P-value > 0.0001). The average changes in mental norms before and three months after the intervention in the test group (23.36±2.49) and the control group (-1.64±1), the difference between these two averages was statistically significant. (P-value > 0.0001). The average change of intention before and immediately after the intervention in the test group (11.6±2.15) and the control group (-0.03±1.12). The difference between these two averages was statistically significant (P-value > 0.0001). The average change of intention before and three months after the intervention was (11.6±2.28) in the test group and (0.13±1.4) in the control group. The difference between these two averages was statistically significant (P-value > 0.0001).

Table 3. the results of the comparison of averages in the structures of planned behavior in two control and test groups

Test result	Test Group	control group	Structures of planned behavior	
t=0/4 **P-value=0/68**	34/77±3/27	35/1±3/13	Before intervention	
t=33/05 **P-value<0/0001**	25/4±3/95	0/06±1/41	Changes immediately after the intervention compared to before the intervention	Attitude Toward Behavior
z=6/75 **P-value<0/0001**	25/56±4/11	0/23±3/3	Changes three months after the intervention compared to before the intervention	
z=0/2 **P-value=0/8**	33±2/13	31/93±2/1	Before intervention	
z=6/7 **P-value<0/0001**	23/33±2/18	0/3±2/16	Changes immediately after the intervention compared to before the intervention	Subjective Norms
z=6/69 **P-value<0/0001**	23/36±2/49	-1±1/64	Changes three months after the intervention compared to before the intervention	
z=0/24 **P-value=0/8**	13/5±1/54	13/6±1/45	Before intervention	
z=6/99 **P-value<0/0001**	9/06±1/81	0/03±0/31	Changes immediately after the intervention compared to before the intervention	Perceived Behavioral Control
z=6/79 **P-value<0/0001**	9/06±1/81	-0/63±1/35	Changes three months after the intervention compared to before the intervention	
z=1/09 **P-value=0/27**	15/73±1/83	14/47±1/5	Before intervention	
z=6/72 **P-value<0/0001**	11/6±2/15	-0/03±1/12	Changes immediately after the intervention compared to before the intervention	intention
z=6/73 **P-value<0/0001**	11/6±2/28	0/13±1/4	Changes three months after the intervention compared to before the intervention	

At the pre-intervention phase, there were no statistically significant differences between the experimental and control groups concerning the Theory of Planned Behavior constructs (attitude, subjective norm, perceived behavioral control, and behavioral intention). However, immediately after the intervention and at the three-month follow-up, the experimental group showed significant improvements in their average scores for these constructs (p < 0.0001).

Regression tests indicated that the changes observed in TPB constructs were significantly related to changes in risky behaviors leading to traffic accidents

behaviors levels because improvements in attitude toward behavior, subjective norms, perceived behavioral control, a behavioral intention were significantly associated with increased the level of preventive behaviors in the intervention group. (Table4)

In our study, multiple regression analysis revealed that perceived behavioral control was the strongest predictor of preventive behaviors behavior among the TPB constructs. Attitude toward behavior ($\beta = 0.24$), subjective norms ($\beta = 0.21$), and behavioral intention ($\beta = 0.29$) also significantly predicted preventive behaviors. However, perceived behavioral control, with the highest beta coefficient of 0.38, was identified as the most influential factor in determining risky behaviors leading to traffic accidents

preventive behaviors.

Table 4. Regression Results for Predicting Preventive Behaviors of risky behaviors leading to traffic accidents

Variables	Beta Coefficient (β)	t-value	*p-value
Attitude Toward Behavior	0.24	2.70	0.005
Subjective Norms	0.21	2.45	0.011
Perceived Behavioral Control	0.38	4.55	0.001
Behavioral Intention	0.29	3.29	0.002

* to examine the predictive value of TPB constructs on Preventive Behaviors of risky behaviors leading to traffic accidents

. A significance level of 0.05 was considered

Based on the findings of the research, the educational intervention significantly improved the preventive performance of the effective factors in performing risky behaviors leading to traffic accidents in students in the test group compared to the control group. In fact, this improvement in behavior can be considered related to the educational method of group discussion, brainstorming, question and answer, and role-playing, which was highly attractive among students. Creating a favorable attitude in order to encourage to perform the target behavior is one of the strategies that have been emphasized a lot in studies related to education.

In the present study, when the average score of attitude was directly compared, it showed that the students of the control group who did not receive the educational program were in the same conditions in terms of the amount of attitude before and immediately after the intervention. This means that The traffic accident training program has been able to have a positive effect on the attitude of students in the field of traffic accident prevention behaviors.

After the educational intervention, in order to monitor and check the continuity of the acquired attitudes, two groups were examined again, and comparing the average scores of the attitudes in the intervention group in the previous stage, three months after the educational intervention, also compared to the previous stage, the average increased. It has been found, that the average difference is significant at an acceptable level. In general, the results of this research regarding attitude showed that in the test group, there was a significant difference between the average score of attitude before, immediately, and after the educational intervention three times and the attitude of people increased significantly after the intervention. The results obtained in terms of the effectiveness of education in improving attitudes in the present study, with the study of Emilio Moyano Diaz (15), which was conducted in the city of Santiago with the title "Theory of planned behavior and the intention of pedestrians to violate traffic regulations" and Also, with the study of Michael Tago and Alan Abaka (16), which was conducted in 2014 at the University of Ghana under the title "Determining the readiness of students in distance learning by mobile phone education at the University of Ghana based on the theory of planned behavior" and also with the study of Janj et al.(17) which was conducted under the title of comparing the effect of teaching by lecture and texting, based on the theory of planned behavior, on the promotion of nutritional behaviors that prevent osteoporosis in high school girls in Mashhad. In general, the results of this research regarding normative beliefs and motivation to follow showed that in the test group, there was a significant difference between the average scores of normative beliefs and motivation to follow before, immediately, and three months after the educational intervention based on Friedman's statistical test at three times. It exists and the mental norms of people have significantly increased after the intervention. The results obtained in terms of the effectiveness of education regarding mental norms in the present study, with the study of Peyman et al.'s (18) study, which was conducted under the title of the effect of education based on the theory of planned behavior on the consumption of low-value snacks in secondary schools, was consistent.

The results obtained in terms of the effectiveness of education in improving beliefs and behaviors in this study are in agreement with those of Hemti et al. They investigated training based on the theory of planned behavior in improving the safety climate, and the study of Blazej Palat(19) in 2011, which investigated the predictive factors in passing drivers when the light turns yellow. It is also consistent with the study of Poulter et al. (20) under the title of the application of the theory of planned behavior in the compliance of truck drivers' behavior with traffic laws.

The results of this research regarding behavioral intention showed that in the intervention groups, there is a statistically significant difference between the average score of behavioral intention before, immediately, and three months after the educational intervention, and the student's intention to perform preventive behaviors from traffic accidents after the intervention has increased significantly. The results of Hemti et al.'s study(21), which investigated the effect of education on promoting safe street crossing behaviors in students, showed

that the behavioral intention increased by 12% after the intervention, which is consistent with the present study and the results of the study Mott et al. (22) and Kain Esler et al. (23) confirm it.

Traffic accidents with high death rates and injuries among drivers, passengers, and pedestrians in all age groups are associated with many economic losses (24), but it is possible to prevent traffic accidents by promoting preventive behaviors because The purpose of health education is to change unsafe and unhygienic behavior into behaviors that lead to the promotion and maintenance of people's health (25-28). Similar to other studies, this study had limitations. The research was conducted only in boys aged 14-15 years old in urban public schools. It is suggested to conduct this survey for students of non-government schools and village schools, 10-14-year-old teenagers, 15-18-year-old non-students, female students, and other at-risk groups. Other limitations of the present study include the lack of necessary cooperation of some students, the lack of sufficient time to carry out educational interventions, the interference of educational programs with their classrooms, and the holding of school events. Therefore, in future studies, it is suggested to get the support of administrators and students and to make the follow-up period longer in order to better evaluate the effects of education.

Conclusion

This study was conducted on a small sample of high school boys, aged between 14 and 15 years, but as it can be seen from the results of the study, although the prevention of traffic accidents is very important, the performance status of the studied students was not at an optimal level. This doubles the need to implement educational interventions in the field of traffic accident prevention. The results of the present study showed that the design and implementation of educational programs during high school can have a significant increase in the type of attitude and mental norms, perceived behavioral control, and the intention to prevent traffic accidents learn driving rules and regulations, and identify risky behaviors. Driving can have a significant impact on reducing traffic accidents in society.

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