

Review

# Human Factors Analysis and Traffic Accident Prevention Program for Motorcycle Drivers: A Systematic Review

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## ABSTRACT

**Background:** The human factor is the main factor in determining the success of traffic safety. The existence of human factors needs to be analyzed in more depth to create a more appropriate accident prevention program. This systematic review aims to investigate human factors, namely motorcycle drivers, causing traffic accidents and determine more effective accident prevention programs. **Methods:** The method used was a systematic review on electronic data sources such as ScienceDirect, ProQuest, PubMed, and Google Scholar using the keywords “human factor, traffic accident prevention program, and two-wheeled motorcycle driver”. Using the inclusion and exclusion criteria in the final stage, nineteen articles were found. **Results:** Human factors are the primary cause of traffic accidents involving motorcyclists, with two main aspects standing out most prominently. First, the high rate of traffic violations, such as speeding, running red lights, failing to maintain a safe distance, and aggressive driving behavior. Second, low compliance with the use of safety equipment, such as not wearing a standard helmet, protective jacket, gloves, or other safety gear. Ongoing specialized education and training programs are the most effective strategy. **Conclusion:** Human factors are the leading cause of traffic accidents, particularly among motorcyclists. The most effective preventive measure is through ongoing education and training programs.

**Keywords:** Human factors; motorcycle drivers; traffic accident prevention

## 1. INTRODUCTION

Traffic safety is an obligation that must be achieved to realize better transport. This condition is certainly a goal in all countries in the world. However, the problem of traffic accidents still requires special attention for countries in the world.<sup>(1)</sup> Every year, 1.35 million people die from traffic accidents worldwide.<sup>(2)</sup> It can be interpreted that every 24 seconds there is one person who loses their life on the roads around the world. For children and adolescents aged 5-29 years, traffic accidents are a major killer factor. More than 50% of traffic deaths, especially in low- and middle-income countries, occur among motorcyclists, cyclists, and pedestrians.<sup>(3)</sup> Compared to other vehicle drivers, motorcycle drivers have the highest risk of traffic accidents.<sup>(4)</sup> This is because motorcycles are highly flexible in driving, easily increase speed suddenly, and have wider road access.

Globally, the use of motorcycles continues to increase from year to year. Based on observations around the world from 2022 to the projected year 2027, motorcycle use is increasing by 4.1% every year. This amounts to nearly 1.5 billion

units. The region in the world that contributes more than 75% of the profits from the motorcycle market is Asia/Pacific.<sup>(5)</sup> The rapid growth of motorcycle use must be balanced with safety awareness for its users.

The Haddon matrix explains that safety in driving can be realized through the interaction between driver, vehicle, and environment.<sup>(6)</sup> The driver is a major factor in causing traffic accidents.<sup>(7)</sup> This includes health and physical fitness, analytical skills on the road, reaction speed in avoiding hazards, and awareness and compliance with traffic rules.<sup>(8)</sup>

Compared to vehicle and environmental factors, human factors are unique.<sup>(9)</sup> The form of human existence can be seen from an action or behavior that is carried out. Existing actions will be influenced by many things. Whether it is contained within the driver or comes from outside himself. The activity of directing human actions, especially on safe driving behavior, will require a special strategy. This is different from road and environmental factors which are inanimate. If the government or private sector is responsible for safety and plans to improve and enhance road and vehicle conditions, then it is likely to be well implemented. Accidents caused by unsafe acts (of the drivers) or conditions (of the vehicle and environmental factors) are related to operational risk, which involve drivers and their daily driving operational activities.<sup>(10)</sup>

Based on this background, this systematic review discusses human factors in causing traffic accidents in motorcycle drivers and good accident prevention efforts in support of improving traffic safety. The benefits of this study include raising awareness among motorcyclists to improve road safety. Additionally, it can provide the government with input for planning sustainable safety programs

## 2. METHODS

### 2.1 Research Questions and Literature Source

The systematic review was conducted to explore the human factor or driver as the main factor causing traffic accidents, especially on motorcycles, and explore existing traffic accident prevention programs. This literature search was conducted from October to November 2024. The researcher searched for data sources in electronic scientific databases. The sources were ScienceDirect, ProQuest, PubMed, and Google Scholar. Through these sources, the researcher entered keywords by the title and objectives of the study. The keywords were “human factor, traffic accident prevention program, and two-wheeled motorcycle driver”.

Researchers limited the published articles to research articles or original articles published during 2014 - 2024. In addition, the inclusion criteria applied were articles that discussed human factors as causes of accidents and accident prevention programs recommended or implemented to improve traffic safety for motorcycle drivers. The text of the article is available in full and in English.

### 2.2 Inclusion and Exclusion Criteria

The systematic review conducted in this study was to answer the research question ‘What are the human factors causing traffic accidents and how are programs implemented to prevent traffic accidents in motorcycle drivers?’. The research search results that will be included in the analysis of this research must be based on predetermined criteria. This study used the PICOS criteria for the inclusion and exclusion of studies approach as shown in Table 1.

**Table 1.** PICOS criteria for inclusion and exclusion of studies

Parameter	Inclusion criteria	Exclusion criteria
Population	Motorcycle driver or two-wheeled motorcycle	Not Two-wheeled motorcycle
Intervention	Human factor and traffic accident prevention program	Vehicle and environmental factors
Comparisons	What are the human factors and traffic accident prevention programs that help realize traffic safety?	
Outcomes	Traffic safety	
Study design	Observational studies: research article or original article	Observational studies: comments, short communication, editorial letters and non-English and Bahasa articles.

## 2.2 Data extraction and Data Synthesis

The search for articles in electronic databases was conducted independently by the researcher and selection of relevant literature using the preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagrams.<sup>(11)</sup> This was done by entering the keywords 'human factors', 'Traffic Accident Prevention Programme', and 'two-wheeled motorcycle driver'. At the initial stage sourced from ScienceDirect, ProQuest, PubMed, and Google Scholar 6,283 articles were found. Next, the researchers conducted screening. There were duplicate articles from some of these sources. 6,167

articles were not duplicated. From these results, 3,729 articles were found that have been published in 2014 - 2024.

The researcher then read the title and abstract. It has been selected by the research objectives and obtained 102 suitable articles. In the next stage, the researcher reviewed in depth based on the suitability of keywords. 57 articles were selected that discussed human factors, traffic accident prevention programs, and two-wheeled motorcycle drivers, and 38 articles were not relevant. The 57 articles were then selected based on inclusion and exclusion criteria. There were 19 articles analyzed in this systematic review.

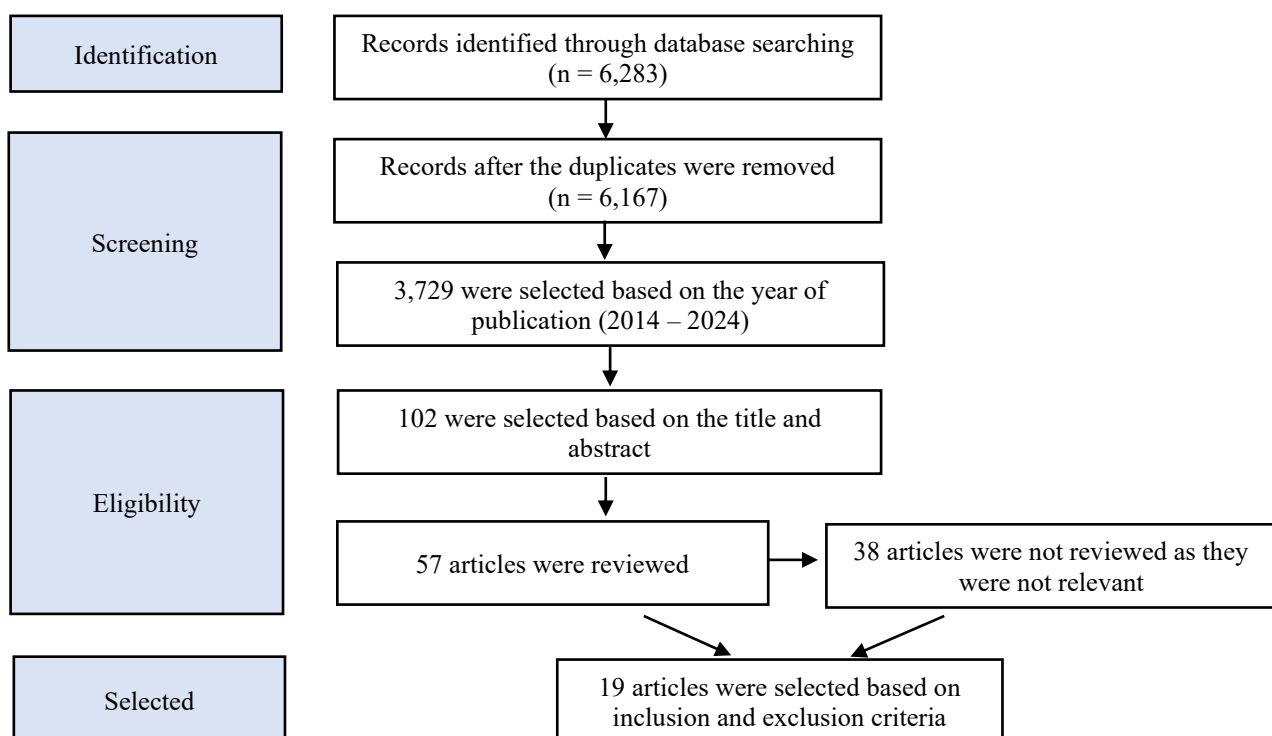


Figure 1. PRISMA flowchart showing the studies that were included and excluded at each screening stage

## 3. RESULTS

The findings of this study are divided into two subcategories. The first category consists of previous studies that examine the relationship between human factors and motorcycle accidents. The second category consists of studies related to effective traffic accident prevention measures for motorcycle riders

### 3.1 Research results on human factors in causing traffic accidents on motorcycles

A total of nineteen articles were analyzed and presented in the research results. Of the nineteen articles, thirteen articles discussed human factors in traffic

accidents among motorcycle drivers. Six articles discussed traffic accident prevention programs for motorcycle drivers. Based on Table 2, it can be explained that most traffic accidents among motorcycle drivers are caused by violations committed by the drivers. These violations are mostly violations of traffic regulations,<sup>(12-14)</sup> and the use of safety gear while driving.<sup>(15-17)</sup> The traffic rule that is most often ignored and causes accidents is compliance with traffic speed.<sup>(16,18,19)</sup> In addition to the violations committed, the human factors that need to be considered are related to the possession of a driver's license and the skills to operate a motorcycle (vehicle maneuvers).<sup>(20-22)</sup> Through a driver's license, the driver will get information and skills through practice tests.

**Table 2.** Summary of research results on human factors in causing traffic accidents on motorcycles

No.	Author (year)	Title	Characteristics			Results
			Methods	Analysis	Instrument	
1	Charef et al. (2024) <sup>(15)</sup>	“Assessing the driving behavior of motorcyclists to improve road safety”	Quantitative research	Computer vision algorithms	Camera phones for gathering data	Traffic offenses that are often committed and increase the risk of accidents are: helmet offenses, running red lights, zigzag, and driving the wrong way
2	Lee et al. (2023) <sup>(16)</sup>	“Calculation of Dangerous Driving Index for Two-Wheeled Vehicles Using the Analytic Hierarchy Process”	Quantitative research	Analytic Hierarchy Process	Realistic driving simulator, questionnaire	The highest indices of dangerous driving behaviors at risk of crashes were helmet violation (0.158), speed violation (0.124), and driving near pedestrians (0.122)
3	Cordellieri et al. (2019) <sup>(12)</sup>	“Driving attitudes, behaviors, risk perception, and risk concern among young student car drivers, motorcyclists, and pedestrians in various EU countries”	Quantitative research	Statistical analyses	Questionnaire	Motorbike riders are more prone to traffic violations than car drivers. Motorcyclists are less concerned about personal safety
4	Wang (2022) <sup>(20)</sup>	“Investigating the Difference in Factors Contributing to the Likelihood of Motorcyclist Fatalities in Single Motorcycle and Multiple Vehicle Crashes”	Quantitative research	The binary logit model and mixed logit model	Secondary data from the National Police Administration (NPA) traffic crash database	Motorcyclists without a license, committing speed-related offenses, positive blood alcohol values, and maneuvering quickly are significant to the likelihood of fatalities in crashes
5	Ding et al. (2019) <sup>(18)</sup>	“Motorcyclist injury risk as a function of real-life crash speed and other contributing factors”	Quantitative research	Statistical analysis	Secondary data from the German In-Depth Accident Study (GIDAS) database	Frontal collisions between motorcycles and passenger cars result from traffic speed violations. Both vehicles travelling at 60 km/h (relative speed 120 km/h), have a 55% risk of serious injury to the motorcyclist <i>(continued on next page)</i>

Table 2. (continued)

No.	Author (year)	Title	Characteristics			Results
			Methods	Analysis	Instrument	
6	Hassanzadeh et al. (2020) <sup>(17)</sup>	"Motorcyclist risky riding behaviors and its predictors in an Iranian population"	Cross-sectional	Statistical analysis	Questionnaire	Among the predictive factors that lead to high-risk behaviors in motorcyclists are violations of the use of safety equipment, violations of the driving license
7	Shaker et al. (2014) <sup>(13)</sup>	"Motorcycle Crashes: Attitudes of the Motorcyclists Regarding Riders' Experience and Safety Measures"	Cross-sectional	Statistical analysis	Questionnaire	The main factors underlying motorcycle accidents are violations of traffic rules, drivers not using complete and correct protection systems, drivers not recognizing the road they are on, and drivers experiencing driving stress
8	Romero et al. (2019) <sup>(30)</sup>	"Personality traits and risky behavior among motorcyclists: An exploratory study"	Cross-sectional	Statistical analysis	Questionnaire	The main causes of motorcycle accidents are careless behavior by other drivers (34.9%), violation of traffic regulations (18.5%), and careless behavior by the drivers themselves (20.6%), traffic rules (18.5%), and careless behavior by the driver himself (20.6%)
9	Sirait and Santoso (2024) <sup>(31)</sup>	"Counterflow riding behavior of motorcyclists: The role of moral obligation and variables in The Theory of Planned Behavior"	Quantitative research	Analysis of variables related to The Theory of Planned Behavior	Questionnaire	The moral obligation to obey traffic rules is strongly correlated with unsafe driving behavior. This suggests that drivers will behave unsafely (against the flow of traffic) when they ignore or violate traffic regulations
10	Sumit et al. (2021) <sup>(14)</sup>	"Risky motorcycle riding behavior among Young Riders in	Quantitative research	Multivariate binary logistic regression	The Motorcycle Rider Behaviour	5 behavioral factors at risk of accidents in motorcycle drivers are violations of traffic

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Table 2. (continued)

No.	Author (year)	Title	Characteristics			Results
			Methods	Analysis	Instrument	
		Manipal, India"		model	Questionnaire (MRBQ)	rules, violations of the use of traffic safety equipment, the inability of drivers to control emotions, aggressive and reckless behavior on the road
11	Sumit et al. (2022) <sup>(19)</sup>	"A Focus Group Study to Explore Risky Ridership among Young Motorcyclists in Manipal, India"	Qualitative research (Semi-Structured Focus Group Discussion)	Thematic analysis	Interviewing techniques	The main causes of accidents in the 18-25 age group are increasing the speed of driving recklessly, violating traffic rules, not wearing a helmet, and driving under the influence of alcohol
12	Anggraini et al. (2024) <sup>(21)</sup>	"Risk Factors Associated with Stress-related Riding Behavior among Indonesian Motorcyclists"	Quantitative research	Multivariate analytical method	Questionnaire	3 factors underlying the occurrence of stress in motorcycle drivers resulting in accidents are: the inability to master driving techniques, aggressive behavior in vehicle maneuvers, and anger while driving
13	Huertas-Leyva et al. (2021) <sup>(22)</sup>	"Human error in motorcycle crashes: A methodology based on in-depth data to identify the skills needed and support training interventions for safe riding"	Quantitative research	Statistical analyses	Secondary data	Motorcycle maneuvering skills have a significant influence on the occurrence of accidents

### 3.2 Research Results on Traffic Accident Prevention Programs Involving Human Drivers

Table 3 shows that an effective traffic accident prevention program in improving the safety of motorcycle drivers on the road is through cross-sector driving education and training activities with an emphasis on fun activities, according to the driver's condition and carried out on an ongoing basis.<sup>(23-25)</sup> Doing so can lead to changes in theoretical and practical skills

that can improve driving safety. In addition, for prevention to be effective, there needs to be strict punishment for any existing offenses.<sup>(26)</sup>

## 4. DISCUSSION

The human factors analysis and classification system explains that unsafe actions are divided into two types, namely errors and violations.<sup>(27)</sup> Unsafe actions in this systematic review are in the form of unsafe

**Table 3.** Summary of research results on traffic accident prevention programs involving human drivers

No.	Author (year)	Title	Characteristics			Results
			Methods	Analysis	Instrument	
1	Chou et al. (2022) <sup>(23)</sup>	“Effectiveness evaluation on cross-sector collaborative education programs for traffic safety toward sustainable motorcycle culture in Vietnam”	Quantitative research	Structural Equation Modeling (SEM)	Questionnaire survey	Cross-sector safety education program activities (motorcycle manufacturers) have a positive impact on Motorcyclists' confidence, Awareness of safety, excitement, and comfort when riding, Perspective-taking ability, Increased altruistic motivation
2	Dewi et al. (2022) <sup>(24)</sup>	“Test of mindful motorcycling as a psychological Intervention to increase awareness of riding”	Mixed methods research (qualitative and quantitative)	Thematic analysis (qualitative), analyzed with visual analysis (quantitative)	Mindful motorcycling manuscripts (qualitative), MAAS (Mindful Attention Awareness Scale) (quantitative)	This program is based on the means that mindfulness means paying attention in a particular way: on purpose, in the present moment, and non-judgmentally. Mindful motorcycling intervention can increase motorcyclists' safety awareness in the university environment
3	Borawski and Borawska (2021) <sup>(25)</sup>	“The use of a computer game in a social campaign to improve road safety”	Experimental research	Specialized computer software	Neurophysiological signals	Social campaigns through driving safety computer games are effective in increasing theoretical and practical knowledge in improving road safety
4	Yu and Tsai (2021) <sup>(32)</sup>	“The effects of Road Safety Education (RSC) on the occurrence of motorcycle violations and accidents for novice riders: An analysis of population-based data”	Quantitative research	Statistical Analysis	Secondary data from the Taiwan Ministry of Transportation and Communication (MOTC)	RSC has a short-term effect of reducing the likelihood of traffic violations by 12%~to 17% and their frequency by 11%. RSC could be more effective if there were certification tests for road safety education or if there were penalties for negligent participants during the training

(continued on next page)

Table 3. (continued)

No.	Author (year)	Title	Characteristics			Results
			Methods	Analysis	Instrument	
5	Dos Santos et al. (2022) <sup>(32)</sup>	"Implementation of a model of awareness-raising for taxi motorcyclists in Benin about helmet use: a quasi-experimental study"	Quasi-experimental study	Chi-square or Fisher, Student's, or Kruskal-Wallis tests	Questionnaire	There was an improvement in the total score in both groups compared to the baseline. The total score increased by 0.2 (0.06–0.3) in the experimental group when the number of sessions attended increased by one ( $p = 0.005$ )
6	Muni et al. (2020) <sup>(34)</sup>	"Motorcycle taxi program increases safe riding behaviors among its drivers in Kampala, Uganda"	Cross-sectional studies	Statistical analyses	Questionnaire	SafeBoda (motorcycle taxi) drivers compared to regular drivers were 21% points higher in applying safe driving behaviors (95% CI 0.15 to 0.27; $p < 0.001$ ) based on CAPI and 45% points higher (95% CI 0.43 to 0.47; $p < 0.001$ ) based on roadside observations

motorcycle driver behavior that causes traffic accidents. Based on the results of the study, it shows that most drivers perform unsafe actions in the form of traffic violations. The fundamental difference between offenses and errors is the intentional factor. A violation is a deliberate action or decision by the driver. At the same time, an error is an unintentional action or decision. This means that this systematic review shows that motorcycle drivers deliberately commit traffic violations by driving fast, driving zigzags, running red lights, and driving without safety gear.

Errors can occur when drivers lack understanding of the theory and practice of driving. This can be seen in the results of the systematic review that has been conducted. A small proportion of motorbike drivers make mistakes. The mistakes made are skill-based errors in driving maneuvers. The result of these actions can be traffic accidents on the road.

The main factor that needs to be considered in providing solutions to improve the safety of motorcycle drivers on the road is the reduction in the number of traffic violations. An action that is done intentionally is

easier to change than an action that is done unintentionally. This condition provides a greater opportunity to improve motorcycle driver safety efforts.

Reducing the number of traffic violations can be done through traffic accident prevention programs on motorcycles through education and training programs. According to the literature findings in Table 2, this program should be designed with cross-sectoral involvement and packaged in a fun way that gives full attention to the driver's condition. This can be done through an age-appropriate approach. Driving education and training programs for two-wheeled drivers can be tailored to the age group of the driver. Teenagers and adults are different.

The theory of behavior change explains that behavior change can be carried out with three variable approaches, namely predisposing, enabling, and reinforcing factors.<sup>(28)</sup> Education and training programs are predisposing factors while the reinforcing factor found in this study is the enforcement of penalties for offending drivers. Safety training is the exercise normally conducted for the people to identify and recognize the

hazards as well as determine the appropriate controlling methods.<sup>(11)</sup> Previous studies explained the training using simulation technology can be divided into three main goals : behavioral test, in-situ training or training inside Virtual Reality (VR), and in-situ behavior improvement within VR.<sup>(29)</sup> Enabling factors are motorbike facilities and road conditions, which are not variables in this systematic review. Through the findings of two factors in the behavior change theory, this article will provide benefits for the development of science and the improvement of traffic safety, especially for motorcycle drivers.

## 5. CONCLUSION

There are two hypotheses in this study. The first is whether human factors are the primary cause of traffic accidents. The second is what constitutes an effective accident prevention program. The conclusion addressing these hypotheses, based on the summary of the systematic review, is that human factors are the primary cause and account for more than 50% of traffic accidents, particularly among motorcycle riders. Meanwhile, the most effective prevention program is providing education and training on proper and safe driving techniques. Through these efforts, drivers will gain a thorough theoretical and technical understanding of safe driving. Recommendations for future research include expanding the analysis to include other contributing factors in traffic accidents.

### Ethical Approval

Not required.

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### Competing Interests

All the authors declare that there are no conflicts of interest.

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### Underlying Data

Derived data supporting the findings of this study are available from the corresponding author on request.

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