The Relationship Between Work-Related Factors, Risky Behaviors, and Major Accidents Among Motorcycle Food Delivery Riders (MFDR) in Thailand

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Abstract

Motorcycle food delivery riders (MFDR) are more susceptible to traffic collisions when compared to regular motorcyclists. Their safety is a major concern in many developing countries, especially Thailand, which has the highest rate of motorcyclist fatalities in the world.

This cross-sectional study aimed to identify the prevalence of accidents, hospitalization, involvement in risky behaviors, and concerning problems among MFDR and determine factors associated with accidents. The data were collected from 709 MFDR in Chiang Mai, Thailand.

The prevalence of any accidents among MFDR in the past six months was 18.9% which can be categorized into 4.9% minor injuries, 2.4% hospitalized major injuries, and 11.6% non-hospitalized major injuries. 84.3% of them engaged in at least one risky behavior and 5.8% of them engaged in ten or more risky behaviors. The most frequent risky behavior was using the mobile phone while riding (78.8%), While the least frequent risky behavior not wearing a helment (9.3%).

Multivariable logistic regression analysis indicates that the factors associated with the major accidents were running a red light (aOR 2.78, 95%CI 1.07 to 7.21) and having concerns for customer behavior (aOR 2.66, 95%CI 1.26 to 5.62). The factors associated with any accidents (both major and minor accidents) were sleeping < 6 hours/day (aOR 2.13, 95%CI 1.41 to 3.21) and working ≥ 48 hours/week (aOR 1.72, 95%CI 1.04 to 2.83)

To reduce the rate and severity of traffic accidents, the government and the delivery firms should provide effective strategies and targeted interventions focusing on the reduction of risky behaviors and other modifiable risk factors.

1. Introduction

More than 1.35 million people lose their life and up to 50 million people are injured each year due to road traffic injuries (WHO, 2019) in low- and middle-income countries (Sharma, 2008). Globally, there is an increasing trend of motorcyclist fatalities rate, from 23% of all road deaths in 2015 to 28% in 2018 (WHO, 2015, 2019). At a regional level, the proportion of motorcycle fatalities ranges from 9% in Africa to 43% in South-East Asia (SEA). From the latest WHO report on road safety, Thailand has become the country with the highest motorcyclist fatality rate in the world (WHO, 2019). The Thai Department of Disease Control reports that the majority of motorcycle accidents result in mild injuries (Out Patient Department cases) (79.4%), followed by severe injuries that necessitate hospitalization (19.5%), and approximately 0.01% result in death (Department of Disease Control, 2021).

Food delivery application (FDA) is an emerging food ordering-delivery platform that provides online services and plays a role as an intermediary between restaurants and customers (Ray, Dhir, Bala, & Kaur, 2019). The popularity of the FDA is constantly rising globally over the past decade, particularly in South-East Asia (Tan, 2022). Since COVID-19 was announced as a public health emergency of international concern, a lockdown policy was enforced to prevent the spread of the virus (Koh, Naing, & Wong, 2020). During the lockdown, the popularity of food delivery services has risen worldwide.

The popularity in Thailand has also risen to its peak in 2022 with a net worth of 79 billion baht, and a growth of 4.5 percent compared to the previous year, due to their usefulness, convenience, and safety in reducing the risk of exposure to COVID-19 (Gavilan, Balderas-Cejudo, Fernández-Lores, & Martinez-Navarro, 2021; T. H. D. Nguyen & Vu, 2020; Sirikeratikul, 2020; Thaiger, 2020). The firms using the online platform are responsible for recruiting, organizing, and employing delivery riders, who are mostly motorcyclists (Sun, 2019). The wages of the MFDR vary depending on various factors such as the number of orders, the number of working hours, minimum wages per order of each platform, the distance of delivery, and the commission per order. They are less likely to be affected by traffic congestion, have better accessibility in the alleyways, and the cost of transportation and fuel is lower (Chung, Song, & Yoon, 2014; Kieling et al., 2011). However, motorcycle accidents tend to cause more serious injuries and require longer-term medical care than other types of transportation (Mayou & Bryant, 2003).

One study on injuries caused by delivery motorcycles was conducted in Korea, where food delivery is extremely popular and there is even more competition. Injury in the delivery motorcycle group increased drastically (two times) in four years (2014–2018) and it was predicted that these injuries would continue. In several studies conducted in China and Vietnam, the MFDR working environment (i.e., long working hours, more daily orders, fatigue, planning the route of delivery) continues to be the main cause of accidents and mental health issues (Tran et al., 2022; Zheng, Ma, Cheng, Guo, & Zhang, 2019). When work is associated with time pressure and physical and mental exhaustion, the accident rate is significantly higher. The riders' undesirable behavior and traffic violations pose another significant risk (McKinlay, Mitchell, & Bertenshaw, 2022). Similar research was conducted on motorcycle taxis, which share similar characteristics with MFDR such as long riding hours. In Vietnam, approximately 30% of app-based motorcycle taxis have been involved in a traffic collision during delivery in the past year. Twenty percent of those who crashed were injured (Nguyen-Phuoc, De Gruyter, Nguyen, Nguyen, & Ngoc Su, 2020). Similar to MFDR, motorcycle taxi accidents are primarily caused by risky driving behaviors such as speeding, not wearing a helmet, and stunting (Nguyen-Phuoc et al., 2020; Ospina-Mateus, Jiménez, & López-Valdés, 2021; Tuan & Mateo-Babiano, 2013). The number of deliveries set the earnings of the riders. During the pandemic, riders were under greater financial pressure and suffered a larger loss of income. Thus, riders with insufficient incomes tend to work under time pressure or in unsafe conditions which lead to engagement in risk-taking behaviors, violation of the law, and eventually involvement in accidents (Nguyen-Phuoc et al., 2020; Tran et al., 2022). They also tend to work longer hours and ride at a higher speed to maximize the number of trips (Barber & Charman, 2018; T. Nguyen et al., 2018).

Overall, motorcyclist safety remains a challenging problem worldwide, especially in SEA. Even with a great impact on society, little is understood about the safety measures and implications of each delivery trip among MFDR. To date, no study has been conducted to investigate work characteristics, behaviors, concerns, and the prevalence of accidents that occur along with the severity among MFDR in SEA before. In terms of conducting the research, Thailand is a good representation of South-East Asia because it has one of the world's fastest-growing MFDR industries and the highest mortality rates from motorcycle

accidents. Therefore, this study aims to examine the prevalence and severity of accidents, risky riding behaviors, and concerns among active MFDR in Thailand and aims to determine the association between potential associated factors and accidents.

2. Material and methods

2.1. Participants

The data were collected from active MFDR from November 2021-February 2022 via an anonymous online survey. (http://redcap.med.cmu.ac.th/MFDRMEDCMU) The inclusion criteria were working full-time as food delivery riders in Chiang Mai for at least six months during the time of research. Three food delivery platforms were operating in Chiang Mai during the survey. We adopted several recruitment, including flyers, posters, and announcements through online platforms such as the Facebook group and LINE OpenChat. This variety of recruitment methods was employed to provide as many responses as possible within the timeframe to maximize the usefulness of the results. A total of 1028 participants accessed the online platform. Of those, 709 (68.9%) participants answered the questions completely.

2.2. Data Collection

The self-reported survey, as part of a wider project, consisted of four main parts and included 38 questions.

Part 1: Socio-demographic information; age (year), gender (male/female), level of education (primary/secondary/undergraduate/graduate or higher), weight (kg.), height (cm.), sleeping time (hours), smoking status (yes/no), alcohol consumption (yes/no).

Part 2: Working conditions; working hours (hour/day), working days (day/week), working time (dayshift/nightshift), working experience (year), daily income (Thai baht), orders per hour (orders/hour), routine motorcycle maintenance (yes/no), accident insurance (yes/no).

Part 3: The frequency of risky riding behaviors and riders' concerns. There was a total of 13 questions about risky behavior and five questions about concerns from the riders. The examples of the questions are driving against the lane direction or the wrong way on a one-way street (wrong way riding), and experiencing difficulty finding the restaurants, the way, or the delivery area for customers even when using the GPS (wayfinding). It was measured on a five-point Likert scale from never, seldom, sometimes, usually, and always over the previous six months. The MFDR who reported always, usually, and sometimes were considered as engaging in risky behavior or concern. In contrast, the riders who reported seldom' and never were considered as not engaging in risky behavior or concern.

Part 4: The self-reported rates of hospitalization and Emergency Room (ER) visits of the most serious accidents over the past six months. The questions included were: have you ever been in an accident while delivering food? What was the severity of the most serious accident? (with three options; ER visit, hospitalization/IPD case, and self-care/mild injury). Riders who reported a hospitalization/IPD case or ER visit were considered to have suffered from major accidents. On the other hand, riders who reported self-care/mild injury were categorized as minor injuries/accidents.

A pilot test of the survey was conducted with 30 motorcycle riders in Thailand (Cronbach's alpha of 0.85). The findings of the study were reported according to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

2.3. Statistical and Data Analysis

The survey data from the web-based platform was analyzed using STATA software version 16.0 (Stata Corp., College Station, TX, USA). A categorical variable was presented as a frequency with a percentage. A continuous variable was presented as a mean with a standard deviation (SD) or a median with an interquartile range, as appropriate. The characteristics of MFDR who had major accidents were compared with those who had minor or no accidents using the Chi-squared test or independent t-test, as appropriate. A multivariable logistic regression analysis was used to explore the factors that contributed to major accidents and any accidents while riding among MFDR. The magnitude of the association is expressed as an adjusted odds ratio (aOR) with 95% confidence intervals (95% CI). All statistical tests were two-tailed, and a p-value of 0.05 was considered statistically significant.

2.4. Ethical Considerations

This study was conducted following the Declaration of Helsinki guidelines and the protocol was approved by the Research Ethics Committee of the Faculty of Medicine, Chiang Mai University, Thailand (Study Code: 8577/2564).

3. Results

3.1. Riders' Characteristics and Working Conditions

The participants consisted of 709 MFDR. Most riders were male (68.8%), with a mean (± SD) age of 32.9 (± 8.6) years. The majority of the subjects had an education level of secondary school (45.8%) and were single (66.1%). Approximately half of them were obese (47.4%) and non-alcohol drinkers (52.5%). Most of the participants were non-smokers (74.2%). The average number of hours of sleep of the riders is 7.1 (± 1.2) hours. In general, the riders had a median working experience (IQR) of 2 (2) years. Their median orders per hour were 3 (3) orders. They had average working hours and working days of 9.14 (± 2.8) hours per day and 6 (± 1) days per week. Overall, the mean daily income of the participants is 15.1 (± 6.1) USD (February 2023). The majority of the riders worked more than eight hours per day (77.2%) and more than 48 hours per week (exceed the weekly maximum allowance) (70.9%). Most of them worked during the daytime (80.7%), had routine vehicle maintenance (91.1%), and had accident insurance (61.6%) as seen in Table 1.

Table 1
Characteristics and working conditions of MFDR.

Characteristics (Mean ± SD) / n (%)	Total (N = 709)			
		Major Accident (n = 98, 13.8%)	Minor and No Accident (n = 611, 86.2%)	P-value
Riders' characteristics:				
Sex	Male	64 (65.3%)	423 (69.2%)	.482
	Female	34 (34.7%)	188 (30.8%)	
Age	Adolescent (< 21 years)	16 (16.3%)	123 (20.1%)	.414
	Adult (≥ 21 years)	82 (83.7%)	488 (79.9%)	
Education	Primary School	7 (7.1%)	28 (4.6%)	.709
	Secondary School	45 (45.9%)	280 (45.8%)	
	Undergraduate	14 (14.3%)	96 (15.7%)	
	Graduate or higher	32 (32.7%)	207 (33.9%)	
BMI	Underweight	4 (4.1%)	29 (4.7%)	.188
	Normal	40 (40.8%)	181 (29.6%)	
	Overweight	13 (13.3%)	106 (17.3%)	
	Obese	41 (41.8%)	295 (48.3%)	
Marital Status	Single	67 (68.4%)	402 (65.8%)	.830
	Married	24 (24.5%)	168 (27.5%)	
	Divorced/Widowed	7 (7.1%)	41 (6.7%)	
Sleeping < 6 hrs/day		38 (38.8%)	189 (30.9%)	.130
Current Smoking		33 (33.7%)	150 (24.5%)	.062
Alcohol Consumption		55 (56.1%)	282 (46.2%)	.081
Working Conditions:				
Experience > 1 year		75 (76.5%)	408 (66.8%)	.062
Order ≥ 4 orders/hour		24 (24.5%)	79 (12.9%)	.005**
Working ≥ 8 hrs./day		74 (75.5%)	473 (77.4%)	.698
Working ≥ 48 hrs./week		68 (69.4%)	435 (71.2%)	.72
Daily Income (USD)		16.7 ± 6.3	14.9 ± 6.0	.007**
Usual Work Shift	Dayshift	68 (69.4%)	504 (82.5%)	.004**
	Night Shift	30 (30.6%)	107 (17.5%)	
Routine motorcycle maintenance		79 (80.6%)	567 (92.8%)	< 0.001**
Has accident insurance		53 (54.1%)	384 (62.8%)	.117

* p < 0.05, ** p < 0.01. Abbreviations: BMI, Body Mass Index; hrs, Hours; USD, United States Dollar.

3.2 Prevalence of Accidents among MFDR

Figure 1 presents the prevalence of the most serious MFDR accidents, which were categorized into major accidents with or without hospitalization and minor accidents. Of 709 riders, 134 (18.9%) riders were injured while working. The prevalence of minor injuries, hospitalized and non-hospitalized major injuries, were 4.9%, 2.4%, and 11.6%, respectively.

3.3. Risky Behaviors and Concerns Among MFDR

Overall, 598 riders (84.3%) engaged in at least one risky behavior listed in the questionnaire. 254 (35.8%) MFDR engaged in only one risky behavior, while 41(5.8%) MFDR engaged in ten or more risky behaviors. Using a mobile phone while riding was the most frequent risky behavior (78.8%), followed by using only one hand to ride and control the motorcycle (29.1%) and speeding over the limit (more than 90 km/h) (23.3%). In contrast, not wearing a helmet (9.3%) was the least frequent risky behavior engaged by the MFDR,followed by running a red light (9.6%) and cutting other vehicles off (9.7%). (Fig. 2A)

Considering the purposes of using mobile phones while riding, about seventy percent of MFDR used a mobile phone for navigation (69.4%). Followed by using mobile phone for accepting new work and competing for work (52%), receiving a call or calling others not related to work (41.6%), chatting with the customer and/or restaurant (37.9%), and calling the customer and/or restaurant (37.1%). About MFDR concerns, most riders were concerned about all five conditions (n = 361, 50.9%), while only 34 riders (4.8%) had no concerns at all. Road conditions were the most frequent concern (90.4%), followed by weather conditions (79.1%), and wayfinding (77.7%) (Fig. 2B)

3.4. Factors Associated with Major and Any Accidents

Table 2 presents the exploratory model results for major accidents and any accidents. The model included rider characteristics and working conditions. These variables were considered potential associated factors of road traffic accidents among MDFR according to prior research and observation from a pilot test (McKinlay et al., 2022).

The variables, "Using a mobile phone while riding" and "Concern for road conditions", were omitted from the multivariable model due to a 'perfect prediction'. The reasons are that (1) most of the riders from the food delivery platform need to use their telephones while riding for various purposes as mentioned above, and (2) the available zones for the riders are in urban areas in which the road conditions are similar. "Concern for vehicle condition" was also excluded from the analysis since it was a result of another variable that was already included in the model, the "motorcycle maintenance".

For major accidents, the riders who ran red lights were significantly more likely to be involved in major accidents compared to those who did not. (aOR 2.78, 95%CI 1.07 to 7.21; p 0.036). The riders who had high concern for customers behaviors also showed an increased number of major accidents compared with those who did not. (aOR 2.66, 95%CI 1.26 to 5.62; p = 0.011). (The MFDR are concerning for customers behavior because customers can evaluate the performance of each rider. High ratings result in extra money per order while low ratings results in a penalty for the rider.)

For any accidents (both major and minor accidents), the results indicated that riders who slept less than six hours a day (aOR 2.13, 95% CI 1.41 to 3.21, p < 0.001) and worked 48 hours or more per week (aOR 1.72, 95% CI 1.04 to 2.83, p 0.033) had significantly higher odds of any accident. Riders who used only one hand to ride the motorcycle also had higher odds of any accident, though this was borderline statistically significant (aOR 1.66, 95% CI 0.97 to 2.83; p = 0.064). It should be noted that not wearing a helmet, speeding over the limit, wrong-way riding, and split lanes were not statistically significant factors in this study.

Table 2
Factors associated with major and any accidents among MFDR.

Factors	Major Accidents				Any Accidents			
	aOR	95% CI		p-value	aOR	95% CI		p-value
Riders' characteristics:								
Male	0.74	0.45	1.22	0.232	0.73	0.47	1.13	.156
Female	ref				ref			
Adolescent (< 21 years)	0.57	0.30	1.08	0.086	1.22	0.74	2.01	.432
Adult (≥ 21 years)	ref				ref			
Sleep < 6 hrs/day	1.36	0.83	2.20	0.22	2.13	1.41	3.21	< 0.001**
Sleep >= 6 hrs/day	ref				ref			
BMI								
Underweight	0.86	0.26	2.85	0.804	0.71	0.24	2.06	.524
Overweight	0.55	0.26	1.15	0.113	0.62	0.34	1.15	.129
Obese	0.84	0.49	1.44	0.53	0.62	0.39	0.99	.045*
Normal	ref				ref			
Working conditions:								
Working experience	0.96	0.88	1.04	0.294	1.05	0.99	1.11	.098
Order/hour	1.10	0.92	1.31	0.296	1.06	0.90	1.25	.475
Working ≥ 48hrs/week	1.05	0.60	1.83	0.877	1.72	1.04	2.83	.033*
Night Shift	1.58	0.89	2.82	0.118	0.79	0.46	1.38	.413
Motorcycle Maintenance	0.61	0.29	1.26	0.179	0.71	0.36	1.40	.324
Risky Behaviors (The reference group is not having any risky behavior)								
Using only one hand to ride	0.53	0.25	1.1	0.088	1.66	0.97	2.83	.064
Speeding over the limit	1.15	0.58	2.28	0.693	1.09	0.62	1.93	.757
Unsafe lanes splitting	1.12	0.49	2.53	0.793	1.62	0.83	3.17	.154
Riding too close to the vehicle in front	1.33	0.57	3.15	0.511	0.91	0.45	1.82	.782
Riding wrong way	0.59	0.25	1.4	0.23	0.59	0.28	1.23	.159
Sidewalk riding	1.45	0.64	3.28	0.378	1.55	0.75	3.20	.232
Not turning on the indicator light	1.34	0.46	3.94	0.591	0.45	0.16	1.29	.139
Turning into an alleyway without reducing the speed	1.22	0.35	4.23	0.75	1.26	0.45	3.58	.661
Not stopping at a crosswalk	0.64	0.27	1.53	0.313	0.63	0.28	1.40	.253
Cutting other vehicles off	1.20	0.34	4.25	0.773	1.60	0.55	4.68	.391
Running a red light	2.78	1.07	7.21	0.036*	1.46	0.60	3.56	.41
Not wearing a helmet	1.82	0.77	4.28	0.171	0.90	0.37	2.17	.811
Riders Concerns (The reference group is not having any concerns)								
Weather conditions	1.17	0.53	2.59	0.694	1.29	0.66	2.52	.451
Wayfinding	0.83	0.39	1.76	0.628	1.14	0.61	2.14	.684
Customer behaviors	2.66	1.26	5.62	0.011*	1.40	0.78	2.53	.261

The results obtained by multivariable logistic regression analysis; * p < 0.05, ** p < 0.010; Abbreviations: BMI, Body Mass Index; hrs, hours.

4. Discussion

Using the results from a self-reported online survey in Thailand, this paper has investigated the prevalence of accidents and the rate of hospitalization among app-based MFDR. The paper also explored the prevalence of risky behaviors and concerns, as well as potential associated factors that affect the rates and severity of accidents.

The results showed that around 18.9% of MFDR reported having been involved in at least one accident during the last six months. About 14% were major accidents. Of these, 2.4% required hospitalization. These rates are lower than the self-reported crash rate of conventional MFDR (riders who work for one specific restaurant) in China, which ranged from 21.4 to 75.0% (Fuxiang et al., 2019; Zheng et al., 2019). The rate of major accident hospitalization was also remarkably lower than a self-reported study in Greece, which was approximately 25% (Papakostopoulos & Nathanael, 2021). The rate of major accidents may be underestimated as a result of our inability to identify riders who died or suffered serious injuries.

MFDR who ran red-lights or had concerned about customers' behaviors were significantly associated with major injuries. It is noted that red-light running is a serious traffic law violation behavior in Thailand. From previous research in Thailand, although running a red light accounts for only 2% of all causes of traffic accidents, most of the accidents result in severe injury or even death. (Jensupakarn & Kanitpong, 2018; Kanitpong, Jensupakarn, Jensupakarn, & Jiwattanakulpaisarn, 2015). These rates are low compared to self-reported RLR rates among commercial motorcyclists (riders who work based on customer demand eg. sending parcels, delivering foods, motorcycle taxi) in Malaysia (9.6%) (Supramani, 2021) Vietnam (20%) (Nguyen-Phuoc et al., 2020) and in Greece (30%) (Choi et al., 2022). The explanation may be due to several reasons such as time of day, length of yellow time interval, approaching speed, and distance from the intersection warning sign to the stop line (Jensupakarn & Kanitpong, 2018). In addition, the riders' decision-making is significantly influenced by the 'time pressure' of delivering the food (Papakostopoulos & Nathanael, 2021). MFDR tend to violate traffic laws such as running a red light to deliver the food as fast as possible(Grunebaum, 2020). The MFDR will also gain a benefit from making the customer satisfied with the services, this issue will be discussed later. There are numerous reasons for Thailand's ineffective law enforcement, such as the excessively low RLR fine or inadequate enforcement of traffic violations. To lessen the number of RLRs, the traffic department might consider raising the fine or installing red-light cameras in other cities apart from the capital (Retting, Ferguson, & Hakkert, 2003).

The behavior of customers has a significant impact on major accidents. Customers play a significant role in the food delivery industry since they can evaluate the performance of each app-based MFDR through ratings, comments, and reports. If a rider is reported with bad behaviors or delayed delivery, the food-delivery firm can lock their account for several days or even ban the rider permanently. On the other hand, if the riders can maintain high ratings, they will increase the earnings of each ride through the incentive reward program (Gandini, 2019). Similar to MFDR in Thailand, many MFDR in Malaysia also had stress and concerns from the customers about the duration of delivery of food, hence they violate traffic laws to get high income and avoid complaints from customers (Bavani, 2021; Rusli, Mohammad, Azreena Kamaluddin, Bakar, & Hafzi Md Isa, 2022; Tuan & Mateo-Babiano, 2013). Since the customer's rating significantly affects the rate of accidents, the firm should adjust the customer rating system concerning real-time events (such as climate, accidents, rush hour, etc.). The 'Rating Back' method could be used in this situation where it is permissible for riders to rate the customers back, based on their manners and behaviors. Customers with high ratings will receive additional benefits such as a discount. Like other companies, the riding firm could also pay the riders on a monthly basis, rather than basing their salary on the number of orders and customer ratings.

It was found that riders who worked ≥ 48hours per week and slept < 6 hours per day were associated with an increased risk of involvement in any accidents. These findings are consistent with a previous study in China (Zheng et al., 2019). Extending the working hours can lead to an increase in risk exposure to traffic accidents (Wolfe, 1982). The possible explanation may be due to the fatigue of riders which has a significant effect on work and riding safety. The reasons why fatigue is related to accidents are complex. The causes of fatigue and low alertness that increase driver risk have been attributed to a variety of factors such as health status, hours performing the task, sleep deprivation, stress, task demands, and circadian rhythm (Taylor & Dorn, 2006). Under Thai labor laws (Labor Protection Act B.E.2541 Chap. 2 Section 23), the maximum number of hours an employee can work is 48 hours per week but the app-based MFDR is not included, these MFDR are classified as "informal employees". As a result, there is no limit on the maximum number of work hours for them. They also do not receive any insurance coverage, protective equipment, sick pay or healthcare rights (health check-ups, health insurance) (Jongrak, 2021).

As previously stated, the poor safety culture of the food delivery industry can be reflected in the results that around 85% of respondents frequently engaged in at least one risky behavior listed in the questionnaire. Other nations, including Greece, China, Korea, and Vietnam, also have these delivery norms (Nguyen-Phuoc et al., 2020; Papakostopoulos & Nathanael, 2021; Zheng et al., 2019). Of all risky behaviors that were considered, 'using a mobile phone while riding' had the highest prevalence with 78.8%. These results are similar to the studies which focused on motorcycle taxis in Vietnam (52-91.6%) (Nguyen-Phuoc et al., 2020; Truong & Hang, 2019). These findings are not surprising since smartphones are inevitable gadgets for every MFDR. These riders need mobile phones to communicate with customers and restaurants. Some riders also use their phones for work and navigation, which could distract them and impair their awareness while riding (Oviedo-Trespalacios, Haque, King, & Washington, 2016). The second most common risky riding behavior was 'using one hand to ride' (29.1%). This is considerably less than previous research in Greece (70%) (Papakostopoulos & Nathanael, 2021). In Thailand, it is illegal to use a hand-held device while riding and the riders will be charged with an offense of 30.0 USD (February 2023). Riders can still legally use a device hand-free while riding. Currently, there are still no definite numbers of food delivery riders who are using a device hand-held and hand-free in Thailand. However, using a mobile phone, whether hand-held or hands-free, is distracting and dangerous to all traffic drivers, which eventually results in accidents and injuries (Al-Jasser, Mohamed, Choudry, & Youssef, 2018; Ortega et al., 2021) .

Interestingly, the non-use of the helmet is the least risky behavior (9.3%) engaged by the MFDR. This was remarkably lower than past research conducted in Thailand in 2009 (about 40%) (Jiwattanakulpaisarn et al., 2013) and 2010 (about 55%) (Suriyawongpaisa, Thakkinstian, Rangpueng, Jiwattanakulpaisarn, & Techakamolsuk, 2013). The possible reason may be that most of the firms include 'wearing a helmet' in the company rules and regulations for MFDR. In addition, there will be a penalty if the riders were reported as not wearing a helmet, the maximum penalty is a lifetime suspension from the company. This reflected the effort of the government and the company in Thailand to reduce the number of MFDR who do not wear helmet.

To the best of our knowledge, this is the first study in Thailand that examines the prevalence of accidents and risky behaviors among MFDR along with their association. The number of participants in this study accounts for nearly one-tenth of all food delivery riders in Chiang Mai, Thailand. However, it is also subject to several limitations. Firstly, a cross-sectional design was used to determine the factors' association. Hence, no casual association could be directly concluded due to temporal ambiguity. Secondly, the results may be underreported since some riders may be concerned that their answers could affect their

own and the business's reputation. Lastly, the study may have been influenced by recall bias due to the use of a self-reported questionnaire and selection bias known as survival bias, which underestimated the number of riders who died or were seriously injured.

Conclusion

In conclusion, our study revealed that the prevalence of accidents among MFDR in Thailand was relatively lower than that of commercial motorcyclists in other countries. MFDR who are running a redlight or concerned about customers' behaviors were significantly associated with major injuries. MFDR who work ≥ 48 hours per week and sleep < 6 hours per day were associated with an increased risk of involvement in any accidents. With the continual growth and expansion of the food delivery industry, especially in developing countries, the incidence of risky-riding behaviors among the riders needed to be of concern. The government needs to focus on the enforcement of traffic law specifically running red-light to reduce the rate and severity of the accident. The food delivery company needs to establish regulations to prevent the MFDR from working over their limit. Strategies such as the 'rating back system' and 'monthly wages' could be used to reduce riders' concerns regarding customer behaviors. In addition, these informal workers should have access to a healthcare system that includes insurance and health check-ups. Further research is needed particularly exploring the insights of the MFDR and their attitudes toward safety practices.

Abbreviations

aOR, adjusted odd ratio; COVID-19, Coronavirus disease of 2019; IQR, Interquartile Range; REDCap, Research Electronic Data Capture; Ref., reference category; SD, Standard Deviation; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology; USD, United States Dollar; 95%CI, 95% confident interval.

Declarations

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Conflicts of Interest

The authors declare no conflict of interest.

Declaration of Interests:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability Statement

The data presented in this study are available on request from the correspondent author.

Author Contributions:

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All authors have read and agreed to the published version of the manuscript.

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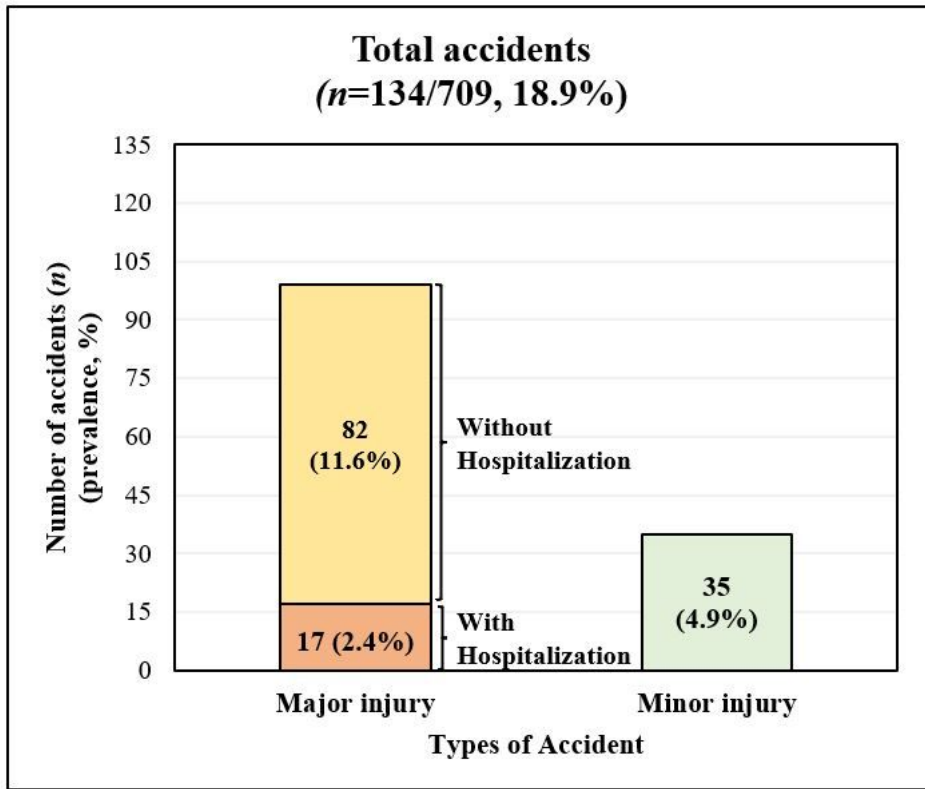
Figures

Figure 1

Prevalence of accidents among MFDR classified by severity of injury.
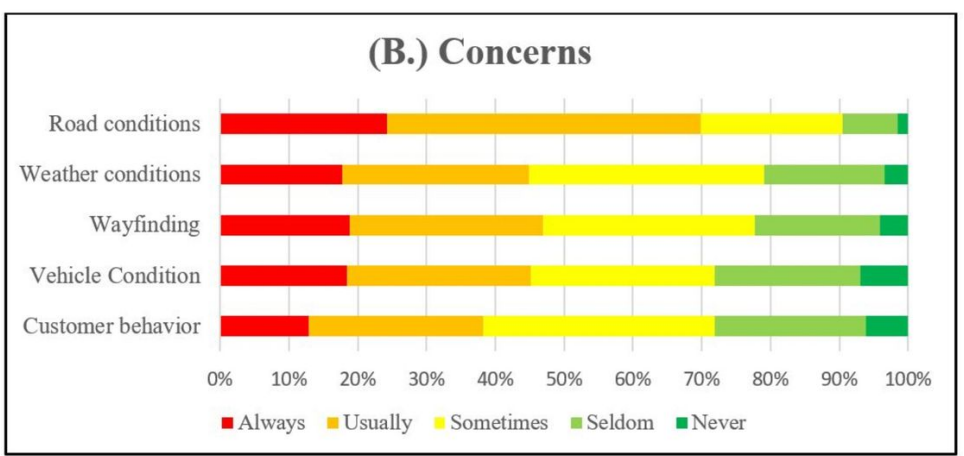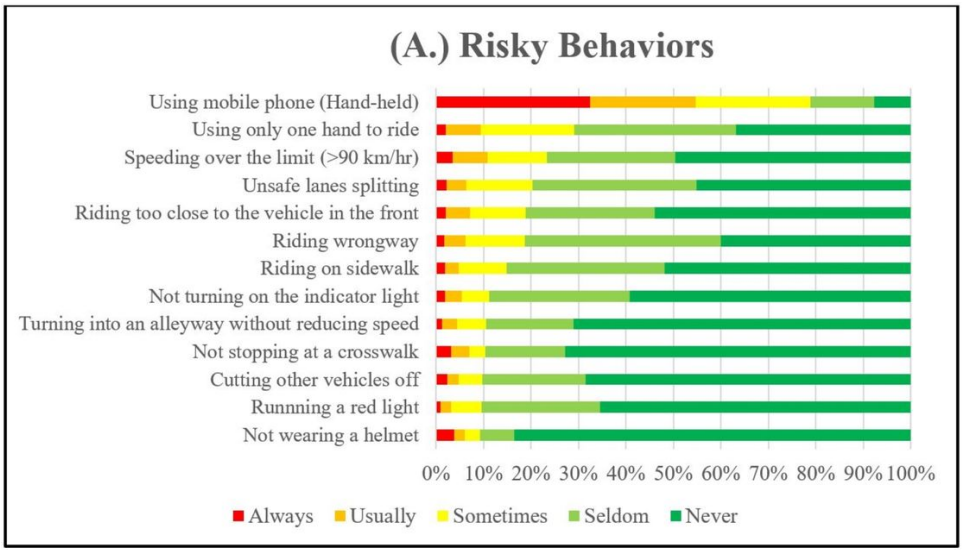
Figure 2

Frequency of risky behaviors (2A) and concerns (2B) reported by the MFDR.