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Review Article

Health Promotion Interventions on Helmet Use: A Systematic Review and Meta-Analysis of Pre-Test and Post-Test Studies

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Abstract

Background: We aimed to review the effectiveness of health promotion interventions in the use of helmet and to identify the types of effective health promotion strategies among the examined studies.

Methods: A systematic search was performed on the PubMed, Scopus, Cochrane, and Embase databases up to 1 Aug 2022 to find the studies evaluated the effectiveness of health promotion interventions for helmet use among target population. In this systematic review and meta-analysis, interventions with pre- post-test design were included. The dependent variable of the study is the percentage of participants who responded positively toward helmet use in the baseline and after the interventions. Random-effects models were used to pool study results.

Results: Overall, 1,675 articles were found in the initial search and entered into the Endnote software. Of these, 917 duplicate articles were removed, leaving 758 articles were screened based on title and abstract. Finally, 12 eligible articles were included in the review and five with pre and post-test design were included in the meta-analysis. The overall random-effects pooled estimation of persons wearing helmets before and after interventions was 70% (95%CI 21 –119; $P<0.001$), without a heterogeneity ($I^2 =0\%$; $P=0.94$), which means that the average percentage of changing to helmet use is 70%. Community-based education program was the most commonly applied for interventional studies. The next most commonly used approaches were campaign designing.

Conclusion: Wearing helmet approximately increased 70% among participant. Health promotion strategies may target helmet-wearing behavior to reduce head injuries in motorcyclist road traffic accidents.

Keywords: Health promotion; Helmet use; Motorcyclists; Effectiveness; Meta-analysis

Introduction

Traffic accidents as predictable and preventable events are among the most important public health challenges and impose a heavy socioeconomic burden on society, especially in developing countries (1). Traffic accidents were the third leading cause of death in 2020 and are predicted to be the seventh leading cause of death by 2030 (2). According to the WHO report in 2015, motorcyclists accounted for about 9% of road accident deaths in Europe, 20% in the United States, and 34% in the Western Pacific and Southeast Asia (3). About 90% of deaths due to traffic accidents occur in middle- and low-income countries, and half of all road accidents result in deaths among motorcycle users (4). For instance, the number of people killed in car accidents in Iran is double the global average, and the number of injured in traffic accidents in Iran is almost five times as high (5). In fact, the number of deaths from traffic accidents is the second highest in Iran after deaths due to cardiovascular disease (6). However, cardiovascular disease primarily kills people over the age of 60 yr, while the average age of death from traffic accidents is 27–36 (7). Moreover, in Iran, casualties due to traffic accidents by vehicle type showed that among the total casualties, 34% were passengers, 25% were motorcyclists, and 24% were pedestrians. One-third of these people were in the age group of 18–24 yr (8). Head and neck injuries are the leading preventable cause of death for motorcyclists (9).

The use of helmets plays an important role in preventing head and neck damage and can reduce about 70% of injuries and 40% of deaths due to accidents. Motorcyclists who do not wear helmets are two to three times more likely to die (10). The best strategy to increase helmet use is to apply helmet law to all motorcycle occupants on all roads and all ages, and include an international or national standard for helmet use. Although 94% of countries have a national law for motorcyclist helmet use, there are several weaknesses and problems in the application of helmet use laws in these countries that result in strong limitations for motorcyclists and the usefulness of helmet use (11). For example, in Iran, only 21.5% of people were wearing helmets at the time of the accident. The most common reasons for not wearing helmets included heavy helmet weight (77%), feeling hot (4.71%), neck pain (4.69%), and feeling suffocated (7.67%) (12).

Demographic variables (such as being male, being less educated, being single, being a young driver, not having a driver's license, and having no previous accident with a helmet) (13), environmental variables (such as weather), hours of motorcycle use per day, duration of motorcycle travel, and type of work with motorcycles (14, 15) are associated with the use of helmets among motorcyclists. Although this law was enacted in Iran only a few years ago, its implementation has been taken seriously since 2002; now, those who violate this law will be fined or their motorcycles confiscated. The same time, public media such as radio and television emphasize and recommend the necessary knowledge and education about the safety features of helmets (16).

We aimed to review the effectiveness of health promotion interventions in the use of helmets and to identify the types of effective health promotion strategies.

Methods

Systematic review protocol

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Statement (17).

Search strategy and data sources

A systematic search was performed on the PubMed, Scopus, Cochrane, and Embase databases up to 1 Aug 2022 to find the studies evaluated the effectiveness of health promotion interventions for helmet use among target population. The following Medical Subject Heading (MeSH)

and non-MeSH keywords were used to search in PubMed: ((((“Helmet”(Mesh)) OR head protective devices(Title/Abstract)) OR personal protective equipment (Title/Abstract))) AND (((“Motorcycle”(Mesh)) OR motor vehicle (Title/Abstract)) OR moped(Title/Abstract))). Sort by: Best Match. To cover all relevant publications, manual searching was performed on reference lists of included papers and previous reviews. For searching in Scopus, Cochrane, and Embase database, we used keywords, title, and abstract by combining the study search keywords. Additionally, for Persian articles, the search was conducted in the “magIran” database.

Studies selections

This study included interventional studies (randomized controlled trials, pre-post-test studies, intervention and control group studies) published in Persian and English that assessed health promotion interventions to encourage the use of helmets among motorcyclists. The titles and abstracts of all articles were evaluated independently by two reviewers (SE and LJ). The full texts of the included studies were retrieved for reevaluation. Any disagreements were discussed and resolved by consensus.

Quality assessments

Quality assessment was conducted using Quality Assessment Tool for Pre and Post Intervention Designs (18). The tool has six items for assessing sampling method, design, control of confounders, data collection and outcome measurements, statistical analysis, and dropouts. Overall validity ratting was calculated by dividing total number of points obtained and total number of points (16). Scores lower than 0.6 was considered low, 0.61-0.79 medium, and 0.8-1 high.

Data extraction and analysis

Data extraction for the included studies were a) author, b) year of publication, c) country, d) study design, e) number of participants, f) mean age of participants, j) helmet use, h) intervention strategy, i) and final results of the studies (results reported in percentage after and before of the intervention). Metaprop random effect analyses of pre-test post-test studies was conducted. Therefore, a systematic review and meta-analysis was done to describe the effectiveness of health promoting interventions related to helmet use among motorcyclist. First, the descriptive characteristics of the included studies were presented. Then, the types of interventions and their effectiveness were reported for the eligible studies.

Statistical analysis

The percentage (%) of motorcyclist responses to helmet wearing was examined. Existence of heterogeneity was tested using Cochran’s Q-test at $P<0.05$ level of significance. The I^2 test was also used to calculate the percentage of heterogeneity (19). A metaprop random-effect model was used to estimate pooled effect sizes. To investigate the source of heterogeneity, predefined subgroup analyses were performed using the type of respondents (i.e., baseline value for wearing helmet and sample size). Publication bias was analyzed by funnel plot analysis and Egger’s regression asymmetry test (20). All of the analyses were performed using STATA version 14.0 (Stata Corporation, College Station, TX, USA), and *P*-values below 0.05 were considered significant.

Ethics approval and consent to participate

The study received ethical approval from the Ethics Committee of Tabriz University of Medical Sciences (NO: IR.TBZMED.REC. 1397. 771). All methods were performed in accordance with the ethical standards. Written informed consent was obtained from all participants.

Results

Overall, 12 eligible articles were included in the review. Of these, 2 were randomized controlled trials (RCT) (21, 22), 4 were studies with an intervention and a control groups (8, 23-25), one was quasi-experimental study (26), and five with pre and post-test design were included in the meta-analysis (27-31) (Fig. 1).

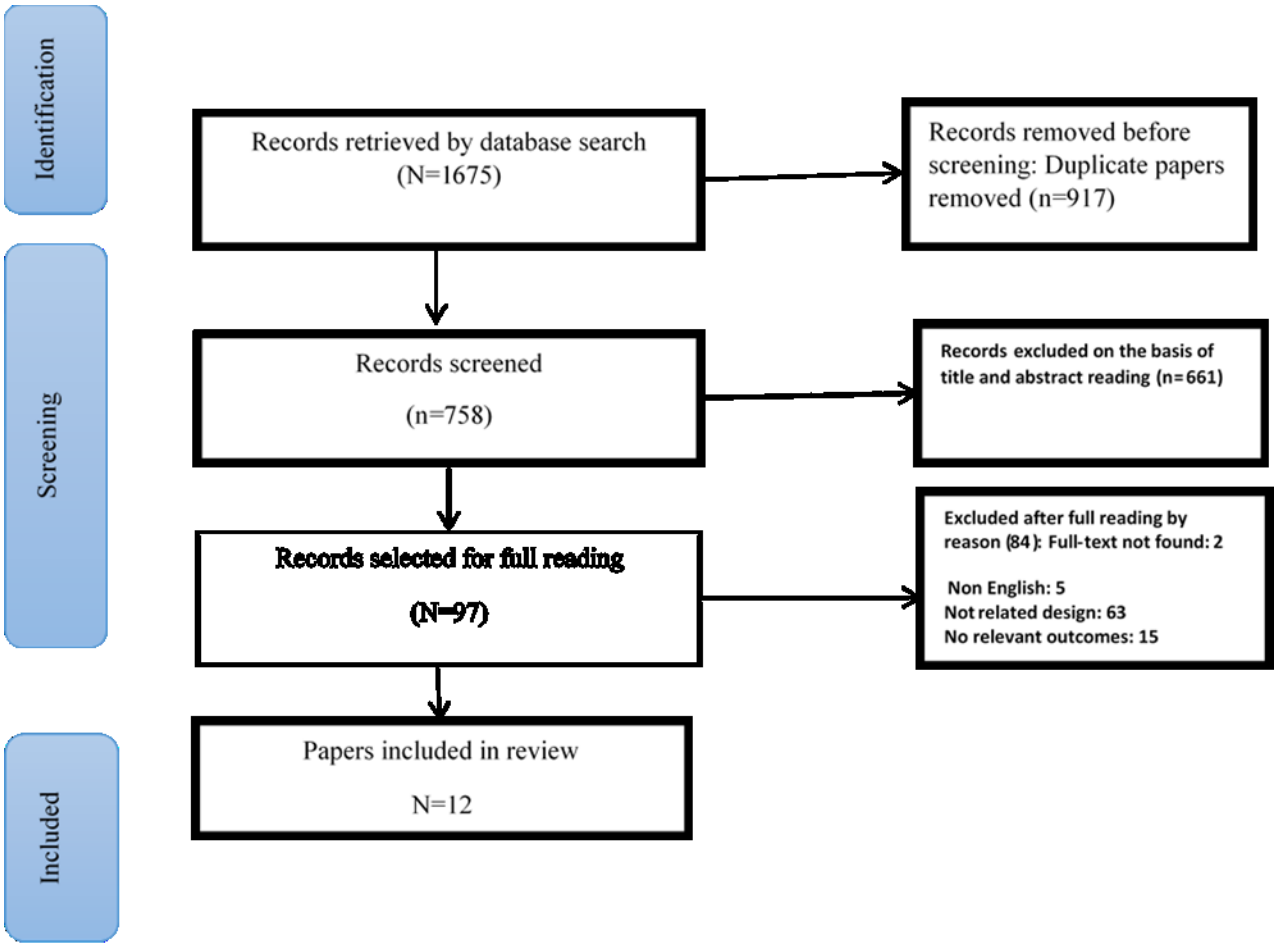

Fig. 1: Study selection process

Study's characteristics

The characteristics of the included studies are presented in Table 1. The studies were published between 1998 and 2022. The sample size of participants varied from 130 to 11146. The studies were conducted in USA (21, 25, 29), Iran (8, 23, 27), Pakistan (28), China (45), Africa (26), Greece (22), China (31), and Thailand (24, 30).

Meta-Analyses results related to helmet wearing

From 12 studies included in this review (21-32), two randomized controlled trials (RCT) (21, 22), four studies with the intervention and control groups (23-26), and one study with quasi-experimental design (26) were excluded of the meta-analysis, finally, five studies with pre and post-test design (27-31) were included to the meta-analysis. In this review, the dependent variable of the study is the percentage of participants who responded positively toward helmet use in the baseline and after the interventions. The percentages of wearing helmet were considered included in the meta-analysis.

Table 1: Summary of studies

	First author	*Year*	*Country*	*Study design*	*Sample size*	*Population*	*Age of participants*	*Intervention period*
1.	Babazadeh (27)	2019	Iran	Pre- post-test intervention	150	Motorcyclists	Not limited	2 months
2.	Bhatti (28)	2011	Pakistan	Pre- post-test intervention	341	Motorcyclists	Not limited	3 months
3.	Campbell (21)	2022	US	RCT	130 per arm	motorcycle taxi drivers	≥18 yr old	3 and 6 wk
4.	Dos Santos (26)	2022	Africa	quasi-experimental study	96, 60 per arm	Motorcycle taxi drivers.	≥18 yr old	6 months
5.	Foroutan (8)	2019	Iran	Intervention and control group	396	Student	<17 yr	15 months
6.	Germeni (22)	2010	Greece	Cluster RCT	438	student	16 yr	1 month
7.	Moghisi (23)	2014	Iran	Intervention and control group	11146, 11652	motorcyclists	18-29	24 months
8.	Ning (31)	2022	China	Pre- post-test intervention	5256	bike riders and motorcyclists	All ages	24 months
9.	Novak (30)	2013	US	Pre- post-test intervention	260	High school student	~13	12 wk
10.	Ratanavarah (29)	2013	Thailand	Pre- post-test intervention	5878	General population	All ages	Not found
11.	Swaddiwudh (24)	1998	Thailand	Intervention and control group	1141	Rural motorcyclists	Not reported	24 months
12.	Williams (25)	2011	US	Intervention and control group	1641 , 708	Students	Not reported	4 months

Fig. 2 provides a forest plot of the five studies, including the percentages of participants wearing seat belts before and after interventions as well as the 95% confidence intervals (CIs). The overall random-effects pooled estimation of persons wearing helmets before and after interventions was 70% (95% CI 21 –119; $P<0.001$), without a heterogeneity (I^2 = 0 %; $P=0.94$), which means that the average percentage of changing to helmet use is 70%.

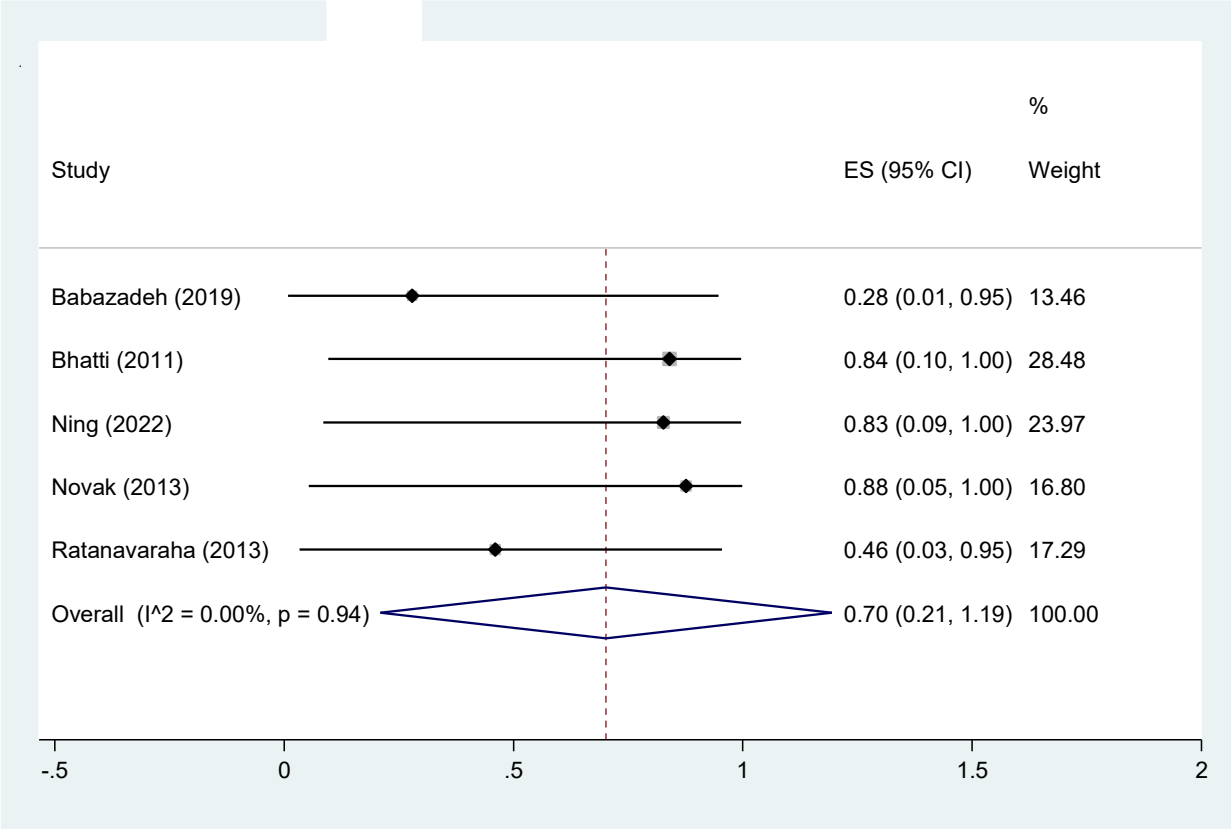

Fig. 2: Forest plot of helmet use interventions effects

Synthesized findings interventions

Community-based education program (24, 25, 27) was the most commonly applied for interventional studies. The next most commonly used approaches were campaign designing (23, 28, 31). community participation (30), health belief model (23), advocacy and helmet law enforcement (8, 24), the theory of planned behavior (26) , and SMS text messaging program were additional approaches applied for promoting helmet wearing among studies (Table 2).

Table 2: Summary of key findings and health promotion strategies in interventions

First author	*Measurements*	*Findings*	*Type of intervention*	*Quality assessment*
Babazadeh (27)	Awareness, attitudes, helmet use	Awareness on helmet use was increased by 28%, positive attitudes towards helmet use increased by 32.6%, helmet use increased by 32.0	Community education for helmet use, tightening of driving laws for offending motorcyclists	Low
Bhatti (28)	Helmet use	(+9.8%; 95%CI=2.6-16.8) increase in helmet use	Wearing helmet use campaign	Low
Campbell (21)	Helmet use	There was little difference between fear appeal and control group recipients (odds ratio 1.03, P=.47)	SMS text messaging program on helmet use	---
Dos Santos (26)	Knowledge, attitudes and practices regarding helmet use	Total score increased by 0.2 (0.06–0.3)	A package of awareness-raising activities, based on the theory of planned Behaviour, have been implemented in the intervention area	-----
Foroutan (8)	Helmet use	Helmet use increased from 3.4 % to 33%	Advocacy and law enforcement	----
Germeni (22)	Knowledge, attitudes and practices on helmet use	Significant improvement in knowledge about helmet use. Its impact on attitudes and practices appeared to vary across different school types.	The concepts of the Health Belief Model related	----
Moghisi (23)	Helmet use	No changes were observed in helmet wearing in both intervention and control groups.	Mandatory helmet law reinforcement, campaigning for motorcyclists' safety, improvement of the rescue services	---
Ning (31)	Helmet wearing	Increasing in helmet wearing from 8.8% to 62.0%	Campaign for helmet-wearing behaviour	High
Novak (29)	Safety knowledge, helmet use	Increasing in safety knowledge questions (45.2% vs 56.2%, P < .001) and helmet use (25.4% to 29.0%, P = .56	No significant change in helmet use (25.4% to 29.0%, P = .56)	Medium
Ratanavarah (30)	Helmet use	An increase of 13.23% in the rates of helmet usage	Community participation for helmet use	Medium
Swaddiwudh (24)	Mortality and helmet use	Wearing helmet was significantly greater in the intervention sample (46.0%) than in the control sample (20.5%).	Community-based education programme	---
Williams (25)	Knowledge and helmet use	Knowledge of appropriate helmet usage increased from 95% to 98.8%	Community-Based Hunter Education Program	----

Publication bias and quality assessment

Publication bias was highlighted and graphically confirmed by the funnel plots. The funnel plots in Fig.3 show no publication bias among the studies, distributed symmetrically about the mean. Large studies are shown at the top of the graph, and smaller studies are shown at the bottom.

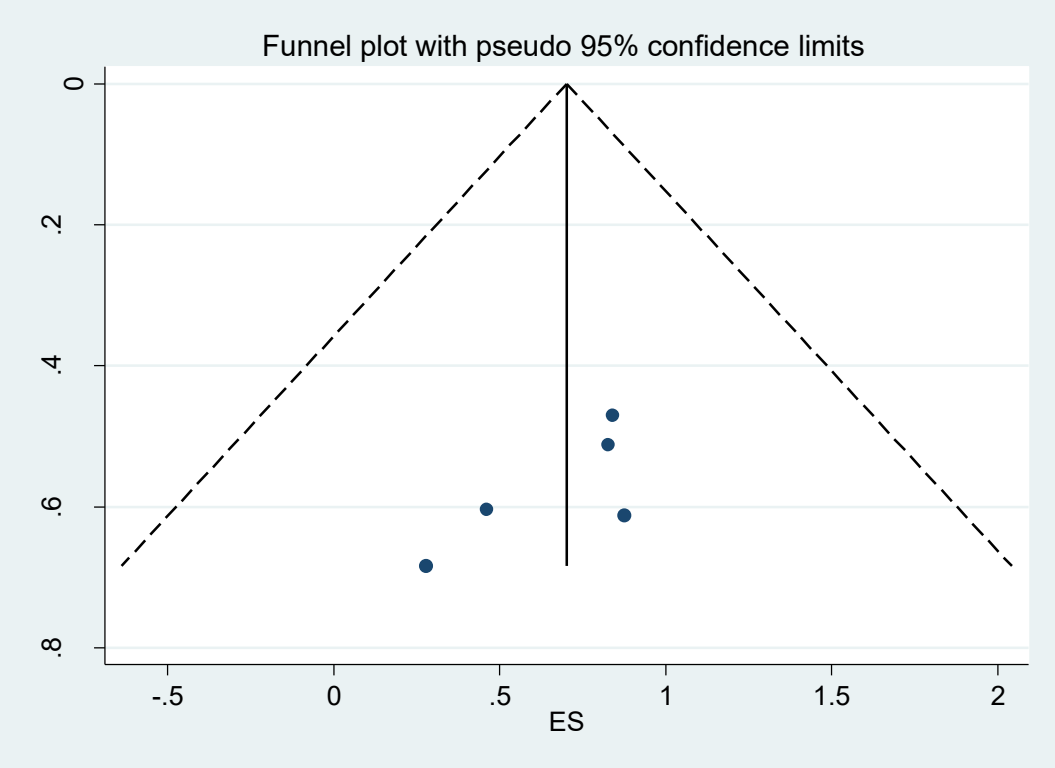

Fig. 3: Funnel plot of publication bias

Discussion

This systematic review and met-analyses aimed to assess the effects of interventional studies to helmet use between studies published in 1998 and studies until 1 Aug 2022. The results of the systematic review and meta-analyses indicated that wearing helmet approximately increased 70% among participant. This increasing appears to be due to the impact of health promoting interventions applied in the reviewed studies including community-based education, campaigns, helmet law enforcement participation, etc. Community-based education is education that focuses on the needs of the community and develops a tailor-made program relevant to the needs of the community. Community-based education consists of learning activities in the community as a learning environment. Community-based education programs can be implemented where people live and wherever it can be organized (32).

Promoting helmet wearing reduces the consequences for motorcyclists in road traffic accidents. This study reviewed studies that suggested health-promoting strategies to increase helmet use. Wearing helmets dramatically increased (from 4.5 to 22.6%) after implementing helmet use legislation (33). Establishing motorcycle rider safety strategies in many countries, such as driver licensing systems and motorcycle rider training, according to which motorcycle license applicants are required to undergo the necessary training for six months under the supervision of an instruc-

tor, has caused a 15% decrease in traffic accidents among motorcyclists (34). After the serious implementation of the helmet enforcement law in Iran in 2003, motorcyclist refused to comply with the law and did not wear helmets, the Tehran City Council carried out a media campaign to raise awareness about the helmet law, resulting in increased helmet use (35).

One of the most important practical approaches for reducing motorcycle accident injuries is related to helmet legislation. The cost-effectiveness of public campaigns for helmet use in several countries has been examined (36, 37).

In Iran, the highest avoidable load in cities is the risk factors of not wearing a helmet by motorcycle passengers' occupants, speeding, and not wearing a seat belt, respectively (27, 38). In suburban areas, men used not to wear helmets in motorcycle, speeding up, and were drowsiness. Women passengers in motorcycle used to not wearing helmets, and did not use seat belts. Because of the high prevalence of not wearing helmets among motorcycle passengers despite having a lower odds ratio than other risk factors, this factor carried the highest risk of death (39). In a study in Spain that was conducted on the protective effect of helmet use among motorcyclists, adjusted odds ratios for covariates were 2.54 for head injuries and 1.35 for death, respectively, in the "not wearing helmet" condition (40).

In Italy, helmet wearing rates increased up to 95% in some areas. The largest increase in helmet wearing occurred in areas where law enforcement was enforced in conjunction with public media campaign (36). The use of helmets by motorcyclists should be fully covered by all those present on the roads and streets. In the countries with no helmet law s should reconsider helmet use adopting policies to control severe head injuries in motorcycle crashes.

Limitations

A limitation of this study was that we were not able to separate the effects randomized controlled trials of helmets use from any researches. However, in this study the effectiveness of pre-post-test interventions were pooled according to the studies characteristics.

Conclusion

Wearing helmet approximately increased 70% among participant. This increasing appears to be due to the impact of health promoting interventions applied in the reviewed studies including community-based education, campaigns, helmet law enforcement participation, etc. Health promotion strategies may target helmet-wearing behavior to reduce head injuries in motorcyclist road traffic accidents. Additional RCT studies should be conducted to investigate further the effectiveness of Health promotion strategies for helmet wearing among countries with high prevalence of motorcyclist accident and no appropriate legislation.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Availability of data and material

The data collection tools and datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Conflict of interest

The authors declare that there is no conflict of interests.

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