A Profiles of Motorcycle Accident Mortality and Risk Behavior in Thai Children

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Abstract
This study investigates motorcycle-related fatalities among children under 15 in Thailand by analyzing three detailed and accurate datasets from the Open Government Data Center. Using exploratory data analysis, including descriptive statistics and two-step cluster analysis, the research seeks to identify trends, patterns, and distinct profiles of motorcycle accident mortality. The analysis reveals a noticeable increase in fatalities from motorcycle accidents during the academic year's second semester (November to February), particularly in the hours of 3-8 p.m., just after school ends. Risk behaviors factors identified include not wearing helmets and alcohol consumption, highlighting the necessity for an immediate reevaluation of the circumstances leading to these accidents and the implementation of specific preventive measures during these high-risk times. Moreover, cluster analysis, considering the timing of accidents, motorcycle usage, gender, and age, reveals five distinct mortality profiles. Significantly, the group most affected comprises boys aged 10-14 years, indicating an urgent need for targeted interventions. This detailed analysis provides critical insights into the demographics most at risk and forms the basis for creating customized safety measures. Furthermore, this research clarifies the temporal patterns of fatalities and emphasizes the essential role of parents, guardians, and educational institutions in closely monitoring children's access to motorcycles during these vulnerable periods. By offering a nuanced understanding of the factors leading to the increased risk of motorcycle accidents among minors, including the effects of gender, age, and timing of incidents in different regions of Thailand, the study contributes valuable perspectives for shaping evidence-based interventions and policies. These insights are crucial for devising strategies aimed at mitigating these preventable tragedies.

Keywords: Child Rider, Motorcycle Accidents, Motorcycle Mortality, Risk Behaviors, Road Safety

1. Introduction

According to a 2018 WHO report, Thailand has the highest road fatality rate in Southeast Asia, with 32.7 deaths per 100,000 people. This places it second globally for road fatalities and first for motorcycle-related deaths among children and youth, resulting in approximately 2,500 deaths annually [1] and [2]. This statistic raises significant concern, especially among Thai youths aged 15-29 and children aged 5-14, for whom road accidents are the primary and a leading cause of premature death, respectively [3]. From 2000 to 2015, road accidents have been the leading cause of death for children under 15, with motorcycles identified as the most dangerous vehicles [4].

The widespread use of motorcycles by teenagers, despite legal restrictions against riders under 15, contributes to this issue, particularly in rural areas where there is notable non-compliance [5]. The increase in accidents incurs significant medical costs and results in a substantial toll of suffering and fatalities [4]. Despite efforts at various governmental levels to reduce these fatalities, there remains a lack of a clear, consistent strategy and comprehensive research into this crisis. Current initiatives focusing on educating high school and tertiary students about safe motorcycle usage are limited in accessibility, highlighting a gap in our understanding of fatalities among children under 15 [6][7] and [8].

Integrating the aspect of risky teenage behavior, especially regarding motorcycle driving, this study emphasizes the psychological factors contributing to Thailand's high road fatality rates. Adolescents are influenced by a combination of developmental, psychological, and social factors that often lead them to engage in risky behaviors, including reckless driving. A range of psychological traits-such as impulsivity, a perceived sense of invulnerability, driving anger, anxiety, angry hostility, excitement-seeking, altruism, normlessness, and the locus of control over driving—plays a significant role in their decision-making processes. These factors contribute to dangerous road behaviors and a distorted perception of risk [9] and [10]. The social normalization of motorcycle use among youth, despite age restrictions, creates an environment prone to risky practices. This issue is exacerbated by lax enforcement of safety laws and the cultural minimization of motorcycle riding dangers. Adolescents' failure to wear proper safety gear and engage in dangerous maneuvers reflects their inclination towards risk-taking [11]. Therefore, it is essential to explore the psychological foundations of teenage road behavior alongside implementing safety policies and educational programs. This study seeks to investigate the mortality profile of this demographic by analyzing monthly death rates, gender and age distribution, and identifying accident patterns and their geographic correlations with risky driving behaviors, offering insights for policy development aimed at mitigating these preventable tragedies.

2. Materials and Methods

2.1 Study Data

Thailand is located at the heart of Southeast Asia on the Indochinese Peninsula, the country stretches from approximately 5°40′N to 20°30′N latitude and from 97°30′E to 105°30′E longitude (Figure 1), encompassing a total area of 513,120 km2, ranking as the 50th largest country globally. With a population nearing 70 million, Thailand shares its borders with Myanmar to the northwest, Laos to the northeast and east, Cambodia to the southeast, and the Gulf of Thailand and Malaysia to the south. Additionally, it maintains maritime boundaries with Vietnam to the southeast and Indonesia to the southwest, while the Andaman Sea graces its southwestern shores.

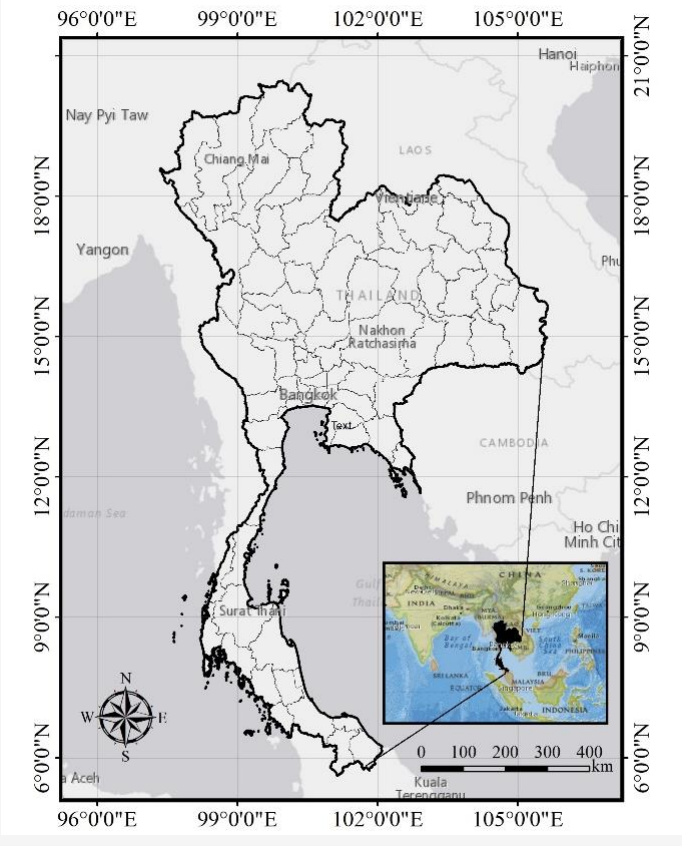


Figure 1: Location of Thailand

2.2 Data Sources

Three mortality datasets were analyzed in this research, comprising data primarily sourced from three Thai agencies namely the Ministry of Public Health, the Royal Thai Police, and the Road-Accident-Victims Protection Company, Limited. These datasets are recognized for their comprehensiveness, accuracy, and integration [12]. Road accident statistics from all 77 provinces of Thailand were compiled. The datasets utilized in this study were obtained from the Open Government Data Center at the Digital Government Development Agency (Public Organization) on April 20, 2021. The mortality data scrutinized in this study pertained solely to fatalities among children aged 0-14 years, who are ineligible to take the motorcycle license exam, spanning the period from 2015 to 2020 across all 77 provinces of Thailand. Three categories of variables were employed in this study: personal data, accident location, and timing of the accident. The timing of the accident was segmented into three intervals: the first semester (May to September), the second semester (November to February), and the semester break (March, April, and October).

2.2 Statistical Analysis

Descriptive statistics were utilized through the SPSS program to analyze the motorcycle-accident mortality rate and the timing of each crash. The Two-Step cluster analysis technique, using the log-likelihood measure in SPSS, was applied to outline profiles of accident-related mortality among children, focusing on the duration of mortality, as well as the victims' gender and age. This method allows for categorizing individuals into clusters, where members within the same cluster exhibit greater similarity compared to those in different clusters [13]. The determination of the optimal number of clusters is based on the natural groupings of several independent variables. A significant advantage of cluster analysis is its ability to examine groups of similar observations instead of analyzing each individual separately, thereby uncovering relationships that might not be apparent through other analytical methods [14].

The Two-step cluster analysis proceeds in two principal steps. Initially, original cases are sorted into preclusters, which subsequently substitute the raw data in hierarchical clustering. Each subsequent case is integrated based on its similarity to these preclusters, using a likelihood distance measure as the criterion for similarity. The algorithm for the two-step cluster analysis is designed to automatically decide the number of clusters or to work with a predetermined number of clusters [15].

In the next phase, preclusters are combined using the agglomerative clustering algorithm, leading to various solutions. This process is refined to the optimal number of clusters as determined by Schwarz's Bayesian Information Criterion (BIC). The BIC is notable for its reduction of subjectivity prevalent in traditional clustering methods, making it a preferred and objective criterion for cluster selection [13].

2.3 Ethical considerations

The research received approval from the Review Boards of the Ethical Committee of Srinakharinwirot University, Thailand, under project number SWUEC-510/2563E.

3. Results

From 2015 to 2020, a total of 2,775 children succumbed to motorcycle accidents, constituting 43.45% of all road accident fatalities among children, with an average of 463 such deaths per year. Figure 2 displays the number of child fatalities from motorcycle accidents across each province in Thailand.

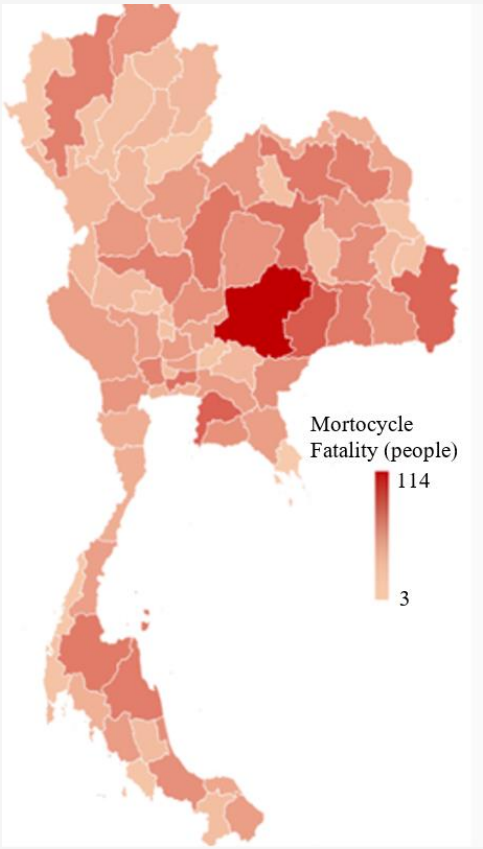


Figure 2: Counts of children's motorcycle fatalities by Thai province, 2015–2020

The age distribution reveals that 64% of the fatalities involved children aged 10-14, followed by those aged 0-4 years at 27%, and 5-9 years at 9%, respectively. The mortality rate for children aged 10-14 years was 2.4 times higher than for those aged 0-4 years and seven times higher than for those aged 5-9 years. Figure 3 illustrates the monthly distribution of accidents, revealing a higher incidence of fatal motorcycle accidents involving children during the second semester (November to February) compared to the first semester (May to September) or the semester break. These accidents predominantly occurred between 3 p.m. and 8 p.m., coinciding with the period after school hours (Figure 4). The number of accidents occurring after school was approximately twice as high as those occurring before school (prior to 8 a.m.). Figure 5 shows examples of child fatality locations from motorcycle accidents (for the accident location map, visit https://qrgo.page.link/L6WHN).

Trends in risky behaviors from motorcycle accidents involving children show an increase in helmet non-use, reflecting the rising trend in injury and fatality rates from motorcycle accidents. Additionally, behaviors related to alcohol consumption and the combination of alcohol consumption with not wearing a helmet demonstrate a gradual annual increase, as depicted in Figure 6. (Note: This excludes the data for 2020 during the COVID-19 outbreak in Thailand).

	Second Semester		First Semester								Second Semester	
Age	January	February	March	April	May	June	July	August	September	October	November	December
0-4	92	83	91	94	68	64	69	67	51	66	75	96
5-9	32	17	27	33	31	28	13	23	18	26	29	31
10-14	180	193	190	158	149	171	185	160	174	202	211	194
Overall	304	293	308	285	248	263	267	250	243	294	315	321

high / low

Note: The intensity of color categorizes the proportion of deaths within each age range.

Figure 3: Children's motorcycle accident fatalities by age and month

	Age				
	0-4	5-9	10-14	Overall	high
12.00 a.m.	34	3	70	107	
1.00 a.m.	29	5	47	81	
2.00 a.m.	28	4	35	67	
3.00 a.m.	11	1	26	38	
4.00 a.m.	18	3	19	40	
5.00 a.m.	16	1	19	36	
6.00 a.m.	22	9	26	57	
7.00 a.m.	28	10	84	122	low
8.00 a.m.	32	17	58	107	school hours
9.00 a.m.	44	23	62	129	
10.00 a.m.	36	9	74	119	
11.00 a.m.	50	15	90	155	
12.00 p.m.	45	9	106	160	
1.00 p.m.	43	16	94	153	
2.00 p.m.	29	15	100	144	
3.00 p.m.	45	20	129	194	
4.00 p.m.	53	29	170	252	
5.00 p.m.	64	28	187	279	
6.00 p.m.	61	19	180	260	
7.00 p.m.	65	22	179	266	
8.00 p.m.	53	18	134	205	
9.00 p.m.	29	18	109	156	
10.00 p.m.	45	8	88	141	
11.00 p.m.	36	6	81	123	

Note: The number of deaths within each age range corresponds to the intensity of color.

Figure 4: Children's fatalities in motorcycle accidents, categorized by age and time of the incident

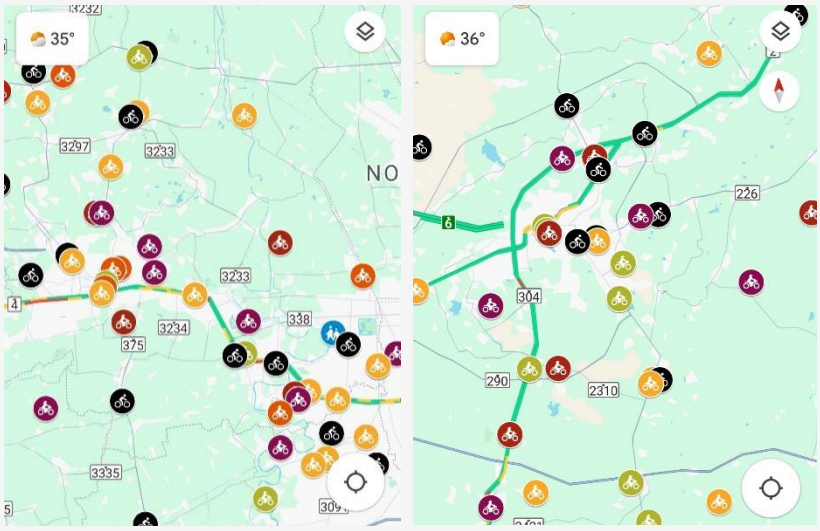
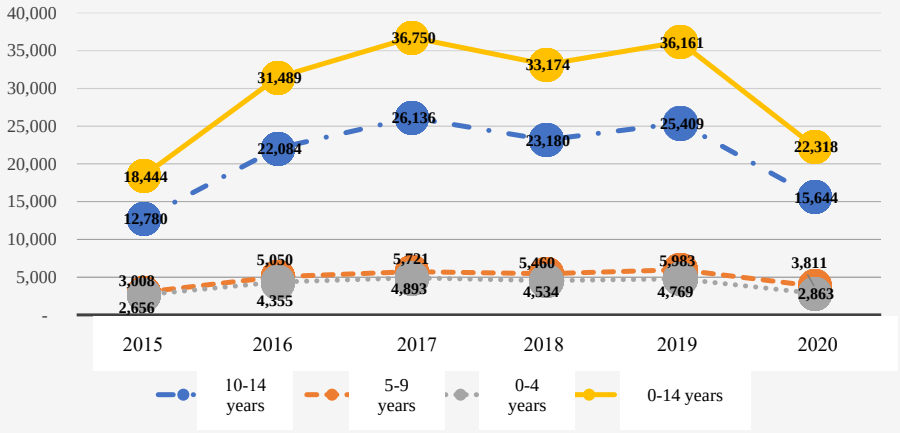
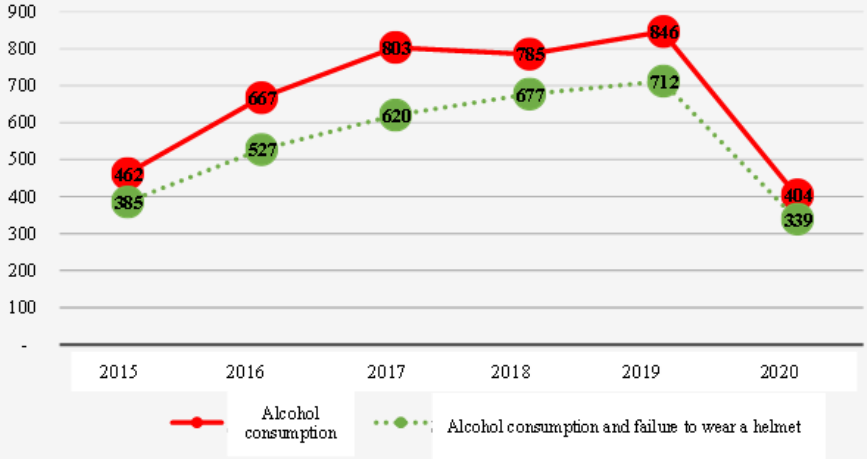


Figure 5: Locations of child fatalities from motorcycle accidents



(a)



(b)

Figure 6: Trends in risky behaviors observed in motorcycle accident fatalities throughout the years 2015-2020
(a) Failure to wear a helmet (b) Alcohol consumption combined with not wearing a helmet

Table 1: Gender, age, duration of mortality, collision type, and accident region in the five clusers (*n*=1,955)

Item	Cluster (accident numbers)									
	1 (378)		2 (356)		3 (474)		4 (440)		5 (307)	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Gender										
Male	0	0.00	195	54.78	474	100.00	440	100.00	307	100.00
Female	378	100.00	161	45.22	0	0.00	0	0.00	0	0.00
Age range										
0-4	0	0.00	178	50.00	0	0.00	0	0.00	0	0.00
5-9	0	0.00	178	50.00	0	0.00	0	0.00	0	0.00
10-14	378	100.00	0	0.00	474	100.00	440	100.00	307	100.00
Duration of mortality										
First semester	162	42.85	129	36.24	474	100.00	0	0.00	0	0.00
Second semester	133	35.19	130	36.52	0	0.00	440	100.00	0	0.00
End of Semester	83	21.96	97	27.25	0	0.00	0	0.00	307	100.00
Collision type										
2-3 wheeled motor vehicle	8	10.96	7	10.29	14	16.28	18	17.82	9	14.29
Car/pick-up track/van	49	67.12	44	64.71	51	59.30	51	50.50	32	50.79
Heavy transport vehicle/bus	8	10.96	10	14.71	11	12.79	18	17.82	12	19.05
Fixed or stationary object	7	9.59	3	4.41	10	11.63	13	12.87	9	14.29
Others	1	1.37	4	5.88	0	0.00	1	0.99	1	1.59
Region of accident										
North	31	8.20	16	4.49	27	5.70	38	8.64	29	9.45
North-east	151	39.95	110	30.90	200	42.19	157	35.68	85	27.69
Central	93	24.60	88	24.72	108	22.78	120	27.27	97	31.60
West	13	3.44	27	7.58	20	4.22	24	5.45	24	7.82
East	38	10.05	35	9.83	49	10.34	43	9.77	35	11.40
South	52	13.76	80	22.47	70	14.77	58	13.18	37	12.05

The Two-Step cluster analysis revealed that a five-cluster solution was the optimal model, as it presented the lowest values for the Akaike Information Criterion (AIC = 2613.98) and the Bayesian Information Criterion (BIC = 2753.25). Additionally, the Silhouette coefficient of 0.70, being close to +1, indicated a distinct separation of the five clusters. The distribution of motorcycle accidents across the clusters—1 (*n* = 378), 2 (*n* = 356), 3 (*n* = 474), 4 (*n* = 440), and 5 (*n* = 307)—accounted for 19.30%, 18.20%, 24.20%, 22.50%, and 15.70% of the total sample, respectively. The categorization of motorcycle accident mortality within these clusters was based on common characteristics such as the time of accidents, as well as the gender and age of the involved Table 1 presents a summary of the frequency distributions for the motorcycle accident profiles within the clusters. Cluster 1 predominantly comprises girls aged 10-14 years who experienced motorcycle accidents during the first and second semesters and the semester break, accounting for 42.85%, 35.20%, and 21.95% of the occurrences, respectively. Cluster 2 consists of boys and girls aged 0-9 years, representing 72.75% of cases, primarily occurring during the semesters. Clusters 3, 4, and 5 primarily involve boys aged 10-14 years, with fatalities occurring during the first and second semesters and the semester break, respectively. The predominant crash patterns resulting in fatalities across the majority of clusters were collisions with cars, pick-ups, or minivans. Clusters 1, 3, 4, and 5 were predominantly located in the northeast region, followed by the central region, while Cluster 2 was primarily found in the northeastern region, followed by the central and southern regions in similar proportions.

4. Discussion

The research findings highlight the circumstances and scale of motorcycle accident fatalities among children under 15 years old in Thailand, who are ineligible for the driver's license exam. These fatalities account for 43.45% of all road accident fatalities among children, frequently resulting in lifelong disabilities for the survivors. A significant majority (64%) of these fatalities involve children aged 10-14 years, followed by those aged 0-4 and 5-9 years. Adolescent development is influenced by various factors such as age [16], gender [17], and cognitive ability [18], making younger adolescents more vulnerable to peer pressure and risk-taking behaviors. Despite legal restrictions, many children under 15 ride motorcycles in Bangkok and across the provinces, as motorcycles are the preferred mode of transportation among both poor and middle-class families [5]. According to 2021 vehicle registration data, motorcycles are the most popular vehicle among Thais, with 21,575,602 private and 164,616 public motorcycles registered [19]. Motorcycles' popularity, affordability, and convenience contribute to a high number of child fatalities in motorcycle crashes. A key risk factor is the widespread lack of knowledge about safe motorcycling among children. Thai schools provide limited education on traffic regulations and safety [20], and safety training initiated after children have already started riding motorcycles often proves ineffective due to already established poor habits. Training conducted after a minor has obtained a license may not significantly impact, as unsafe habits may persist or worsen [21]. High-risk and unsafe driving behaviors among adolescents are frequently influenced by peer-related factors. These influences are explained by the integrated model of the Prototype Willingness Model (PWM) and the Theory of Planned Behavior (TPB) [22]. According to the PWM, adolescents' risky driving behaviors are shaped by their identification with and favorable views of risky driver prototypes. The TPB further suggests that adolescents' perceptions of behavioral control and risk are influenced by their attitudes and the norms within their peer group [23] and [24]. Family members have a vital role in instilling safe driving practices, highlighting the significance of schools in organizing activities aimed at reinforcing these skills [25].

The analysis reveals that boys aged 10-14 are at the highest risk, with the majority of fatal accidents occurring during school semesters, significantly more than during school breaks. This risk pattern is also observed among girls aged 10-14 but at a lower rate than boys. Developmental theory suggests that, despite increased physical growth and generally improved cognitive abilities compared to childhood, adolescents' frontal brain regions controlling decision-making are not as mature as those related to emotion, challenging their behavior regulation and emotion management [26], making them prone to engaging in risky behaviors [27] and [28]. Notably, the period between 3-8 p.m., after school, sees double the number of accidents compared to before school. Most accidents occur on routes used by children traveling between home, school, a friend's house, or a nearby convenience store [5], with nighttime riding posing the greatest risk [29][30] and [31].

The profiling of motorcycle accident fatalities among Thai children has identified pivotal factors—time of death, gender, and age—that categorize these incidents into five distinct clusters. Detailed information on each cluster sheds light on the monthly death toll across different age groups and their geographical distribution. This data is crucial for developing programs aimed at enhancing safe driving practices. Efforts should focus on creating targeted initiatives that customize messages and activities for these young individuals. The insights gained from each cluster lay a solid foundation for more strategic management and planning [32]. For example, Cluster 5, which includes boys aged 10-14 who died in motorcycle accidents during semester breaks (March, April, and October), saw that 50.79% of the fatalities resulted from collisions with cars, pickups, or minivans. This particular cluster was more common in the central region than in the northeast, setting it apart from other clusters. Research highlights that adolescent males are naturally more prone to high-risk behavior [33], with a tendency among boys to engage in speeding, racing, and neglecting helmet use [34]. The concept of optimistic bias, where individuals perceive their risk of negative outcomes as lower than that of their peers engaging in similar behaviors, supports the need for targeted accident prevention efforts, especially in central Thailand, focusing on boys aged 10-14 and their families. This is because family dynamics play a significant role in shaping children's behavior [35]. With children being closer to home during semester breaks, it becomes essential for parents and guardians to actively teach safe driving practices [36]. Cluster 2, consisting of boys and girls aged 0-9 years, showed a higher likelihood of being involved in motorcycle accidents during the school semesters compared to the breaks, a pattern that contrasts with the other clusters, where the mortality profile in southern Thailand resembles those of the northeastern and central regions. Previous studies have indicated that not wearing helmets significantly increases the risk of severe injuries and fatalities [37].

A 2019 survey by the ThaiRoads Foundation and Road Safety Watch Network found that only 8% of children wore helmets while riding motorcycles [21]. Boys in this age group are particularly more likely to engage in speeding, racing, not wearing helmets, and consuming alcohol [34].

The tendency of adolescents to underestimate the riskiness of their actions, despite engaging in behaviors similar to their peers, is known as optimistic bias. This bias leads individuals to believe their personal risk of experiencing negative outcomes is lower than that of others engaging in comparable behaviors [38]. In Indonesia, research found that young drivers with higher optimistic bias and difficulties in emotion regulation showed increased levels of risky driving behaviors [39]. As a result, efforts to prevent and mitigate accidents during school breaks, especially in central Thailand, have primarily targeted boys aged 10-14 and their families, acknowledging the significant influence of family dynamics on children's behavior [35]. During semester breaks, when children are closer to home than school, the proactive involvement of parents and guardians in teaching safe driving practices becomes crucial [36]. Therefore, strategies for accident prevention and reduction among children aged 0-9 years, particularly in the northeastern, central, and southern regions, should emphasize helmet usage during school sessions. A collaborative effort from parents, guardians, teachers, and school administrators is essential, alongside stringent and consistent law enforcement at the local level [40].

5. Conclusion

Children aged 10-14 face the highest risk of fatality while riding motorbikes on the road. The period from November to February, coinciding with the second semester of school, and the hours from 3-8 p.m. after school, represent the most perilous times. The findings of this study will offer invaluable insights for policymakers aiming to reduce accident and mortality rates nationwide. Collaboration among adult relatives, teachers, school administrators, and local law enforcement is essential in this endeavor. Research on safe driving practices must receive robust support, including efforts to curb the prevalence of underage and unlicensed drivers. Furthermore, comprehensive and consistent public relations campaigns via television, online platforms, and public posters across the country are imperative. Parents themselves should undergo essential training, as effective safety practices begin at home. Schools and parents must collaborate diligently to restrict children's motorcycle usage during school hours, particularly during the high-risk period from 3-8 p.m.

6. Limitations and Future Work

Despite the range of studies referenced in this report, readers should be mindful of certain inherent limitations. Firstly, the datasets utilized in this analysis were somewhat constrained. Future research endeavors should prioritize the establishment of datasets encompassing variables such as driver and passenger behaviors in severe accidents, vehicle and road quality, lighting conditions, and other pertinent social and physical factors. Secondly, the findings presented here solely depict the number of fatalities across different genders, age groups, dates, times, and locations, without delving into specific causative factors underlying the accidents themselves. Subsequent research initiatives ought to incorporate in-depth interviews with survivors and individuals familiar with their circumstances, alongside an examination of the insights gleaned by children in each cluster. This approach will facilitate the identification of optimal strategies for mitigating these tragic occurrences.

Acknowledgments

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