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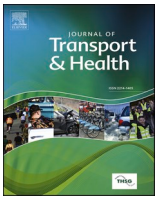

Achieving a first detailed understanding of risky (motor)cycling behavior among Vietnamese adolescents: Findings from video elicitation focus groups

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ABSTRACT

Introduction: Vietnamese adolescents are at high risk on roads. There has been limited focus on the underlying motives for their risky (motor)cycling behaviors, particularly risky-prone circumstances from interactions with other road users in the local traffic environment. This study aims to explore risky behaviors among Vietnamese adolescents and the motives behind them, considering these behaviors as consequences of their interaction with the local traffic environment.
Methods: This study employed video elicitation focus groups to explore the risky (motor)cycling behaviors of Vietnamese adolescents and their underlying motives. Videos were recorded by adolescents to capture perspectives from both moped and motorcycle riders. Focus groups were conducted to gain insights into their behaviors and their motives, with responses categorized according to the research questions and sub-questions.
Results: Adolescents engaged in risky behaviors, such as riding in the wrong lane and dangerous overtaking, influenced by the risky behaviors from other road users (motorcyclists, cyclists, cars, pedestrians). They tend to mimic or avoid these behaviors by engaging on their own without careful consideration. Both objective and subjective safety can explain these situations.
Conclusion: Comprehensive strategies including education, engineering, and enforcement, are recommended to help educators, practitioners and policymakers enhance traffic safety among adolescents in Vietnam. Traffic safety education should focus on skill development and awareness of local traffic situations. Dedicated lanes for bikes and e-bikes should be established. Motorcycle Graduated Driver Licensed programs and stricter enforcement could help reduce illegal motorcycle use.

1. Introduction

Adolescents make riskier choices than children and adults regarding road traffic crashes (Steinberg et al., 2008). In the first nine months of 2023, traffic fatalities in Vietnam decreased by 1.24 %, while injuries increased by 3.87 % compared to the same period in

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2022 (Communist party of Vietnam, 2023). During this time, there were 563 traffic crashes involving children and adolescents, resulting in 329 deaths and 528 injuries (Communist party of Vietnam, 2023). Vietnamese adolescents aged 15 and 18 have a fatality rate in road traffic crashes five times higher than the national average for all ages and eight to nine times higher than their peers in developed countries (Vu and Nguyen, 2018). Motorcycles account for over 90 % of vehicles and are the primary transport mode in Vietnam (Le and Blum, 2013; Nguyen-Phuoc et al., 2024). According to the Law on Road Traffic Order, adolescents can legally ride mopeds under 50 cc before the age of 18, but riding motorcycles is illegal (The National Assembly of the Socialist Republic of Vietnam, 2008; The National Assembly of the Socialist Republic of Vietnam, 2024). Vu and Nguyen (2018) studied 225 child-related traffic crashes in Ho Chi Minh City from 2013 to 2015 and found that one-fifth illegally rode motorcycles over 50 cc to school. Nguyen et al. (2023a,b) studied 832 parents of adolescents aged 16 to 18 in Ho Chi Minh City and found that 61 % of adolescents use motorcycles illegally.

In the road safety sector, risky behaviors among adolescents may result in collisions or crashes (Fryt and Szczygiel, 2021). Human behavior is the primary cause of road crashes, followed by vehicle and environmental factors. The most frequent risky behaviors among Vietnamese adolescents include wrong lane riding, dangerous direction changes, speeding, dangerous overtaking, and dangerous road crossings (Vu and Nguyen, 2018). Although recent studies have examined these behaviors (Vu and Nguyen, 2018; Le et al., 2023, 2024; Le et al., 2024a,b), little attention has been given to the underlying motives related to risky-prone circumstances from interactions with other road users.

This study aims to explore risky behaviors among Vietnamese adolescents on the roads and the underlying motives behind these behaviors. Rather than focusing solely on internal factors, this study considers risky behaviors as consequences of interactions within the local traffic environment. To eliminate the self-reporting biases, visual elicitation focus groups were used to capture risk-prone circumstances through videos recorded by adolescents using mopeds and illegal motorcycles. This innovative technique is rarely employed in Vietnam. This study addresses the following research questions (RQs): 1) What risk-prone factors do adolescents encounter on the roads?, 2) What risky behaviors do adolescents exhibit, and what underlying motives are revealed in the video footage?, 3) How can risky behaviors among adolescents be reduced?

The remainder of this paper is structured as follows: Section two presents the literature review. Section three outlines the data analysis methods. Section four presents the results, and section five discusses the results, policy recommendations, limitations and future research. The final section summarizes the key conclusions.

2. Literature review

2.1. Adolescents' risk-taking and its causation

Risk-taking in adolescence can be explained by limitations in physical, cognitive, and social development (WHO, 2015). Two key internal factors are sensation-seeking and impulsivity (Romer et al., 2017; Khurana et al., 2018). Sensation-seeking involves a desire for new experiences and peaks during adolescence (Steinberg et al., 2018). Impulsivity refers to acting with minimal planning (Shulman et al., 2016) and includes acting without thinking and a preference for immediate rewards (Edelson and Reyna, 2023). Adolescents with high sensation-seeking tendencies exhibited high impulsivity, making it hard to resist immediate rewards (Romer et al., 2017). Unlike adults, adolescents tend to rely on real-time information for risk judgments (Reyna, 2004; Reyna et al., 2005; Reyna and Brainerd, 1991; Reyna and Farley, 2006), underestimate crash chances and overestimating their skills (Harré, 2000; Shope and Bingham, 2008). In addition, they face stressors like academic demands (Uy and Galván, 2020). Externally, risk-taking is heightened in the presence of peers, as seen in increased crash rates when carrying passengers (Andrews et al., 2020), and running a yellow light with their peers (Chein et al., 2011). Nam (2023) suggested that traffic safety campaigns should target those close to Vietnamese e-bike riders, as they influenced their risky driving behaviors. Policies, such as the legal drinking age, shape opportunities for risk-taking (Icenogle and Cauffman, 2021). Macioszek and Granà (2021) stated that adolescent traffic crashes result from various factors, including alcohol use, speeding, and environmental conditions.

2.2. Video-elicitation technique as potential approach to investigate adolescents' risky behaviors

Researchers have explored different risky behaviors among adolescents on roads using quantitative and qualitative approaches. Vu and Nguyen (2018) used secondary data from the Police Department and identified five most popular risky behaviors among Vietnamese adolescents: wrong lane riding, dangerous direction changes, speeding, dangerous overtaking, and unsafe road crossings. Through online surveys, Le et al. (2023, 2024) found that Vietnamese students possess unfavorable behavioral beliefs, normative beliefs, and control beliefs regarding wrong lane riding and speeding, conflicting with Vu and Nguyen (2018)'s findings. Møller et al. (2021) conducted focus groups revealing that Danish adolescents have more favorable behavioral beliefs, normative beliefs, and control beliefs concerning traffic violations such as speeding, not wearing helmets, riding with passengers, doing tricks on mopeds, and riding where bike paths are available. Saber et al. (2022) found that Iranian adolescents engage in risky bicycle stunts due to their underestimation of risk. The inconsistency in findings about risky behaviors and intentions stem from a lack of risk-prone circumstances. Additionally, social desirability bias affects adolescents' responses (Le et al., 2023, 2024). Regarding the lack of risk-prone circumstances, Johnson et al. (2010) stated that the road network and environment contribute to crash and injury risk. Since traffic crashes are caused by road users, vehicles, roads, and environmental factors (Doong and Lai, 2012), focusing only on road users' limits understanding of the entire traffic system (Iamtrakul et al., 2023). Additionally, social desirability bias arises from self-reports, as respondents struggle to recall sensitive memories (Useche et al., 2021).

Elicitation technique involves using visual, verbal, or written stimuli to encourage people to share their ideas (Warren et al., 2002). The visual stimuli help participants grasp researchers' expectation, reduces verbal (Barton, 2015), sharpens memories, and creates more precise information than conventional interviews (Zehe and Belz, 2016). It includes three forms: arrangement tasks, construction tasks, and explanation tasks (Jamshidnejad et al., 2020). Arrangement tasks, like sorting and ordering, encourage participants to categorize stimuli and explain their arrangements. Construction tasks involve drawing and imagination to shape responses. Explanation tasks help participants think aloud, engage in stimulated recall, and use photo-elicitation, which includes static images and videos.

Photo-elicitation interviews have been applied to understand behavioral and environmental factors affecting road safety among adolescents on their routes to school (Gautam et al., 2021). However, capturing feelings on complex topics through photographs may not be effective (Zehe and Belz, 2016). This approach may not suit risk-prone circumstances in moving traffic. Therefore, video elicitation technique, which reconstructs past experiences, can enhance interviews and focus groups (Jewitt, 2012). Recently, Gautam et al. (2024) used this technique to explore mobility experiences of people with disabilities, identifying facilitators and barriers to safe travel.

3. Methods

This study is conducted according to the flowchart (see Fig. 1).

3.1. Participants

Three higher secondary schools in the urban areas of Ho Chi Minh City were contacted and informed about the study. Principals asked students for voluntary participation. Registered participants included 18 adolescents who rode bicycles, mopeds, and illegal motorcycles.

3.2. Videos

This study viewed risky (motor)cycling behavior as a consequence of adolescents interacting with other factors in a local traffic environment, including traffic characteristics, road users' risky behaviors, or environmental factors. Videos were recorded to capture the adolescents' perspectives as moped riders and motorcyclists. Among the 18 participants, five moped riders and illegal motorcyclists agreed to record their travels.

To ensure the adolescents' safety, several protocols were established. A meeting with these adolescents was held in the StudioLab of the Institute of Smart City and Management (ISCM) at University of Economics Ho Chi Minh City. They were informed about safety measures, including helmet use with a mounted camera, emergency contacts, and pre-ride checks. They were instructed on using the SJCam4000 action camera, mounting it on their motorcycle helmets, ensuring its viewpoint matched theirs. A list of emergency contacts, including local authorities and medical services, was provided in case of an emergency. Safe stopping guidelines were shared, and pre-ride checks were recommended to ensure that vehicles' brakes, lights, and tires were in good condition. Adolescents were

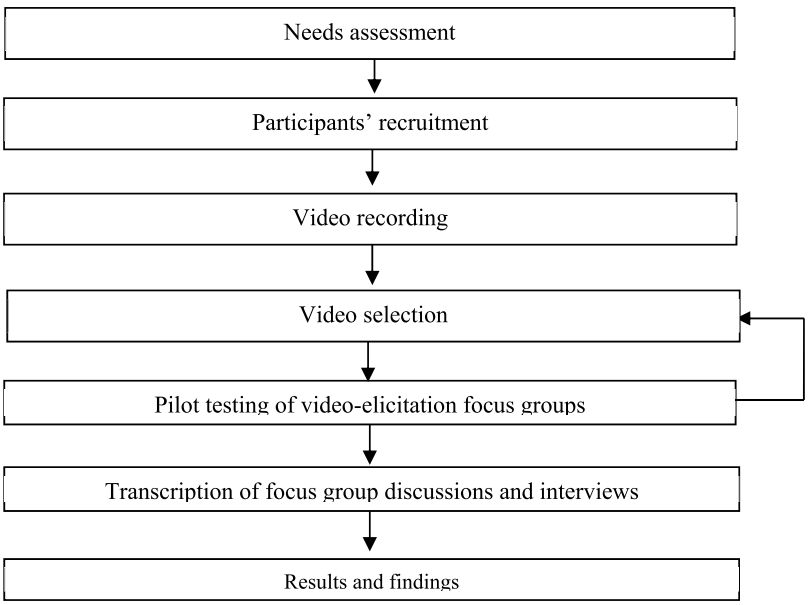


Fig. 1. The study flowchart.

instructed to ride as they normally would while recording.

After the recording, the video stimuli were selected based on two criteria. Firstly, the footage needed to show urban road segments in Ho Chi Minh City and adolescents' daily riding behaviors, including risky behaviors. Secondly, the footage had to be clear and stable. This criterion was defined based on specific technical parameters, including resolution, frame rate, and stabilization features. The video footage was ensured to meet a minimum resolution of 720p and a frame rate of 30 frames per second to facilitate clear analysis. To assess video stability and filter out footage with excessive motion blur or instability, software tools named Adobe Premiere Pro and VirtualDub were used for stabilization analysis and frame-by-frame inspection, respectively. A systematic review process was applied to ensure a balanced representation of behaviors. Videos were first categorized based on defined criteria, and then a random sampling method was employed to select footage for analysis, minimizing bias towards riskier or safer behaviors. In total, five videos were selected for this study, with an average duration of 60 s each.

3.3. Video-elicitation focus groups

Video-elicitation focus groups were conducted. In the footage, adolescents experienced mixed traffic interactions involving (motor) cyclists/mopeds, cars, pedestrians, and buses. Participants who recorded footage were called "active respondents" (n = 5), while those who did not were "passive respondents" (n = 13).

Research questions guided focus groups, particularly RQ1: "What risk-prone factors do adolescents encounter on the roads?". Sub-questions included: "How do you identify a behavior as risky?", "Which road users' behaviors did adolescents encounter in the video footage?", "Which of these are considered risky?", and "Were there other risk-prone factors in the local traffic environment?".

To discuss RQ2, "What risky behaviors do adolescents exhibit, and what underlying motives are revealed in the video footage?", sub-questions included: "How did adolescents react to these road users' risky behaviors?", "If there was no risky behavior from road users, did adolescents engage in risky behaviors?", "Why do they take such risky behaviors?". Active participants were also asked: "Are there other reasons for your reactions?", "Do you feel at risk during these behaviors?", and "How do you feel watching your behaviors in the footage?". Passive participants were also asked: "How would you react if you were in the footage?", and "What do you feel watching the risky behaviors?".

For RQ3 "How can risky behaviors among adolescents be reduced?", sub-questions included: "Does knowledge of traffic rules and signs helps you act safely?", "How effectively is knowledge about traffic rules and signs applied to local traffic environments?", "What factors encourage safe behaviors?".

A pilot test of the focus groups was conducted with two participating adolescents.

3.4. Study process, data collection and analysis

The study was approved by the institutional ethical committee of the University of Economics Ho Chi Minh City (No.2079/QLKHHTQT). Participants and their parents received information about the study's objectives. Then, informed consent was obtained from both the participants and their parents, emphasizing the voluntary nature of participation and the right to withdraw at any time without consequence. Each participant provided their socio-demographic characteristics, including age, gender, transport modes, risky behaviors, and traffic fines due to violations in a Google Form. After video footage was recorded, it was reviewed during the group discussions in the Studio Lab of ISCM. The video watching and discussion took 40 min per group. Participants' responses were recorded, transcribed, and analyzed using Nvivo 10.

4. Results

4.1. Participants' characteristics

Eighteen adolescents (mean age = 16.1 years, 50 % male) from three urban higher secondary schools (six adolescents per school) in Ho Chi Minh City participated in this study. All participants reported learning about road safety education, including traffic rules and signs at schools. Participants' transport modes included 27.8 % cyclists, 33.3 % moped riders, and 38.9 % motorcyclists. All cyclists indicated that they knew how to use mopeds and motorcycles, having them with their parents' approval. Over the past three years, 22.2 % of cyclists, 22.2 % of moped drivers, and 33.3 % of motorcyclists received fines. Although student motorcyclists had no driving license, they received no fines. Improper behaviors leading to fines included wrong lane riding and not using helmets.

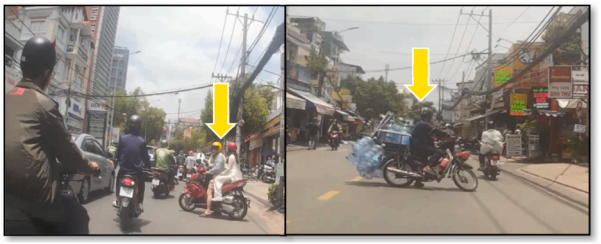
4.2. Results from research questions

4.2.1. RQ1 "what risk-prone factors do adolescents encounter on the roads?"

All participants identified a behavior as "risky" if it violated a rule and/or could lead to a collision or crash, such as wrong lane riding (Table 1). While watching the footage, they realized risky behaviors by other road users, including wrong lane riding and wrong side riding (motorcyclists), careless or sudden direction changes (motorcyclists), riding abreast (cyclists), walking in the road or not using zebra crossings (pedestrians), and illegal parking (car drivers). Only four participants, including one active participant, considered crossing a solid white line to be "risky." These behaviors are displayed in Table 1.

In addition, all participants found that adolescents also engaged in risky behaviors, such as wrong lane riding and dangerous overtaking, without the influence of other road users (Table 2).

Table 1
Risky behaviors performed by other road users.

No.	Risky behaviors	Image captured from the video footage
1	Wrong lane riding	
2	Dangerous overtaking	
3	Motorcyclists ride on the wrong side	
4	Motorcyclists intend to do direction change or performs it in front of adolescents	
5	Cyclists go abreast	
6	Pedestrians walking along the road or not on zebra crossing	

(*continued on next page*)

Table 1 (*continued*)

No.	Risky behaviors	Image captured from the video footage
7	Illegal parking	
8	Parking cars and other moving cars	
9	Adolescents crossing a solid white line	

Moreover, all participants emphasized how adolescents were affected by simultaneous interactions in the mixed traffic. Parked cars on a "no parking" street led adolescents to follow motorcyclists driving in the wrong lane and to move into the opposite lane. Participants noted a dangerous crossing between a car and a motorcyclist. While active participants missed the hidden motorcyclist on the roads, both active and passive participants recognized a motorcyclist hidden by a car exiting a small alley in the video footage. This motorcyclist, referred to "Ninja lead", is a woman dressed fully to protect herself from the sun and who engages in risky behaviors. Another noted scenario involving adolescents encountering a closed truck and a heavily loaded tricycle while in the wrong lane. These behaviors are presented in Table 3.

4.2.2. RQ2 "what risky behaviors do adolescents exhibit, and what underlying motives are revealed in the video footage?"

Adolescents engaged in risky behaviors, such as wrong lane riding, dangerous crossings, and crossing solid white lines, in response to other road users' risky behaviors. Their reactions involved either following or avoiding specific road users without careful consideration. They chose to follow for a sense of community, regardless of recognizing the risks. In contrast, their avoidance was aimed at preventing collisions or crashes. Unfortunately, both responses constituted risky behavior, as they violated rules and/or could

Table 2
Adolescents performing risky behaviors without effects from other road users.

No.	Risky behavior of adolescents	Image captured from the video footage
1	Adolescent perform wrong lane riding	
2	Adolescents perform dangerous overtaking	

Table 3
Simultaneous risky factors affecting adolescents' behaviors.

No.	Risky behaviors	Image captured from the video footage
1	Dangerous crossing by cars and motorcyclists	
2	Car and hidden "Ninja lead" moving from alley	
3	Adolescents encountered a closed truck and a tricycle with a heavy goods when performing wrong lane riding	

lead to collisions or crashes with other road users who were out of their attention. Ultimately, adolescents sought safety with specific road users, but this created risks with others. All adolescents confirmed their ultimate goal was to achieve safety on the roads.

Adolescents reported reasons for engaging in risky behaviors, including being in a hurry to get to school or to move from schools to a teacher's house for extra classes, avoiding the sun and hot weather, and returning home after extra classes at night. They engaged in these behaviors due to habits formed from past experiences and observations of motorcyclists. When confronted with road users, they sought sensations and found it "cool." They did not see their behaviors as risky or think carefully before reacting. However, watching the footage made them realize their behaviors were risky.

The footage showed that the adolescents continued risky behaviors, even when the road users were not exhibiting risky behaviors. In these circumstances, sensation-seeking, haste, and habits drove their behaviors, with following or avoidance being absent. Other participants stated they would likely react similarly if they were adolescents on the roads.

4.2.3. RQ3: "how can risky behaviors among adolescents be reduced?"

Most participants revealed a lack of knowledge about solid white lines and "no parking" signs. They continued engaging in wrong lane running and dangerous overtaking, despite recognizing these behaviors as risky. This implied that they did not apply traffic rules learned in schools to real-life situations. Both active and passive participants felt that their school-based knowledge was too basic for local traffic conditions. While navigating the roads, they encountered various risky behaviors and had to react immediately without careful thought.

The remaining participants reported other risky behaviors not captured in the footage, such as running yellow lights, changing lanes without signaling, and using mobile phones while driving. Additionally, all participants did not consider an unsafe following distance as "risky," citing difficulty of maintaining it in crowded traffic. All participants admitted that although they learned the meanings of traffic signs in school, they struggled to recall them in real-life situations and lacked the habit of observing traffic signs. They only noticed the signs' location at the beginning of road segments when watching the footage.

All participants indicated that they followed the behaviors of their friends and other road users. Therefore, peers and other road users should model safe behaviors to encourage similar actions. Student cyclists found commuting challenging due to various transport modes in mixed traffic. While student motorcyclists did not discuss their illegal practices, student cyclists questioned this common violation among their peers. Video footage showed student motorcyclists parking at schools. They received no fines as their behaviors occurred in the absence of police. Based on their experience, they typically received only warnings when caught by police.

5. Discussion

The objective of this study was to explore risky behaviors among Vietnamese adolescents using bicycles, mopeds, and illegal motorcycles on the roads, as well as the underlying motives for these behaviors through video-elicitation focus groups.

5.1. Discussion on adolescents' characteristics

Results showed that most adolescents used engine-powered vehicles, particularly mopeds and motorcycles. Despite underage and lacking licenses, they still illegally operate these vehicles (Vu and Nguyen, 2018). This aligns with findings from other developing countries, such as Indonesia (Amalia and Brilianti, 2024), Bangladesh (Alam and Sheoti, 2024), Thailand (Tongklao et al., 2016), Malaysia (Nurain and Razelan, 2022), and Cambodia (Kitamura et al., 2018). In Vietnam, major cities are motorcycle-dependent (Trinh and Le, 2016; Nguyen et al., 2022), and adolescents use motorcycles with parental permission for convenience (Nguyen et al., 2023a,b). Due to lax enforcement, they faced no sanctions. They only received fines for wrong lane riding and not wearing helmets. While most studies on wrong lane riding/driving focusing on young and adult riders/drivers (Hsu et al., 2003; Chang and Yeh, 2007; Putranto and Alyandi, 2019); V Luot, 2020; Nguyen et al. (2022); Sumit et al. (2022), this behavior is the most popular risky behaviors among Vietnamese adolescents (Vu and Nguyen, 2018; V Luot, 2020; Le et al., 2023). A comprehensive motorcycle helmet-use legislation has been adopted in Vietnam since 2007 (Passmore et al., 2010). Li et al. (2020) observed 479,892 Vietnamese motorcycle riders from 2015 to 2019 and found that while over 90 % wore helmets, correct usage dropped from 80.8 % to 55.6 %. No helmet use is prevalent among adolescent and young motorcyclists in many countries (Pitaktong et al., 2004; Germeni et al., 2009; Brijs et al., 2014; Vu and Nguyen, 2018).

Traffic safety education in Vietnam is limited to basic knowledge taught in civil education classes, and it is not mandatory. Although awareness campaigns have been conducted for years, their effectiveness in enhancing knowledge and skills have not been evaluated (Pham, 2023a,b). Traffic safety education needs to be engaged and tailored to local traffic environments to enhance its effectiveness.

5.2. Discussion on findings from RQs

Regarding RQ1, "**What are the risk-prone factors that adolescents encounter on the roads?**", all participants identified risky behavior as violation of traffic rules that could lead to collisions or crashes (Fryt and Szczygiel, 2021). Transport mode and urban environment influenced students' perception around schools (Oestreich et al., 2021). Participants witnessed mixed traffic in Ho Chi Minh City, including interactions among adolescents, motorcyclists, moped riders, cyclists, car and bus drivers, and pedestrians (Huong et al., 2024). Adolescents were influenced by the risky behaviors of most road users, except bus drivers. These behaviors include wrong lane riding (Satiennam et al., 2023), riding on the wrong side (Janpla et al., 2022), illegal directional changes (Trinh et al., 2013), going abreast (Nguyen et al., 2022), walking along the road (Tulu et al., 2013), jaywalking (Wilmut and Purcell, 2022), illegal parking (VU, 2017), and crossing solid white lines (Weissenfeld et al., 2014).

Wrong lane riding is popular among adolescent and young motorcyclists (Vu and Nguyen, 2018; Nguyen et al., 2022; Le et al., 2023), electric bike/moped riders (Ma et al., 2019; Qian et al., 2020). Although this behavior increases crash risk (Hung, 2011), Vietnamese adolescents prioritize safety and tend to implement their intentions (Le et al., 2023). Therefore, educational intervention should be encouraged to enhance these intentions. Hsu et al. (2003) stated that wrong lane riding in Vietnam is influenced by road layout lacking physical median traffic island (Hsu et al., 2003). According to López et al. (2025), motorcyclists are less visible due to their smaller size, further decreasing detection when engaging in risky behaviors. These behaviors increased the risk of collisions and crashes. According to Nguyen et al. (2022), going abreast could distract cyclists, leading to reckless overtaking.

Prendergast and Earl (2025) stated that pavements in Ho Chi Minh City were occupied by small businesses, forcing pedestrians to walk along the roads (Tulu et al., 2013). This lack of separation increased the risk of vehicle-pedestrian crashes in developing countries (Tulu et al., 2013). Pedestrians walking with traffic faced a higher likelihood of fatalities and head injuries compared to those walking against it (Luoma and Peltola, 2013; Pai et al., 2019). Pedestrians tend to walk on the left/right based on their intended turn (Bitgood and Dukes, 2006; Jazwinski and Walcheski, 2011). Pasha et al. (2015) found that jaywalking occurred due to time constraints and lack of designated crossings. Mfinanga (2014) stated that female and younger pedestrians were more vulnerable due to their willingness to cross at non-level spots. Wilmut and Purcell (2022) concluded that older adults were influenced by various personal factors and environmental conditions when crossing roads.

Vu (2017) identified reasons for illegal parking, such as a lack of spaces and low enforcement. Although knowing their actions were harmful, drivers still violated parking rules. Therefore, regulatory policies and strict enforcement should be implemented to address illegal parking (Song et al., 2022). Thanh and Friedrich (2017) suggest implementing "para-parking" spaces in high demand areas, transforming from "private" into "semi-private" spaces for parking in Vietnam. All participants recognized the most risky behaviors among road users, except for crossing solid white lines. This indicated a lack of knowledge regarding solid white lines. Adolescents encountered various risky behaviors in mixed traffic. "Ninja leads" were identified as risky and hidden road users (Cam, 2020).

Regarding RQ2, "**What risky behaviors do adolescents exhibit, and what are the underlying motives for these behaviors as captured in video footage?**", results showed that adolescents engaged in risky behaviors regardless of road users' risky behaviors. Their risky behaviors included wrong lane riding, dangerous overtaking, and crossing solid white lanes. Their reactions could be explained by primary and secondary objectives. The primary objective, directly related to their final goal, is to prevent collisions or crashes on the roads. The secondary objective is to gain subjective safety from the surrounding road users in the mix of traffic. This

secondary objective facilitates the achievement of the final goal. Subjective safety refers to the perception of safety among road users (Sørensen and Mosslemi, 2009). Adolescents experienced subjective safety as they reacted to the visible risky behaviors of the road users, but their focus on these risks blinded them to other hidden dangers in the mixed traffic. They recognized risks only when observing their behaviors in the footage. During the process of seeking subjective safety, adolescents experienced "cool" feelings (WHO, 2015), a sense of belonging, and low impulsive control.

Objective safety refers to actual collisions or crashes (Sørensen and Mosslemi, 2009). Cyclists' subjective safety does not always correlate significantly with objective safety (von Wirth et al., 2015; Schmidt and von Stülpnagel, 2018). Both subjective safety and objective safety could be used to explain the road safety of Vietnamese adolescents. Objective safety is related to an increasing trend in traffic crashes among Vietnamese adolescents (Vu and Nguyen, 2018). Although Le et al. (2023) found that Vietnamese adolescents hold negative beliefs on wrong lane riding and intended not to engage in it (Le et al., 2023), they still engaged in these risky behaviors (Vu and Nguyen, 2018). Road crashes are associated with risk perception and actual behaviors (Ibrahim et al., 2012). This can be explained by the fact that they felt subjective safety. In other words, they feel safe in real-life traffic environments, regardless of the risky behaviors of other road users. They overlooked risk-prone factors due to low impulsive control (Shulman et al., 2016) and self-esteem (Harré, 2000; Shope and Bingham, 2008). Additionally, they have their own expectations to arrive at destinations on time, such as schools or extra classes. It is obvious that Vietnamese adolescents attend extra classes at their teachers' houses after schools (Labik Amanquandor et al., 2022). Adolescents may not recognize the high level of risk they encountered when in a hurry (Pešic et al., 2022). They rush to reach their destinations to escape environmental factors like hot weather, which contributes to aggressive behaviors (Anderson, 2001). Ho Chi Minh City is among the cities with high temperatures on the roads (Dang et al., 2019).

There was a lack of knowledge about traffic signs and markings among participants (Dandona et al., 2011). They could not understand the meaning of the "no stop" sign and solid white line markings. They identified that various road users influenced their behaviors. "Ninja leads" were among the hidden road users who may pose risks to adolescents on the roads, among others (Cam, 2020). Participants confirmed that no observation of traffic signs based on their experience on the roads. Crundall et al. (2006) stated that traffic signs were noticed only when they were within road users' focus. Complying with traffic signs was crucial for reducing traffic crashes among students (Johnson and Adebayo, 2011; Lachapelle et al., 2013; Nagar, 2022). The ability to recognize these signs is a key factor in preventing traffic collisions (Retting et al., 2003).

5.3. Policy recommendations

Regarding RQ3, "**How can risky behaviors among adolescents be reduced?**", education could enhance adolescents' knowledge of traffic rules and recognition of traffic signs (Zhang et al., 2010; Alonso et al., 2016; Trifunović et al., 2017; Nagar, 2022). When road safety education was not mandatory in schools, online gamified e-learning platforms could enhance motivation and engagement outside of classrooms. Embedding game elements such as points and rewards to the online learning platform could inspire the sense of being "cool" as adolescents complete challenges and share achievements with peers (Pham, 2023a,b; Le et al., 2024a,b). However, knowledge alone did not directly translate into actual behaviors on the roads (Alonso et al., 2018, 2020; Helal et al., 2018; Lal, 2022). Cyclists failed to apply road safety knowledge in practice despite possessing good knowledge (Mirza and Daud, 2013; Ratna et al., 2017). Therefore, road safety education should focus on skill developments and practical application (Twisk et al., 2013). Instead of being taught the meanings of isolated traffic signs, adolescents should practice observing, comprehending, and obeying traffic signs in real traffic environments (Pham, 2023a,b). Interventions that enhance awareness and safe riding habits could improve adolescents' comprehension and practice (John et al., 2012; Ryanto et al., 2023).

Moreover, comprehensive strategies combining education, infrastructure improvements, and enforcement are required to enhance road safety for adolescents (Kohli et al., 2013). There is an increasing trend in e-bikes among adolescents in Ho Chi Minh City (Nguyen et al., 2023a,b). To prevent road crashes with other vehicles in a mix of traffic, bikes and e-bikes should have dedicated lanes (Nguyen and Nguyen, 2015; Gadsby et al., 2022). The National Strategy for 2021–2030, with a vision for 2045, emphasized developing dedicated bike lanes to improve road safety in Vietnam (Ferreira et al., 2024). The local authority in Ho Chi Minh City is investigating cycling infrastructure and public bike sharing (HealthBridge, 2023). Starting in 2024, the Ho Chi Minh City Department of Transport assigned the Road Traffic Infrastructure Management Center to study routes for priority bike lanes in the central area and along Metro Line 1 (Nguyen et al., 2025; Quan and Anh, 2024).

Additionally, adolescents may be less inclined to follow driving regulations when the likelihood of legal enforcement is low (Le and Blum, 2013). Stricter enforcement should be implemented when risky behaviors are observed. Camera surveillance or non-motorized traffic enforcement cameras could be equipped to detect traffic violations among moped riders or motorcyclists (Lv et al., 2022). According to the Ho Chi Minh City's Department of Information and Communications, there are 2000 cameras installed to monitor public security and traffic conditions. Additionally, over 1000 outdoor cameras are supervised by the Urban Traffic Control Center (Bui Tuan, 2023).

Given that Vietnamese adolescents use motorcycles illegally and lack official training, Graduated Driver Licensing (GDL) programs have the potential to reduce motor vehicle use, contributing to a decrease in crashes and fatalities among teenage drivers, particularly for 16- and 17-year-olds (Robertson and Finnegan, 2003; Chen et al., 2006, Karaca-Mandic and Ridgeway, 2010; Masten et al., 2011) in both urban and rural areas (Morrisey and Grabowski, 2006). Dong et al. (2023) stated that young drivers in low-income areas were less likely to complete GDL programs and obtain licenses before the age of 18. Financial support policies for these drivers could reduce their burden. Cost-benefit assessments could evaluate if subsidies are justified by reducing property damage and injuries resulting from safer driving. Dee et al. (2005) found that the major cost from GDL programs is the limitation on driving in the late evening, which causes inconvenience for both parents and youths. Although some calculations showed that GDL policies may generate costs exceeding their

benefits, this perspective overlooked the benefits of reduced injuries in both fatal and non-fatal crashes. Many policy makers and citizens rejected these cost-benefit analyses in favor of an unrepentantly paternalistic opinion about the merits of these licensing regulations (Dee et al., 2005).

According to Vietnam's Law on Traffic, adolescent moped riders with a cylinder capacity of under 50 cc currently do not require a driving license. Since June 2024, this law has been divided into the Law on Roads and the Law on Road Traffic Order. The draft amendment to the Law on Road Traffic Order and Safety included provisions requiring a driving license for moped riders. Despite the enactment of this law, it still lacks specific provisions for issuing licenses or examining riders of moped under 50 cc. Meanwhile, the Vienna Convention stipulates that riders of motorcycles under 50 cc need to be issued an AM category license. Therefore, GDL programs should be studied for Vietnamese adolescents to align local laws with international standards, contributing to enhancing knowledge and skills for adolescents in Vietnam.

5.4. Limitations and future research

This exploratory study gathers eighteen adolescents from three higher secondary schools in urban areas of Ho Chi Minh City, Vietnam. The small sample may not represent all adolescents in the city, so future research should use a more randomized recruitment process for better representativeness. More adolescents using different transport modes, including motorcyclists, mopeds, (e)-cyclists, pedestrians, and pillion passengers, should be included. Additionally, local traffic environments should encompass various areas beyond just urban areas and include different weather situations, such as sunny and rainy weather. Involving stakeholders such as road users, parents, police, and road safety experts is essential to gain insights into risky behaviors among adolescents. Video recording times should vary from morning to evening and include weekdays and weekends. Furthermore, the lack of quantitative data, such as the frequency or severity of risky behaviors, reduces the ability to statistically validate findings or compare them with existing studies. Therefore, future research should combine qualitative and quantitative data to provide a comprehensive understanding of the risky behaviors and underlying motives of Vietnamese adolescents.

6. Conclusions

This study applied video elicitation focus groups to achieve the first detailed understanding of risky (motor)cycling behaviors and their underlying motives among Vietnamese adolescents. Prevalent issues included illegal motorcycle use, wrong lane riding, no helmet use, and lax enforcement. Motorcyclists, cyclists, car drivers, and pedestrians influenced adolescents by their risky behaviors, such as wrong lane riding, going abreast, and illegal parking, among others. Regardless of whether they follow or avoid these risky behaviors, adolescents still aim for safety. It is recommended that educators, practitioners and policymakers focus on innovative education that empathizes practical knowledge and skill development, improve infrastructure such as dedicated lanes for cyclists, implement a Graduated Driver License system, and enforce strict regulations to enhance the safety for Vietnamese adolescent cyclists on roads.

CRediT authorship contribution statement

Nguyen Hoai Pham: Writing – review & editing, Writing – original draft, Visualization, Investigation, Funding acquisition, Data curation, Conceptualization. **Tú Anh Trinh:** Writing – review & editing, Supervision, Software, Methodology. **Ariane Cuenen:** Writing – review & editing, Supervision, Methodology. **Davy Janssens:** Writing – review & editing, Supervision. **Geert Wets:** Writing – review & editing, Supervision.

Declaration of competing interest

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.

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Data availability

The data that has been used is confidential.

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