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Analyzing Traffic and Safety Violations Behavior of Motorcyclists in Thailand

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ABSTRACT

This study aims to identify the key factors influencing road accidents in Thailand, with a specific focus on unsafe motorcycle riding behaviors. Data were collected through an online survey targeting 496 motorcycle riders. The survey explored the impact of demographic factors such as marital status, income, age, and riding experience on riding behavior and accident risk. Key unsafe behaviors identified include eating while riding and transporting passengers, which compromise rider control. ANOVA analysis revealed that marital status is significantly related to traffic violations and injury severity, while higher income levels correlate with safer riding practices. Factor analysis classified risky behaviors into two groups: Traffic Violations (TV) and Safety Violations (SV), both of which are significantly associated with injury severity in accidents. Structural Equation Modeling (SEM) confirmed a clear relationship between these factors and accident outcomes. The findings highlight the importance of addressing risky behaviors, particularly helmetless riding and passenger transportation, in reducing accidents and injuries. The study provides insights for developing road safety strategies in Thailand, although it acknowledges limitations such as potential duplicate responses and the impact of social media platforms on data collection.

1. INTRODUCTION

Road accidents have become a major public health issue globally, resulting in a high number of deaths and injuries annually. According to the World Health Organization’s 2018 Global Status Report on Road Safety, approximately 1.35 million people lose their lives each year due to road accidents worldwide. This imposes a significant economic burden due to the costs associated with treating the injured and disabled. In response, the United Nations has set an ambitious target to reduce road accident injuries and fatalities by 50% by 2030, as part of the Global Plan for the Decade of Action for Road Safety 2021-2030. Reaching this goal will require sustained and collaborative efforts from all nations [1]. Thus, it is becoming increasingly important for each country to evaluate the performance of various regions to ensure a thorough and fair approach to enhancing road safety. National assessments can help identify specific solutions tailored to each area appropriately. Road accident forecasting aims to evaluate the frequency or risk of future road accidents, which is crucial for developing policies and strategies to prevent accidents. Forecasting data can assist government agencies and organizations in understanding trends and risk factors that may lead to accidents more clearly [2]. Developing the capability to accurately forecast road accidents not only supports the government’s decision-making in advance but also increases public confidence in safety measures and enables efficient resource allocation, such as improving road infrastructure and developing stricter traffic laws. Additionally, it encourages active participation from all regions in reducing road traffic fatalities and severe injuries.

Thailand faces challenges in aligning with this goal. Despite efforts to improve road safety, Thailand remains among the highest in the world for road traffic fatalities, particularly for motorcyclists, a popular mode of transport in the country. According to the Department of Land Transport (DLT), in 2022, more than 22 million motorcycles were registered, making up around 51% of the total registered vehicles in the country. The population-to-motorcycle ratio is 3 to 1, making Thailand have the highest ratio in the ASEAN region, second only to Malaysia and Vietnam [3]. When considering the fatality rate of motorcycle riders specifically, Thailand ranks first in the world [4]. As a result, motorcycle riders remain the most at-risk group. Combined with economic losses exceeding 100 billion baht in 2022, this underscores the urgent need for targeted actions to address both behavioral and infrastructure issues specific to Thailand. Road safety issues persist, including unsafe behaviors and the public’s disregard for regulations, which are further exacerbated by insufficient awareness about the importance of road safety measures [5]. Traffic law violations, including speeding, driving under the influence, and failure to wear seat belts, continue to be major contributors to fatalities and injuries in road accidents. Despite significant resources allocated to prevent these behaviors (e.g., law enforcement measures and educational/media campaigns), traffic law violations remain widespread, and road accidents remain a significant problem in Thailand [6].

Improving road safety standards requires cooperation from all sectors, including government, private, and civil society. The Deputy Prime Minister signed the Road Safety Master Plan 2022-2027, providing a framework for reducing accidents by focusing on mitigating risk factors related to driver behavior, vehicles, and the environment. To achieve concrete results in accident prevention, two main strategies have been outlined: 1) reducing risky behavior among motorcyclists and youth, and 2) minimizing accident risks from driving behavior and improper use of safety equipment [7]. The first strategy aims to reduce fatalities and serious injuries among road users. Another risk factor is the psychological characteristics of drivers, which are difficult to measure directly. Psychological characteristics, including impulsiveness, anxiety, and a propensity for risk-taking, play a crucial role in elevating driving risks, leading to violations, mistakes, and accidents on the road [8]. Psychological elements, including attitudes towards safety and the perception of risk, have been recognized as critical factors influencing the safety of motorcycle riders [9].

However, the widespread use of motorcycles in Thailand, coupled with hazardous riding practices and insufficient road infrastructure in developing nations, this creates substantial risks not only for motorcyclists but also for other road users [10]. Conducting surveys on motorcycle accidents is one of the most common approaches to identifying risk factors [11]. Similar to the study [12], motorcycle riders of powered two-wheelers are among the most vulnerable road users due to the lack of protection from impact or collisions, especially when not wearing helmets, which can lead to severe injuries. Motorcycle accidents not only impact the health of the riders but also have repercussions for families and communities who bear the burden of caring for the injured or disabled. Injuries from motorcycle accidents also lead to high medical costs and affect absenteeism from work, resulting in income loss for the injured, as well as the social burden of the reduced work capacity for those affected by the accidents [13].

Additionally, studies on motorcycle accident characteristics in Thailand and factors affecting accident severity suggest that relevant authorities should consider improving the safe riding skills of motorcyclists to reduce fatalities from motorcycle accidents [14]. All riders should adopt essential safety practices, including defensive riding techniques, awareness of alcohol-related hazards, correct helmet usage, and effective collision avoidance strategies. Proper training programs are crucial to equip riders with the necessary skills and knowledge for safely operating motorcycles in traffic [15]. The enforcement of laws related to the five key risk factors in observable areas, such as speed laws, drunk driving laws, helmet laws for motorcycles, seatbelt laws, and child restraint laws, is also necessary [16]. Moreover, traffic safety strategies and collision avoidance skills are crucial [3]. These research findings highlight that traffic laws alone are insufficient for safe motorcycle riding, and motorcycle riding behavior should be assessed holistically. Therefore, there is an urgent need to develop policies and take action to reduce road accidents in Thailand.

According to Vuong et al. [8], Exploratory Factor Analysis (EFA) serves as an initial method for identifying underlying factors or dimensions in data, which helps explain observed behaviors. In the context of studying risky behaviors, EFA aids in identifying relationships among variables and uncovering factors that may influence behaviors, such as traffic violations or accident risks. Once these factors are identified, Confirmatory Factor Analysis (CFA) is employed to validate the proposed structure by testing the relationships between observed indicators and latent variables. As noted by Erdem and Erol [17], this analysis confirms the results of the exploratory phase and evaluates the model's fit to the data. Additionally, statistical tools such as the Kaiser-Meyer-Olkin (KMO) index and Bartlett's test are utilized to assess data suitability for analysis, along with Cronbach's alpha coefficient and other validity measures to ensure reliability.

SEM is then applied to examine the structural relationships among the identified factors. As described by Satiennam et al. [18], this approach is used to evaluate model fit and analyze causal relationships between variables. Typically, SEM begins with CFA to validate the measurement model, followed by analyzing the relationships between variables. For instance, Bui et al. [19] employed SEM to study how demographic characteristics influence accident risks and traffic violations, while Zhai and Xi [20] used dimension reduction techniques in EFA before confirming a two-factor model using CFA.

Analysis of Variance (ANOVA) is used to identify differences in unsafe riding behaviors, such as traffic violations, accident rates, and injury severity. The first step is to conduct the Omnibus F test to determine if there are significant differences between the groups. If the F test indicates that there are differences between the groups, the Tukey Honestly Significant Difference (Tukey HSD) test is performed to compare the differences between groups in detail. This helps identify which pairs of groups differ significantly. The Tukey HSD test can only be conducted if the results of Bartlett's Test confirm that the variances across groups are equal (homogeneity of variance), with a p-value greater than 0.05 [9].

This research aims to examine unsafe riding behaviors and the impacts of accidents in Thailand, particularly among motorcyclists. An analysis of risk factors is lacking and reliability testing of risk behavior models within the Thai context. This research develops new tools for analyzing riding behaviors by employing EFA to explore risk factors, CFA to validate the model structure, and SEM to examine causal relationships. Consequently, this study identifies high-risk behaviors that may lead to accidents, enabling stakeholders to better understand the issues and foster awareness and engagement among various agencies to develop legislation or educational campaigns aimed at reducing unsafe riding behaviors in the future.

2. METHODOLOGY

2.1 Sample size and participants

This study aims to examine unsafe motorcycle riding behaviors and traffic accident outcomes in Thailand using an online data collection tool validated in previous research [21]. Participants were strategically selected from the entire population of motorcycle riders in Thailand to ensure the sample adequately represents riding behaviors across different seasons. To determine the appropriate sample size for the large population, the Taro Yamane formula was utilized, offering a straightforward method for calculating sample sizes based on maximum variability ($p = 0.5$) and 95% confidence level, as shown in Eq. (1) [22]. The minimum required number of surveys was calculated to be 400. However, the study achieved

496 valid responses, exceeding the minimum threshold. This oversampling strategy improves the dataset's robustness and statistical power, enabling more detailed analyses. Despite this, oversampling may lead to limitations, such as potential selection bias, which could limit the generalizability of the findings. The survey instrument was divided into three key sections: demographic profiling, risk factor assessment (e.g., traffic violations, accidents, and injury severity), and 15 items evaluating unsafe riding behaviors.

$$n = \frac{N}{1 + Ne^2} \tag{1}$$

2.2 Data collection and survey instrument

This research design incorporates a multiplatform digital distribution strategy using Google Forms, disseminated via email, Facebook, Line, and X. The data collection period spans from December 2022 to February 2023. The questionnaire developed for this study introduces a new approach to assessing motorcycle riding behaviors in Thailand, differing from traditional self-report measures by focusing on riders' perceptions of unsafe riding behaviors to aid in analyzing factors influencing risk. The questionnaire consists of three sections that capture sociodemographic variables, risk factors, and unsafe riding behaviors, using 15 items specifically adapted to the Thai context. Notably, this study employs a 6-point satisfaction scale, ranging from (1 = Never) to (6 = Always), to measure the frequency of risky behaviors [22]. This innovative approach enhances the understanding of riding behaviors and provides valuable insights for assessing potential road hazards, which in turn supports the development of targeted road safety policies. By incorporating demographic information alongside a thorough behavioral analysis, this questionnaire functions as an all-encompassing instrument for investigating motorcycle riding practices that influence road safety concerns in Thailand, while also assessing the appropriateness of the proposed model based on the gathered data.

2.3. Data analysis

This study analyzed the demographic data of participants using percentages to understand the characteristics of the sample. IBM SPSS Statistics Version 26 was then employed to calculate the mean and standard deviation, as well as to evaluate the consistency of the results employing Cronbach's Alpha, where a value above 0.80 was deemed reliable [23]. Cronbach's Alpha was selected because it is suitable for assessing the consistency of the questionnaire utilized in the study. Additionally, chi-square analysis was conducted to examine the relationship between risk factors and demographic characteristics, while One-Way ANOVA was used to analyze the differences between the data, with a significance level of $P < 0.05$ used to test differences among groups [24]. These methods were selected to address the research question regarding demographic differences and their effects on risky behaviors.

For the Exploratory Factor Analysis (EFA), which explored descriptive statistics related to unsafe riding behaviors, the suitability of the sample was evaluated using the Kaiser-Meyer-Olkin (KMO) measure (> 0.6) and Bartlett's Test of Sphericity ($p < 0.05$) [25]. This process aimed to restructure and reduce the dimensions of the diverse questionnaire responses. EFA was deemed appropriate for identifying latent factor structures in the data, and only factors with a factor loading higher than 0.5 were considered, reflecting the importance of variables within each factor. Confirmatory Factor Analysis (CFA) was subsequently performed utilizing Amos Version 29, following the guidelines of the study [26], to test the model's structural fit and assess the accuracy of the measurements. Fit indices used to evaluate the model included Chi-Square ($p > 0.05$), Comparative Fit Index (CFI > 0.90), Normed Fit Index (NFI > 0.80), Tucker-Lewis Index (TLI > 0.90), Root Mean Square Error of Approximation (RMSEA < 0.08), Goodness of Fit Index (GFI > 0.90), Adjusted Goodness of Fit Index (AGFI > 0.80), and Standardized Root Mean Square Residual (SRMR < 0.08) [18, 19]. These indices were chosen to ensure the model's adequacy in fitting the data and provide clear statistical answers. Finally, Composite Reliability (CR) was calculated to measure the overall reliability of the model, while Average Variance Extracted (AVE) was used to assess how much variance in the construct was explained compared to variance caused by measurement errors [27]. These processes aligned with the research questions aimed at developing a model that effectively explained risky riding behaviors and associated factors. The research process is illustrated in Figure 1.

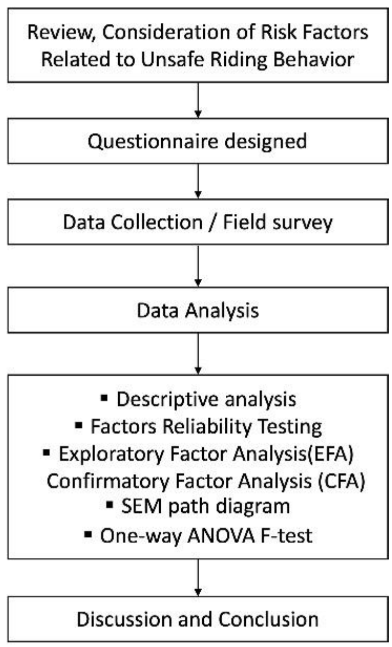

Figure 1. The research processes

3. RESULTS

3.1 Respondents' features

The study recruited 496 respondents, with a gender distribution skewed toward males (63.7%) compared to females (36.3%). Age demographics revealed that the majority of respondents were middle-aged, with 35.9% falling within the 45-54 years bracket, followed by 22.2% in the 35-44 years category. This age distribution suggests a sample predominantly composed of experienced road users. The educational profile indicates a highly educated sample, with 67.1% holding bachelor's degrees and 16.5% possessing postgraduate qualifications. Regarding socioeconomic characteristics, approximately two-thirds (65.3%) of participants were married. The monthly income distribution showed considerable variation, with the highest proportion (33.5%) earning more than 35,000 THB, while 16.1% earned less than 9,000 THB, reflecting diverse economic backgrounds. Occupationally, the sample represented a broad spectrum of the workforce, with general employees (24.8%), government employees (22.2%), and business owners (20.6%) forming the largest groups. Notably, 76% of participants held a rider's license, indicating formal qualification for motorcycle operation. This high percentage of licensed riders enhances the reliability of the data in understanding risk-riding behaviors in Thailand, as the majority of respondents have undergone formal training and licensing procedures [16, 27], as shown in Table 1. The content validity of the research tool was validated by ensuring that the study objectives were consistent with the items. The Cronbach's Alpha for the 15 items was 0.918, spanning a range of 0.909 to 0.925, demonstrating strong reliability, as shown in Table 2.

Table 1. Demographics of the respondents (n = 496)

Item	Description	Percent (%)
Gender	Female	36.3
	Male	63.7
Age group (years)	< 18	4.0
	18-24	1.2
	25-34	14.3
	35-44	22.2
	45-54	35.9
	55-64	12.7
	> 64	9.7
Education level	< Bachelor's	16.3
	Bachelor's	67.1
	> Bachelor's	16.5
Marital status	Married	65.3
	Nonmarried	34.7
Monthly income (THB)	< 9,000	16.1
	9,001-15,000	13.5
	15,001-25,000	21.8
	25,001-35,000	15.1
	> 35,000	33.5
Occupation	Student/College student	17.3
	Business owner	20.6
	Government employee	22.2
	General employee	24.8
	Freelancer	5.4
	Worker	7.3
	Farmer	2.4
Rider's license	Yes	76.0
	No	24.0

3.2 Descriptive statistics of risky riding behavior items

In this study, risk-riding behaviors were categorized into two main constructs: traffic violations (TV) and safety violations (SV), assessed using a 6-point scale. The results showed relatively low mean scores for TV (ranging from 1.25 to 1.55), indicating that participants engaged minimally in traffic violations. Among TV behaviors, the highest mean scores were found for using a cell phone while riding (M = 1.55) and running red lights (M = 1.53), while eating while riding had the lowest occurrence (M = 1.25), suggesting it is the least frequent violation. In contrast, the SV construct exhibited significantly higher mean scores, indicating that safety violations were more common. The most frequent safety violation was carrying passengers while riding (M = 2.56), followed by riding without a helmet (M = 2.13). These findings suggest that safety violations are more frequently practiced compared to traffic violations. It is possible that motorcyclists perceive safety violations as less risky or more socially acceptable, despite the potential severe consequences such as injury or death. The disparity between TV and SV mean scores implies that behaviors related to safety may not be viewed with the same level of concern as traffic violations, even though they pose significant risks. This difference can help inform targeted intervention strategies and policy development. For example, campaigns focused on the dangers of carrying passengers or not wearing helmets could be crucial in reducing these risky behaviors and improving overall road safety [28], as shown in Table 3.

Table 2. Detailed reliability of the instrument

Description	Variable	Cronbach's Alpha
Carrying passengers while riding	TV-1	0.925
Not wearing a helmet while riding	SV-3	0.918
Using GPS to see the maps while riding	SV-6	0.915
Riding in a pedestrian lane	TV-2	0.913
Riding in a motor vehicle lane	SV-2	0.913
Eating while riding	TV-3	0.912
Failure to headlights / Use proper headlight beam	TV-1	0.912
Drowsiness	TV-7	0.912
Failure to give signals when parking or having the parking area	TV-4	0.912
Failure to keep left on multiple lane highways	TV-5	0.911
Running the red light	TV-9	0.911
Texting while riding	TV-6	0.910
Riding against the traffic flow	SV-5	0.910
One hand riding	SV-4	0.910
Using a cell phone while riding	TV-8	0.909

Table 3. Descriptive statistics (n = 496)

Variable	Mean	SD	Minimum	Maximum
SV1	2.56	1.363	1	6
SV3	2.13	1.202	1	6
SV2	1.92	1.042	1	6
SV4	1.74	0.999	1	6
SV6	1.71	1.060	1	6
SV5	1.59	0.811	1	6
TV8	1.55	0.851	1	6
TV9	1.53	0.806	1	6
TV5	1.42	0.807	1	6
TV4	1.40	0.729	1	6
TV6	1.39	0.804	1	6
TV7	1.39	0.753	1	6
TV2	1.30	0.708	1	6
TV1	1.29	0.712	1	6
TV3	1.25	0.634	1	6

3.3 Exploratory Factor Analysis (EFA)

EFA was carried out on data from 496 participants using Principal Component Analysis (PCA), varimax rotation, and Kaiser normalization. The KMO value was 0.943, indicating that the sample was suitable for the analysis [29]. Bartlett's Test of Sphericity also showed significant results (χ^2 = 4395.532, df = 105, $p < 0.001$), confirming the data's suitability for extracting components, as shown in Table 4. Verifying the appropriateness of the data for component extraction through PCA. Factor Loadings below 0.50 were suppressed. A total of 15 components were identified, but only 2 components had eigenvalues greater than 1. The graph line indicated a decrease after the second component, suggesting that these two components could explain a total variance of 61.189%. This finding aligns with previous studies [30, 31], with factor loadings varying from 0.843 to 0.525, indicating consistency of values within each component. The components were grouped into 2 categories: Traffic Violations (TV), which included variables TV-1 to TV-9 with a Cronbach's Alpha reliability of 0.924, an eigenvalue of 7.732, and explained variance of 37.480%, and Safety Violations (SV), which included variables SV-1 to SV-6 with an alpha of 0.817, an eigenvalue of 1.446, and explained variance of 23.709%. Both groups exhibited acceptable reliability (>0.70) [32], as presented in Table 5.

Table 4. KMO and Bartlett's test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.943
Bartlett's Test of Sphericity	Approx. Chi-Square	4395.532
	df	105
	Sig.	0.000***

Table 5. Factor loadings by EFA (Pattern matrix of the factors and item)

Pattern Matrix		
Variable	Component 1	Component 2
TV-1	0.843	
TV-2	0.796	
TV-3	0.791	
TV-4	0.767	
TV-5	0.758	
TV-6	0.740	
TV-7	0.698	
TV-8	0.635	
TV-9	0.579	
SV-1		0.788
SV-2		0.708
SV-3		0.695
SV-4		0.677
SV-5		0.587
SV-6		0.525

3.4 Confirmatory Factor Analysis (CFA)

The CFA analysis was performed prior to the Structural Equation Modeling (SEM) analysis to confirm the validity of the measurement model for evaluating unsafe driving behaviors. The crosstabulation results of the two factors revealed a multicollinear relationship between them as independent variables. A positive correlation of 0.684 was observed, with a significant relationship between the factors ($p < 0.01$), as shown in Table 6. The analysis demonstrated convergent validity by utilizing two latent variables and a total of 15 indicators, with Composite Reliability (CR) values greater than 0.7 and Average Variance Extracted (AVE) values higher than 0.5 [18]. Table 7 shows the CR values for each component, ranging from 0.974 to 0.975, and AVE values from 0.851 to 0.862, as well as the unstandardized and standardized estimates of 15 indicators from the two factors affecting motorcycle accident occurrences. The standardized coefficients varied between b = 0.519 to b = 0.801, which exceeded the acceptable threshold (> 0.5) [29]. According to all statistics, with a p-value < 0.001 indicating statistical significance, the measurement model satisfies the standards for reliability and validity. A Structural Equation Model (SEM) was developed to investigate the connections between Traffic Violations and Safety Violations. In summary, the model showed a good fit, as shown in Figure 2 (χ^2= 317.724, df = 81, p < 0.001, GFI = 0.915, NFI = 0.929, TLI = 0.929, CFI = 0.945, RMSEA = 0.077, RMR = 0.047, and AGFI = 0.875).

Table 6. Correlation matrix of the factors in the CFA model

	Traffic Violations (TV)	Safety Violations (SV)
Traffic Violations (TV)	1	
Safety Violations (SV)	0.684**	1

Note: ** p< 0.01.

Table 7. Results of estimates in the CFA model

Factors	Variable	β	b
Traffic Violations (AVE=0.815, CR=0.975)	TV-1	0.899	0.801
	TV-2	0.840	0.758
	TV-3	0.766	0.767
	TV-4	0.920	0.797
	TV-5	0.990	0.778
	TV-6	0.942	0.754
	TV-7	0.881	0.743
	TV-8	1.000	0.745
	TV-9	0.856	0.681
Safety Violations (AVE=0.862, CR=0.974)	SV-1	0.939	0.519
	SV-2	0.972	0.702
	SV-3	0.989	0.620
	SV-4	1.000	0.754
	SV-5	0.789	0.742
	SV-6	0.857	0.614

Note: β = Unstandardized regression estimate, b = standardized regression estimate.

3.5 Driving behavior factors related to risk factors

The ANOVA results in Table 8 show that both Traffic Violations (TV) and Safety Violations (SV) have a significant impact on traffic offenses and injury severity. Traffic violations are moderately associated with traffic offenses (F = 3.257, p < 0.05) and strongly associated with injury severity (F = 4.980, p < 0.001), suggesting that these behaviors heighten the probability of violations and the intensity of injuries in accidents [33]. Similarly, safety violations, such as riding without a helmet, have an even greater impact on traffic offenses (F = 9.130, p < 0.001) and injury severity (F = 9.059, p < 0.001) [16]. These results imply that following traffic laws and focusing on safety while riding is crucial in lowering the likelihood of accidents and injuries.

However, neither traffic violations nor safety violations showed a significant relationship with accident rates, meaning that while these behaviors raise the likelihood of offenses and injury severity, they do not necessarily increase the frequency of accidents [2]. These results emphasize the need for actions to minimize safety violations in order to reduce the risk of serious injuries among motorcyclists. In practice, promoting helmet use and strictly enforcing safety regulations should be key components of road safety strategies. Such measures align with the results of the study and have the potential to significantly reduce injury severity, contributing to overall public safety improvements.

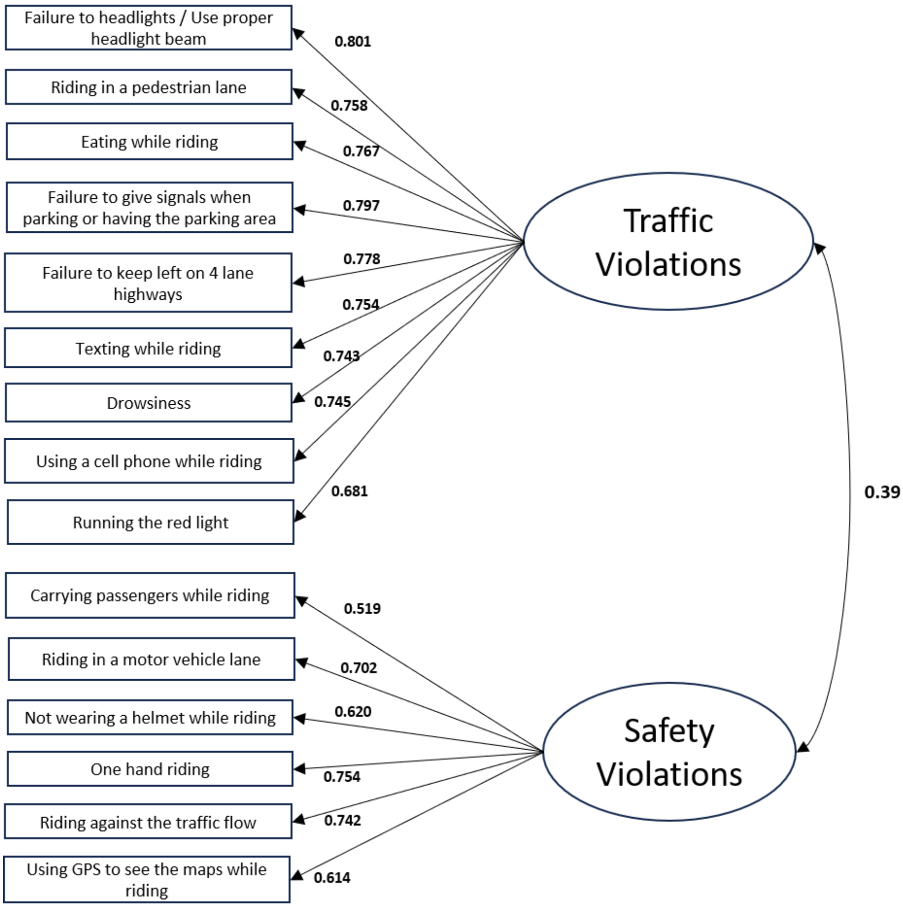

Figure 2. The structural path model with standardized estimates

Table 8. ANOVA results for traffic violations and safety violations related to risk factors

Factors	Traffic Offense	Accidental Rate	Injury Level
	F-stat	F-stat	F-stat
Traffic Violations (TV)	3.257*	1.777	4.980**
Safety Violations (SV)	9.130**	0.387	9.059**

Note: *p< 0.05, ** p< 0.01.

3.6 Participants' demographic related to risk factors

This study emphasizes the demographic characteristics that may contribute to unsafe driving as the most critical factor in assessing differences in driving risk. ANOVA testing was employed to explore differences within education levels. Table 9 presents the results of the ANOVA test regarding risk factors and participant characteristics. Significant relationships were identified between various demographic characteristics and risk factors through. Marital status demonstrated consistently strong associations across all three risk factors [34], with highly significant F-statistics observed for traffic offense ($F = 7.557$, $p < 0.001$), accident rate ($F = 11.744$, $p < 0.001$), and injury level ($F = 6.541$, $p < 0.001$). Monthly income similarly exhibited significant relationships across all measures [35], with particularly strong associations with accident rate ($F = 9.704$, $p < 0.001$). Riding experience was found to be highly significant in relation to accident rate [29] ($F = 8.454$, $p < 0.001$), while age showed a strong association with accident rate [36] ($F = 5.380$, $p < 0.001$). Notably, riding hours significantly influenced traffic offense [37] ($F = 4.249$, $p < 0.01$), and riding time was significantly associated with accident rate ($F = 4.738$, $p < 0.01$). Gender differences were found to be marginally significant only for traffic offense ($F = 3.104$, $p < 0.05$), while riding area and license status showed modest associations primarily with accident rate ($p < 0.05$).

Table 9. ANOVA testing of risk factors related to participant characteristics

Category	Traffic Offense	Accidental Rate	Injury Level
	F-stat	F-stat	F-stat
Gender	3.104*	2.549	1.369
Age	2.411	5.380***	2.212
Education	2.532	3.208*	1.686
Marital status	7.557***	11.744***	6.541***
Monthly income	2.740*	9.704***	4.880***
Riding area	0.673	2.905*	2.842*
Riding license	2.198	3.028*	0.496
Riding time	0.613	4.738**	2.244
Riding hours	4.249**	1.659	0.308
Riding experience	1.109	8.454***	0.459

Note: *p < 0.05, **p < 0.01, ***p < 0.001.

This study emphasizes the importance of using demographic data to develop strategies for accident reduction, with marital status and income playing a key role in determining risky riding behaviors and outcomes, in order to enhance road safety at a practical level.

4. DISCUSSION

The elements influencing road accidents in Thailand, particularly unsafe motorcycle riding behaviors, have been identified, including risk behaviors that can lead to accidents and the severity of injuries. Examples include riding without a helmet and transporting passengers. Data analysis showed that traffic violations (e.g., using a mobile phone while riding and running red lights) and safety violations (e.g., transporting passengers and riding without a helmet) are common behaviors, and both types are associated with the severity of injuries in accidents.

Specific policy recommendations to address these risky behaviors include stricter enforcement of helmet laws, such as laws requiring both riders and passengers to wear helmets at all times, and public education initiatives on the risks of riding without a helmet and carrying passengers. These campaigns could include public media, such as television broadcasts and social media, to help riders understand the risks of these behaviors. The campaigns should clearly communicate the potential consequences, such as more severe injuries or fatalities from accidents, to raise awareness of the importance of following safety regulations. Additionally, organizing training or educational programs on road safety in schools and workplaces can be part of the strategy to reduce risky behaviors. Another key policy approach is improving road infrastructure to accommodate motorcycle riders, such as creating dedicated motorcycle lanes or safe routes, to prevent accidents caused by close encounters with cars.

The study's results emphasize the need to develop policies that focus on reducing these risky behaviors to improve road safety and decrease the injury rate from motorcycle accidents in Thailand, ultimately contributing to a safer environment for motorcycle riders in the long term.

5. CONCLUSION

This study examines the factors influencing road accidents in Thailand, with a focus on unsafe motorcycle riding behaviors. Data were collected through an online survey of 496 motorcycle riders. The results show that demographic factors, including marital status, income, age, and riding experience, play a role in shaping riding behavior and the risk of accidents. Risky behaviors, like eating while riding and carrying passengers, were found to be factors that impair control over the vehicle. ANOVA analysis found that marital status is significantly related to traffic violations and injury severity, while higher income levels correlate with better access to education and training that promote safer riding practices. Furthermore, both traffic violations (TV) and safety violations (SV) were significantly associated with injury severity in accidents, indicating that risky behaviors like riding without a helmet and transporting passengers are crucial factors in increasing the likelihood of accidents and severe injuries. Factor analysis (EFA) showed that these risky behaviors can be categorized into two main groups: traffic violations and safety violations, both of which exhibited high Cronbach's Alpha values, verifying the consistency of the data. Structural Equation Modeling (SEM) further validated the connection between these factors and the incidence of accidents.

The research findings highlight the importance of developing preventive strategies that focus on reducing these risky behaviors, particularly riding without a helmet and transporting passengers, to assist in lowering the chances of accidents and serious injuries. Policy recommendations to address these risky behaviors include the stricter enforcement of helmet regulations and public education campaigns about the dangers of riding without a helmet and carrying more than one passenger. Specifically, the policy could limit passenger transportation to only one additional person, namely the rider and one passenger, which would help reduce traffic violations and improve road safety.

6. LIMITATION AND FUTURE WORK

This study reveals that several factors contribute to the risk of road accidents in Thailand, such as marital status, driving hours, gender, and income. Each factor has a clear relationship with driving behavior and safety. Marital status may influence driving responsibility, while longer driving hours often lead to fatigue and loss of focus, which are major causes of accidents. Gender also plays a significant role in different driving behaviors, and lower income may indicate driving in unsafe conditions, such as vehicles lacking maintenance or insurance. Additionally, the risks of traffic violations (TV) and the lack of safety measures (SV), such as not wearing a helmet, also increase the likelihood of accidents. Therefore, promoting safety and raising awareness of traffic laws is crucial to reducing accidents and fostering a safer driving culture in Thai society.

ETHICS STATEMENT

This study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of the Mae Fah Luang University Ethics Committee on Human Research (Protocol No.: EC 22046-12). Informed consent was obtained from all participants or their guardians for minors. Participation was voluntary, and data confidentiality was maintained. The authors declare no conflicts of interest.

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