



# A PRECEDE–PROCEED-Based Intervention for Pedestrian Safety in Students Aged 6–12 Years: A Field Trial

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## Abstract

**Introduction:** Road traffic injuries are a leading cause of death and disability worldwide, especially among children in low-income and middle-income countries, including Iran. Therefore, this study evaluated the effectiveness of a PRECEDE-PROCEED model-based educational intervention on safe street-crossing behavior among primary school students in Semirom, Isfahan Province, Iran.

**Methods:** A field trial was conducted involving 80 students aged 6–12 years, equally allocated to the intervention and control groups via multi-stage random sampling in 2023–2024. The intervention comprised five structured educational sessions using participatory methods, visual aids, and practical demonstrations, designed to enhance knowledge, attitudes, and behaviors concerning road safety. Moreover, pre-intervention and post-intervention data were collected using validated questionnaires and environmental checklists. Ultimately, data were analyzed by SPSS 22 using t-tests, Mann-Whitney U, Chi-square tests, and multiple linear regression.

**Results:** The intervention group confirmed significant post-intervention improvements in knowledge, enabling factors, reinforcing factors, and safe behavior scores. Additionally, attitude and peer influence emerged as essential predictors of behavior, while radio and television represented a negative association. Notably, boys demonstrated higher gains in safe crossing behavior compared to girls. Eventually, environmental audits revealed partial remediation of infrastructural deficits.

**Conclusion:** The PRECEDE-PROCEED-based intervention significantly improved students' road safety behaviors. The findings support integrating structured, gender-sensitive education into school curricula, along with media and infrastructure improvements.

**Keywords:** Pedestrian safety, PRECEDE-PROCEED, Accident prevention, Students

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## Introduction

Road traffic injuries are a major public health problem worldwide, causing approximately 1.19 million deaths and 20–50 million non-fatal injuries annually.<sup>1</sup> Children and adolescents are particularly vulnerable, with traffic injuries accounting for about 30% of deaths among individuals younger than 19 years and representing the leading cause of death among those aged 5–19 years.<sup>2</sup> Nearly 90% of these deaths occur in low-income and middle-income countries, although these countries possess only 60% of the world's vehicles.<sup>3</sup> In Iran, road traffic mortality rates are estimated at 30.6 and 10.6 per 100,000 among men and women, respectively.<sup>4</sup> In addition to their human toll, traffic injuries impose considerable economic burdens through healthcare costs, rehabilitation, lost productivity, and long-term disability.<sup>5–7</sup>

Moreover, children aged 6–10 years are especially at risk because of developmental and behavioral characteristics, including difficulty judging vehicle speed and distance,

limited visual fields, and impulsive crossing behaviors.<sup>8–13</sup> As pedestrians, children are among the most vulnerable road users.<sup>14</sup> Given that most road traffic injuries are preventable, improving children's traffic safety behaviors is an important public health priority. Likewise, experiences from countries such as Sweden suggest that combining education with supportive policies and safer road environments can substantially reduce traffic-related injuries and deaths.<sup>15, 16</sup>

Education is considered one of the most effective approaches for promoting safe traffic behaviors among children.<sup>17, 18</sup> However, educational programs are more likely to be effective when they are designed using established behavioral frameworks.<sup>19</sup> In particular, the PRECEDE–PROCEED (Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation; Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development) model is a widely used planning model that helps identify behavioral

and environmental factors influencing health-related behaviors and supports the development of structured interventions.<sup>16</sup> Despite growing research on child traffic safety, relatively few studies have examined theory-based educational interventions focused on pedestrian safety among primary school children, particularly in low-income and middle-income countries.<sup>20–24</sup>

Therefore, in line with Sustainable Development Goal 3.6, which aims to reduce traffic-related deaths and injuries by 50% by 2030<sup>25</sup>, this study seeks to investigate the effect of a PRECEDE–PROCEED-based educational intervention on safe street-crossing behavior among primary school students in Semirom, Isfahan Province, Iran.

## Materials and Methods

### *Study Design and Study Population*

This field trial was conducted among primary school students in Semirom, Isfahan Province, Iran, in 2023–2024. The inclusion criteria were age range of 6–12 years, enrollment in grades one through six of primary school, and full physical health. Nonetheless, the exclusion criteria included use of school transportation services, lack of parental consent for the child's participation, unwillingness of the student to take part in the study, and active membership in the "School Police Assistant" program. Written informed consent was obtained from the students' parents prior to the commencement of the study procedures. It should be noted that the public was not involved in designing, conducting, reporting, or disseminating the plans of our research.

### *Sample Size and Sampling Method*

Considering a significance level of 0.05, a statistical power of 0.95, a 1:1 ratio between the groups, and the reported post-intervention means and standard deviations (intervention group:  $39.78 \pm 4.25$ ; control group:  $35.55 \pm 5.86$ ), the required sample size was calculated to be 40 participants per group using G\*Power software (version 3.1.9.4).<sup>26</sup>

In addition, multi-stage random sampling was employed in this study. A complete list of primary schools in Semirom was compiled. Then, considering the proportion of boys' and girls' schools, two girls' schools and two boys' schools were randomly selected and assigned to the intervention (one for girls and one for boys) and control (one for girls and one for boys) groups.

Next, three classes were randomly selected from each school in the intervention and control groups. Within these classes, a total of 40 students (22 girls and 18 boys) were chosen using the proportional simple random sampling method to reach the study size in the intervention and control groups.

### *Data Collection*

Following approval from the Department of Education and the intended schools, the researcher visited each school, explained the study objectives to the students, and distributed informed consent forms. Moreover,

students were instructed to return the completed forms, signed by their parents, at the next session. Subsequently, pre-intervention questionnaires were distributed and completed by the students. Finally, a tailored educational intervention was designed and implemented based on the analysis of the baseline data.

### *Description of the Intervention*

The educational intervention was developed using a data-driven approach informed by the baseline assessment. Prior to the intervention, students completed questionnaires measuring knowledge, attitudes, reinforcer factors, enabler factors, and behavior related to safe street-crossing. Baseline comparisons between the intervention and control groups revealed significant gaps in knowledge and attitudes. Furthermore, multiple regression analysis identified attitude, reinforcer, and enabler factors as significant predictors of safe street-crossing behavior. These findings guided the design of the intervention curriculum, which was specifically tailored to address the identified deficits and strengthen the key determinants of safe behavior.

Then, the educational intervention was conducted over five consecutive sessions, utilizing visual and auditory tools and emphasizing a participatory approach with participation of 40 students. The first session aimed to enhance students' awareness of fundamental concepts related to safe traffic behaviors. Additionally, the content covered the recognition of traffic signs and signals, definitions of safe traffic behavior, and the objectives of the educational intervention. It is noteworthy that this material was delivered through group discussions and interactive classroom engagement. Moreover, posters and visual aids were employed to reinforce visual learning.

Further, the second session focused on familiarizing students with traffic laws and increasing their awareness of traffic signs and signals. Key topics included the meaning of traffic light colors and signs, the importance of wearing reflective clothing at night, and the proper methods for crossing streets and pedestrian bridges. These topics were taught through lectures that were supported by visual presentations.

Likewise, the third session began with a review and reinforcement of the previously covered material through a question-and-answer format. Subsequently, students' attitudes toward safe street crossing, adherence to traffic laws, and attention to traffic regulations were assessed, and their personal opinions were collected. Additionally, the researcher presented perspectives on safe traffic behavior. After the session, the students were asked to express their ideas about safe street crossing by creating drawings or crafts. These topics were taught through lectures.

The fourth session also aimed to teach children appropriate and inappropriate behaviors as pedestrians, cyclists, and vehicle passengers. Following the educational presentation, students were encouraged to share their personal experiences and identify correct and incorrect behaviors in these situations.

The fifth session concentrated on discussion and exchange of views regarding reinforcing factors, including family and school support in performing safe behaviors, as well as enabling factors such as television messages and the role of the police. Then, the students provided feedback on the educational program. One month after the intervention, post-test questionnaires were administered to both the intervention and control groups.

After identifying deficiencies through checklists, a safe community committee was established in the county with the participation of relevant departments, including the Education Council and the Parent-Teacher Association. Moreover, supportive measures were implemented to address identified problems and provide necessary equipment. Following these interventions, the evaluation checklists were completed again to assess the changes.

### Data Collection Instruments

A questionnaire developed by Omid et al<sup>26</sup> was utilized to collect data related to behavioral factors (the PRECEDE section). This instrument has several sections: demographic variables, including predisposing, enabling, and reinforcing factors. Predisposing factors consist of 11 questions on knowledge and 10 questions on attitudes. In addition, enabling factors include 8 questions regarding the availability of facilities and educational resources. Further, reinforcing factors encompass 2 questions about parental (as reinforcer 1) and teacher (as reinforcer 2) support and 15 questions addressing safe traffic behaviors. The questionnaire demonstrated good psychometric properties. Furthermore, face and content validity were established by an expert panel of 10 health education specialists. Moreover, reliability for the knowledge, behavior, enabling, and reinforcing factor scales was confirmed via test-retest (15 students, 8-day interval). The attitude scale also showed good internal consistency (Cronbach's  $\alpha=0.85$ ). Additionally, the maximum attainable score on this questionnaire was 45, with higher scores indicating appropriate traffic behavior.<sup>26</sup>

Likewise, environmental data related to the PROCEED section were collected using a standardized checklist. This checklist comprised 14 items related to laws and regulations, 3 items regarding human resources, 3 items concerning financial resources, and 10 items about equipment. Finally, the checklist was completed by the education department's director and deputies, school principals and teachers from the participating schools, and traffic police experts.

### Data Analysis

Data were analyzed using SPSS software, version 22. The normality of data was assessed using the Shapiro-Wilk test. In addition, independent samples t-tests were employed to compare the means of normally distributed variables between the two groups. For variables with non-normal distributions, the Mann-Whitney U test was also used for group comparisons. Furthermore, multiple linear regression analysis using the Enter method was

conducted to examine the effect of multiple independent variables on the dependent variable. Eventually, the Chi-square test was utilized to compare demographic variables between the two groups, and a significance level of 0.05 was considered for all statistical tests.

## Results

### Descriptive Findings of Demographic Variables

A total of 80 participants (44 girls and 36 boys) were equally enrolled in both the intervention and control groups. Data normality was assessed to compare demographic characteristics. Fathers' and mothers' ages were normally distributed in both groups ( $P>0.05$ ), allowing the use of the parametric Student's t-test. Moreover, the non-parametric Mann-Whitney U test was applied since student ages were non-normally distributed. Additionally, median (interquartile range) student age was 10 (8-12) years and 10 (9-12) years in the intervention and control groups, respectively. No significant differences were found between the groups for parental or student age.

### Normality of Data and Baseline Comparison of Variables

The normality of primary data was evaluated using the Shapiro-Wilk test, revealing non-normal distributions for all key variables in both groups before and after the intervention ( $P<0.05$ ). Based on the results (Table 1), significant baseline differences were observed in knowledge and attitude scores, with the control group scoring higher on knowledge ( $P<0.001$ ) and marginally higher on attitude ( $P=0.011$ ). Nonetheless, no other variables, including baseline behavior, significantly differed between the groups.

### Results of Multiple Regression Analysis

In this analysis, safe street-crossing behavior served as the dependent variable, with enabling factors, facilitating factors, reinforcing factors, attitudes, knowledge, and educational resources (police, teachers, family, radio/television, and peers) as predictors. The assumptions of multiple linear regression were met; all variance inflation factor values were below 5, indicating no multicollinearity. In addition, the Durbin-Watson statistic was 2.09, confirming residual independence, and residual normality was supported by the standardized residuals plot and Shapiro-Wilk test ( $P>0.05$ ).

**Table 1.** Baseline Comparison of Study Variables Between Intervention and Control Groups Before the Intervention

| Variable     | Intervention Group<br>(n=40) Median (IQR) | Control Group<br>(n=40) Median (IQR) | P-Value |
|--------------|-------------------------------------------|--------------------------------------|---------|
| Knowledge    | 7 (6-8)                                   | 9 (8-9.75)                           | <0.001  |
| Attitude     | 28 (25.25-29)                             | 29 (28-30)                           | 0.011   |
| Reinforcer 1 | 3 (2-3)                                   | 3 (2.25-3)                           | 0.545   |
| Reinforcer 2 | 12 (10-12)                                | 12 (11-12)                           | 0.504   |
| Enabler      | 3 (2-3)                                   | 3 (2-3)                              | 0.109   |
| Behavior     | 52 (48.25-56)                             | 54 (50-57.75)                        | 0.854   |

Note. IQR: Interquartile range. Data were analyzed using the Mann-Whitney U test.

Moreover, the final model significantly explained 52% of the variance in safe street-crossing behavior [ $R^2=0.52$ ,  $F(11, 78)=8.37$ ,  $P<0.001$ ]. Table 2 presents the results of the regression analysis.

Attitude ( $\beta=.26$ ,  $P=.032$ ), reinforcer 2 ( $\beta=.32$ ,  $P=.013$ ), and enabler ( $\beta=.22$ ,  $P=.037$ ) were significant predictors of safe street-crossing behavior. Among educational resources, friends had a significant positive effect ( $\beta=.31$ ,  $P=.015$ ), whereas radio/television had a significant negative effect ( $\beta=-.44$ ,  $P<.001$ ).

### Post-Intervention Findings

Post-intervention comparison revealed no significant difference in reinforcer 1 between groups. However, reinforcer 2 ( $P=0.005$ ), enabler ( $P=0.044$ ), and behavior ( $P=0.002$ ) substantially differed between the intervention and control groups (Table 3).

Significant baseline differences in knowledge and attitude scores between the intervention and control groups precluded valid direct comparisons of post-intervention scores, and change score analysis was utilized accordingly. Given the non-normal distribution of the data, between-group comparisons were conducted using the non-parametric Mann-Whitney U test. The results represented a significant increase in knowledge change in the intervention group versus control ( $P=0.013$ ), with median scores of 21 and 19 points, respectively. The intervention group's median attitude change was higher but not statistically significant (Table 4).

Before the intervention, no significant gender difference

**Table 2.** Multiple Regression Analysis Results for Predicting Safe Street-Crossing Behavior Among Students

| Predictor        | B     | SE   | $\beta$ | t     | P-Value |
|------------------|-------|------|---------|-------|---------|
| Constant         | 10.76 | 8.65 | -       | 1.24  | .218    |
| Knowledge        | 0.45  | 0.35 | .15     | 1.29  | .202    |
| Attitude         | 0.67  | 0.31 | .26     | 2.20  | .032*   |
| Reinforcer 1     | 0.30  | 1.15 | .03     | 0.26  | .796    |
| Reinforcer 2     | 0.91  | 0.35 | .32     | 2.55  | .013*   |
| Enabler          | 1.60  | 0.75 | .22     | 2.14  | .037*   |
| Police           | 2.11  | 1.15 | .20     | 1.85  | .070    |
| Teacher          | 2.08  | 1.17 | .19     | 1.78  | .080    |
| Family           | 0.37  | 1.19 | .03     | 0.31  | .756    |
| Radio/television | -5.45 | 1.43 | -.44    | -3.82 | <.001** |
| Friends          | 5.47  | 1.18 | .31     | 2.51  | .015*   |

Note. SE: Standard error of the mean.

**Table 3.** Scores of Safe Street-Crossing Dimensions in the Intervention and Control Groups After the Intervention

| Variable     | Intervention Group Median (IQR) | Control Group Median (IQR) | P-Value |
|--------------|---------------------------------|----------------------------|---------|
| Reinforcer 1 | 3 (2-3)                         | 3 (2-3)                    | 0.156   |
| Reinforcer 2 | 12 (11-12)                      | 11 (9-12)                  | 0.005*  |
| Enabler      | 3 (3-3)                         | 3 (2-3)                    | 0.044*  |
| Behavior     | 56 (53-58)                      | 53 (4-55)                  | 0.002*  |

Note. IQR: Interquartile range. \*Significant at  $P<0.05$ . The Mann-Whitney U test was used to analyze the data.

in mean safe street-crossing scores was observed in either group. Post-intervention, however, a significant gender difference appeared in the intervention group, with boys scoring higher than girls. Finally, no gender difference was found in the control group (Table 5).

### Findings of Non-Behavioral Factors

Data collected using the checklist in the non-behavioral domain indicated that out of 30 checklist items, 13 exhibited deficiencies related to laws and regulations (1), human resources (2), financial resources (3), and equipment and facilities (7). Following the intervention, 7 of these deficiencies were resolved, while no changes occurred in the remaining 6 items, including human resources (2), financial resources (3), and equipment-related issue (1).

### Discussion

Our findings demonstrated that the intervention based on the PRECEDE-PROCEED model significantly enhanced knowledge, attitudes, reinforcing and enabling factors, and ultimately, safe street-crossing behavior. As a comprehensive and structured framework for planning educational interventions, the PRECEDE-PROCEED model facilitates multilayered analysis of factors that influence behavior.<sup>27</sup>

After the educational intervention, significant increases and positive changes were observed in knowledge levels and participants' attitudes toward traffic safety behaviors, respectively. Although increased knowledge alone does not guarantee safe behavior, it serves as a foundational prerequisite for attitude change and practical action.<sup>28</sup> Despite greater attitude changes in the intervention group, these changes were not statistically significant. This finding is noteworthy and may be attributed to cultural factors or the insufficient duration of the intervention to produce a measurable shift in attitudes, which aligns with the findings of previous studies, emphasizing the positive impact of structured educational programs on enhancing

**Table 4.** Comparison of Changes in Knowledge and Attitude Scores Between Intervention and Control Groups

| Variable          | Intervention Group Median (IQR) | Control Group Median (IQR) | P-Value |
|-------------------|---------------------------------|----------------------------|---------|
| Knowledge changes | 21 (19-23)                      | 19 (18-21.75)              | 0.013*  |
| Attitude changes  | 1 (0-2.75)                      | 0 (0-2)                    | 0.061   |

Note. IQR: Interquartile range. \*Significant at  $P<0.05$ . Data underwent analysis using the Mann-Whitney U test.

**Table 5.** Comparison of Safe Street-Crossing Behavior Scores Between Girls and Boys After the Intervention

| Group        | Gender | Median (IQR)     | P-Value |
|--------------|--------|------------------|---------|
| Intervention | Girls  | 53 (52-56.75)    | 0.002*  |
|              | Boys   | 58 (56-59)       |         |
| Control      | Girls  | 51 (47-54)       | 0.092   |
|              | Boys   | 55 (47.25-57.75) |         |

Note. IQR: Interquartile range. \*Significant at  $P<0.05$ . Data were assessed using the Mann-Whitney U test.

awareness of traffic hazards.<sup>29-33</sup>

These studies reported that educational interventions, whether through multimedia educational packages or face-to-face classes, remarkably increase knowledge related to safe traffic behaviors among children and adolescents. In the aforementioned studies, children in the intervention groups exhibited a higher tendency to comply with safety measures following the training, indicating the direct effectiveness of education in internalizing safe behaviors. Evidence confirms that theory-based educational interventions effectively enhance safety knowledge while reducing risk-taking behaviors. These programs facilitate behavioral changes through dual mechanisms of awareness-raising and attitude modification, thereby establishing critical cognitive foundations for safer practices.<sup>34</sup>

Likewise, the intervention group demonstrated significant improvements in reinforcing factors, enabling factors, and safe behaviors compared to controls. Similar results were found by Fisa et al, representing that multifaceted education can impact behavioral components.<sup>35</sup> This finding highlights the critical role of the educational environment and school support structures in shaping safety behaviors, particularly among children and adolescents. More precisely, these elements not only enhance motivation for repeated safe behaviors but also contribute to the consolidation and internalization of these behaviors within the child's procedural memory.<sup>36</sup>

Based on the results of the multiple regression analysis, individual attitudes, school-based reinforcing factors, and environmental enablers were significant predictors of safe street-crossing behavior, whereas knowledge alone had no independent effect on behavior. This finding conforms to behavioral health theories, which assert that awareness and information alone are insufficient for behavior change; positive attitudes, self-efficacy, and supportive environmental and social factors are essential as well.<sup>34</sup> Similar studies emphasized that effective educational programs not only convey knowledge but also address environmental and social determinants of behavior.<sup>37</sup>

<sup>38</sup> Accordingly, empowering individuals with resources, structural support, and behavioral incentives is crucial for sustaining safe behaviors.

Notably, peer influence was a significant positive predictor of students' safe street-crossing behavior, while radio and television had a negative impact. This issue suggests that traditional media may be ineffective or even counterproductive in promoting safety, underscoring the need for aligning media content with official traffic safety education objectives.

The positive impact of peers on safe behavior underlines their role as key agents of social learning and behavioral modeling. At this developmental stage, peer interactions serve as powerful social reinforcers shaping students' adoption or rejection of traffic safety behaviors.

A key finding was the emergence of a gender difference in safety behavior post-intervention, with boys outperforming girls an effect absents at baseline.

This indicates the need for gender-sensitive educational designs. Recent studies suggest boys frequently respond more effectively to interventions emphasizing practical, participatory, and experiential learning.<sup>39, 40</sup> However, these differences must be viewed within a complex psychological, social, and cultural context, cautioning against broad generalizations.

In the non-behavioral domain, deficiencies in regulations, human resources, and equipment revealed that education alone is insufficient to improve safety behaviors. Thus, strengthening environmental infrastructure is essential, underscoring the necessity of intersectoral collaboration and structural policy measures, as education alone cannot sustain behavioral changes without supportive infrastructure.<sup>41</sup> This finding is in line with the World Health Organization's call for multidimensional strategies, combining education, engineering, and enforcement, to advance traffic safety.<sup>42</sup>

A structured behavioral model, school-based intervention, and robust evaluation were the strengths of this study. However, cautious interpretation is advised due to the short follow-up, baseline imbalances, limited generalizability, lack of gender tailoring, partial environmental improvements, and reliance on self-reported data. Moreover, our sampling of public and private schools, as well as affluent and less affluent regions, was constrained by administrative and logistical limitations. As a result, the final sample was not completely proportional to the broader school population, which may have limited the generalizability of our findings.

Hence, future research should address the limitations associated with the study. In addition, future investigations are encouraged to incorporate larger, more diverse samples across multiple sites. Ultimately, future works should employ qualitative analyses of media content to elucidate potential mechanisms underlying this relationship.

## Conclusion

The findings of this study confirmed the effectiveness of structured educational interventions grounded in the PRECEDE-PROCEED model in enhancing students' safe street-crossing behaviors. Given the preventable nature of many child traffic accidents, it is recommended that such interventions be institutionalized as ongoing, nationwide school programs. Likewise, complementary actions, such as revising mass media content, addressing gender-specific needs, and investing in safety infrastructure, are crucial to support sustained impacts.

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During the preparation of this manuscript, the authors used ChatGPT by OpenAI to assist with editing the language, refining the text, and improving clarity. Moreover, they reviewed and edited all generated content. Finally, the authors declare that they take full

responsibility for the accuracy and integrity of the manuscript.

### Authors' Contribution

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### Competing Interests

The authors declare that there is no conflict of interests.

### Ethical Approval

The study protocol was approved by the Ethics Committee of Yasuj University of Medical Sciences (ethical code IR.YUMS.REC.1399.188).

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### References

- World Health Organization (WHO). Road Traffic Injuries. WHO; 2023. Available from: <https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries>.
- Khan UR, Razzak JA, Wärnberg MG. Global trends in adolescents' road traffic injury mortality, 1990-2019. *Arch Dis Child* 2021;106(8):753-7. doi:10.1136/archdischild-2020-319184
- Segui-Gomez M, Luo F, Tingvall C, Taylor MP. Assessing the impact of the WHO Global Status Reports on Road Safety. *Inj Prev* 2025;31(Suppl 1):i1-i6. doi:10.1136/ip-2024-045536
- World Health Organization (WHO). Health Data Overview for the Islamic Republic of Iran. WHO; 2021. Available from: <https://data.who.int/countries/364>.
- World Health Organization (WHO). Global Status Report on Road Safety 2023. WHO; 2023. Available from: <https://www.who.int/publications/i/item/9789240086517>.
- Rezaei S, Arab M, Karami Matin B, Akbari Sari A. Extent, consequences and economic burden of road traffic crashes in Iran. *J Inj Violence Res* 2014;6(2):57-63. doi:10.5249/jivr.v6i2.191
- Ainy E, Soori H, Ganjali M, Le H, Baghfalaki T. Estimating cost of road traffic injuries in Iran using willingness to pay (WTP) method. *PLoS One* 2014;9(12):e112721. doi:10.1371/journal.pone.0112721
- Sadeghian Tafti MR, Ostovar A, Saeedi Moghaddam S, Shobeiri P, Ehrampoush MH, Salmani I, et al. Burden of road traffic injuries in Iran: a national and subnational perspective, 1990-2019. *Inj Prev* 2023;29(2):101-10. doi:10.1136/ip-2022-044677
- Kendi S, Johnston BD. Epidemiology and prevention of child pedestrian injury. *Pediatrics* 2023;152(1):e2023062508. doi:10.1542/peds.2023-062508
- Riaz MS, Cuenen A, Polders E, Akram MB, Houda M, Janssens D, et al. Child pedestrian safety: Study of street-crossing behaviour of primary school children with adult supervision. *Sustainability* 2022;14(3):1503. doi:10.3390/su14031503
- Deluka-Tibljša A, Šurdonja S, Ištoka Otković I, Campisi T. Child-pedestrian traffic safety at crosswalks—literature review. *Sustainability* 2022;14(3):1142. doi:10.3390/su14031142
- Wang H, Schwebel DC, Tan D, Shi L, Miao L. Gender differences in children's pedestrian behaviors: developmental effects. *J Safety Res* 2018;67:127-33. doi:10.1016/j.jsr.2018.09.003
- Lakim LL, Ghani NA. A review of road traffic hazard and risk analysis assessment. *Journal of Tourism, Hospitality and Environment Management* 2022;7(27):297-309. doi:10.35631/jthem.727023
- Wang W, Hua J, Schwebel DC, Li J, Li L, Rao Z, et al. Assessing the global data availability and characteristics of eight risk factors for road traffic injury: an evaluation study across 194 countries/territories, 2000-2019. *J Glob Health* 2025;15:04057. doi:10.7189/jogh.15.04057
- Naumann RB, Lajeunesse S, Keefe E, Heiny S, Lich KH, Jones K, et al. A novel Vision Zero leadership training model to support collaboration and strategic action planning. *Front Future Transp* 2023;4:923786. doi:10.3389/ffutr.2023.923786
- Eisapareh K, Nazari M, Kaveh MH, Cousins R, Mokarami H. Effects of an educational intervention program based on the PRECEDE-PROCEED model for anger management and driving performance of urban taxi drivers: a comparison of traditional and online methods. *Saf Sci* 2023;157:105933. doi:10.1016/j.ssci.2022.105933
- AlSallum GA, Alwassel AA, Alshushan AM, Abaalkhail AK, Alhasoon MA, Aldamigh AS. Parent's knowledge, attitude, and practice about children car seats at Unaizah city, KSA. *J Family Med Prim Care* 2019;8(3):805-11. doi:10.4103/jfmpc.jfmpc\_75\_19
- Freitas C, Rodrigues MA, Parreira P, dos Santos Ac, Lima S, Fontes VS, et al. Educational program for the promotion of knowledge, attitudes and preventive practices for children in relation to traffic accidents: experimental study. *Rev Paul Pediatr* 2019;37(4):458-64. doi:10.1590/1984-0462/2019;37;4;00012
- Ryan P. Integrated Theory of Health Behavior Change: background and intervention development. *Clin Nurse Spec* 2009;23(3):161-70. doi:10.1097/NUR.0b013e3181a42373
- Fanai S, Okyere E, Marfoh K. Behavior change interventions for dangerous driving behavior in low- and middle-income countries: a systematic review of interventions and outcome measurement instruments. *Front Public Health* 2025;13:1597331. doi:10.3389/fpubh.2025.1597331
- Schwebel DC, Barton BK, Shen J, Wells HL, Bogar A, Heath G, et al. Systematic review and meta-analysis of behavioral interventions to improve child pedestrian safety. *J Pediatr Psychol* 2014;39(8):826-45. doi:10.1093/jpepsy/jsu024
- Schwebel DC, Wu Y, Li P, Severson J, He Y, Xiang H, et al. Featured article: evaluating smartphone-based virtual reality to improve Chinese schoolchildren's pedestrian safety: a nonrandomized trial. *J Pediatr Psychol* 2018;43(5):473-84. doi:10.1093/jpepsy/jsx147
- Meir A, Tapiro H, Oron-Gilad T. Towards safer, more walkable urban environments for child-pedestrians - application of the theory of Planned behavior. *Saf Sci* 2023;164:106148. doi:10.1016/j.ssci.2023.106148
- Vijay NC, Rokade S, Bivina GR. Towards safer streets: a review of child pedestrian behavior and safety worldwide. *Transp Res Part F Traffic Psychol Behav* 2024;103:638-60. doi:10.1016/j.trf.2024.05.005
- Soori H, Razzaghi A. Advancing road traffic injury measures in the WANA region towards road safety specific SDGs. *Int J Inj Contr Saf Promot* 2025;32(1):3-11. doi:10.1080/17457300.2024.2440936
- Omid S, Farmanbar R, Mokhtarpour S. The effect of educational intervention based on PRECEDE-PROCEED model on promoting traffic safety behaviors in primary schools students of Tabriz in 2014. *J Educ Community Health* 2016;2(4):48-56. doi:10.21859/jech-02047

27. Kim J, Jang J, Kim B, Lee KH. Effect of the PRECEDE-PROCEED model on health programs: a systematic review and meta-analysis. *Syst Rev* 2022;11(1):213. doi:[10.1186/s13643-022-02092-2](https://doi.org/10.1186/s13643-022-02092-2)
28. Albarracín D, Fayaz-Farkhad B, Samayoa JA. Determinants of behaviour and their efficacy as targets of behavioural change interventions. *Nat Rev Psychol* 2024;3(6):377-92. doi:[10.1038/s44159-024-00305-0](https://doi.org/10.1038/s44159-024-00305-0)
29. Amirkhani M, Balaghi Inalu F, Arman A, Zarghamian M, Afzali Harsini P, Khani Jeihooni A. The effect of educational intervention based on the theory of planned behaviour on promotion of traffic-safe behaviours in students. *Int J Adolesc Youth* 2025;30(1):2488465. doi:[10.1080/02673843.2025.2488465](https://doi.org/10.1080/02673843.2025.2488465)
30. Khan N, Muhammad K, Hussain T, Nasir M, Munsif M, Imran AS, et al. An adaptive game-based learning strategy for children road safety education and practice in virtual space. *Sensors (Basel)* 2021;21(11):3661. doi:[10.3390/s21113661](https://doi.org/10.3390/s21113661)
31. Ranaei V, Hassani L, Shahab Jahanlou A, Roshanaei G, Rezapur-Shahkolai F. Effect of educational intervention on safe traffic behaviors of high school male students in Iran, using the theory of planned behavior: a quasi-experimental study. *BMC Public Health* 2021;21(1):1876. doi:[10.1186/s12889-021-11943-x](https://doi.org/10.1186/s12889-021-11943-x)
32. Shams M, Maleki M, Shariatnia S, Omidimorad A, Zakeri H, Fallah Zavareh M, et al. Insights for speed management among Iranian drivers: a social marketing formative research study. *J Inj Violence Res* 2022;14(3):199-208. doi:[10.5249/jivr.v14i3.1690](https://doi.org/10.5249/jivr.v14i3.1690)
33. Tolide M, Dehghani Tafti A, Rahaei Z, Eisapareh K. The impact of a school-based educational intervention on safe road crossing in elementary school students. *Payesh* 2020;19(2):167-75. doi:[10.29252/payesh.19.2.167](https://doi.org/10.29252/payesh.19.2.167)
34. Glanz K, Rimer BK, Viswanath K. *Health Behavior: Theory, Research, and Practice*. John Wiley & Sons; 2015.
35. Fisa R, Musukuma M, Sampa M, Musonda P, Young T. Effects of interventions for preventing road traffic crashes: an overview of systematic reviews. *BMC Public Health* 2022;22(1):513. doi:[10.1186/s12889-021-12253-y](https://doi.org/10.1186/s12889-021-12253-y)
36. Fields NL, Dabelko-Schoeny H, Murphy IE, Highfill C, Cao Q, White K, et al. Social cognitive theory, driving cessation, and alternative transportation in later life. *J Appl Gerontol* 2023;42(11):2252-60. doi:[10.1177/07334648231177215](https://doi.org/10.1177/07334648231177215)
37. Estell DB, Perdue NH. Social support and behavioral and affective school engagement: the effects of peers, parents, and teachers. *Psychol Sch* 2013;50(4):325-39. doi:[10.1002/pits.21681](https://doi.org/10.1002/pits.21681)
38. Pakarinen E, Lerkkanen MK, von Suchodoletz A. Teacher emotional support in relation to social competence in preschool classrooms. *Int J Res Method Educ* 2020;43(4):444-60. doi:[10.1080/1743727X.2020.1791815](https://doi.org/10.1080/1743727X.2020.1791815)
39. Vasilenko SA, Lefkowitz ES, Welsh DP. Is sexual behavior healthy for adolescents? A conceptual framework for research on adolescent sexual behavior and physical, mental, and social health. *New Dir Child Adolesc Dev* 2014;2014(144):3-19. doi:[10.1002/cad.20057](https://doi.org/10.1002/cad.20057)
40. Maartensson H, Loi NM. Exploring the relationships between risk perception, behavioural willingness, and constructive hope in pro-environmental behaviour. *Environ Educ Res* 2022;28(4):600-13. doi:[10.1080/13504622.2021.2015295](https://doi.org/10.1080/13504622.2021.2015295)
41. Akbari M, Heydari ST, Razzaghi A, Vali M, Tabrizi R, Bagheri Lankarani K. Effectiveness of interventions for preventing road traffic injuries: a systematic review in low-, middle- and high-income countries. *PLoS One* 2024;19(12):e0312428. doi:[10.1371/journal.pone.0312428](https://doi.org/10.1371/journal.pone.0312428)
42. World Health Organization (WHO). *Global Status Report on Road Safety* 2018. WHO; 2018. Available from: <https://www.who.int/publications/i/item/9789241565684>.