



Drunk Driving, Sleep Deprivation, Unsafe Vehicle, and Poor Road Design: Converging Hazards in a Road Traffic Crash in Sukhothai Province, Thailand, 2025

Sethapong Lertsakulbunlue^{1,2}, Sirirat Tunsawai³, Chatuphon Sanseela³, Rungnapa Kamkhae³, Rapeepong Suphanchaimat^{4,5}, Peeriya Watakulsin^{3,4}, Pitiphon Promduangsi^{3,6*}

- 1 Thailand Field Epidemiology Training Program (FETP), Division of Epidemiology, Department of Disease Control, Ministry of Public Health, Thailand
- 2 Department of Pharmacology, Phramongkutklao College of Medicine, Thailand
- 3 Office of Disease Prevention and Control 2 Phitsanulok, Department of Disease Control, Ministry of Public Health, Thailand
- 4 Division of Epidemiology, Department of Disease Control, Ministry of Public Health, Thailand
- 5 International Health Policy Foundation, Thailand
- 6 Division of Communicable Diseases, Department of Disease Control, Ministry of Public Health, Thailand

*Corresponding author, email address: pitiph.pr@gmail.com

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Abstract

Road traffic injuries are a leading cause of death globally, with alcohol impairment increasing the risk of an accident. At 7:10 AM on 10 Feb 2025, a pickup truck rear-ended a passenger vehicle carrying students in Sukhothai, Thailand. This study aimed to identify factors associated with the crash and recommend preventive measures. Data were collected through medical record reviews, site surveys, interviews with witnesses and stakeholders, and a joint agency meeting. Haddon's Matrix guided the analysis. All 20 occupants (2 drivers, 18 students) sustained injuries, with one case requiring admission for eyelid laceration. The weather was clear, the road was dry, and both drivers were experienced. Pre-crash risks included driver intoxication (blood alcohol concentration of 133 mg/dL) and drowsiness, the use of a modified passenger vehicle with unsafe seating and no seatbelts, and an inadequate road design, specifically a sudden lane reduction and a sub-standard U-turn constructed at villagers' request. Crash-phase risks included speeding, an abrupt lane change, and a steep roadside with a narrow (30 cm) shoulder, which caused the passenger vehicle to overturn. Post-crash issues included a lack of initial scene management, resulting in poor crowd control. This incident illustrates how alcohol impairment, an unsafe passenger vehicle, poor road design, and emergency response gaps contributed to the crash severity. The investigation led to policy actions, including U-turn closures, school transport vehicle reforms, and improved emergency medical services training. The value of field investigations in turning real-world crashes into targeted, system-level prevention strategies is underscored.

Keywords: pickup truck, alcohol, microsleep, school truck, Thailand

Introduction

Road traffic injuries (RTIs) are the leading cause of death globally, with 1.2 million deaths annually.¹ In 2023, Thailand ranked first in ASEAN in RTI mortality.¹ In 2022, the disability-adjusted life years

lost was 1.35 million among males and 0.49 million among females.² Although the national RTI mortality rate declined from 34.3 to 26.9 per 100,000 population between 2011 and 2023, it remains more than twice the national target of 12 per 100,000.^{2,3}

Pickup trucks accounted for the highest proportion of RTIs by vehicle type in 2023, comprising 36.1% of reported cases with eight of the top ten causes of RTI are driver-related.⁴ Drunk driving remains a major contributor to RTIs.¹ In Thailand, 2025 injury surveillance data indicated that 16.8% of RTIs were alcohol-related.⁵ National surveys from 2007 to 2017 showed a rise in binge drinking among current drinkers from 17.3% to 42.8%.⁶ Alcohol impairs reaction time and increases lane deviation and risk-taking behaviors such as speeding and heightened vulnerability to drowsy driving.⁷⁻⁹

On 10 Feb 2025, in Sukhothai Province, Thailand, a pickup truck rear-ended a modified passenger vehicle, resulting in one severe and 19 minor injuries. This event met Thailand's RTI investigation criteria according to the Ministry of Public Health (updated on 13 Sep 2024). Accordingly, a joint investigation team (JIT) investigated the event on 14 Feb 2025, aiming to describe the characteristics of the event, identify risk factors, and provide recommendations for future prevention.

Methods

Study Design

This descriptive study outlined the accident site and surrounding healthcare facilities, provided details of the event, characterized the injuries sustained, and described the rescue timeline and management. Additionally, road, environmental, and vehicle assessments were conducted.

Data on the number of accident victims and injury cases, driver behavior, blood alcohol levels, passenger seating arrangements, seatbelt availability and use, date of tax expiration and inspection of the vehicle, and driving licenses of the drivers, were obtained from a stakeholder meeting of the Road Safety Operations Center Committee, Sukhothai Province. Participating agencies included the Office of Disease Prevention and Control Region 2 Phitsanulok, the Sukhothai Provincial Public Health Office, Department of Disaster Prevention and Mitigation, Provincial Transport Office, Sukhothai Highway Department, the Primary and Secondary Educational Service Area Offices, Sukhothai Provincial Education Office, Ban Dan Lan Hoi Hospital, Ban Dan Lan Hoi Police Station, the Office of Insurance Commission, and an insurance agency in Pak Khwae Subdistrict. Additional insights into drivers' and passengers' behavior and barriers to rescue operations were obtained through interviews with drivers and nursing staff. A case was defined as an individual who sustained a physical injury during this event. The

review of case triage was based on the Modified National Triage Algorithm.¹⁰

Medical records from Ban Dan Lan Hoi Hospital were reviewed to collect data on injury characteristics. Details of emergency medical management, including the type of rescue team, receiving hospitals, and timelines, were documented. The prehospital time frame provided by Thailand's National Institute for Emergency Medicine included: (1) dispatch time: time between emergency call receipt from the Emergency Medical Services Command and Control Center, also known as the 1669 hotline, to dispatch decision, (2) activation time: time from call receipt to Emergency Medical Services (EMS) being dispatched, (3) response time: time from call receipt to scene arrival, (4) on-scene time: time from arrival to departure, and (5) transfer time: time from scene departure to hospital arrival.^{11,12}

The JIT surveyed the collision site for road type, number of lanes, structural features, traffic direction, roadside objects, surrounding terrain, and the presence of tire marks at the scene. Information on previous accidents was obtained from the stakeholder meeting, Thailand Road Accidents Data Centre for Road Safety Culture (ThaiRSC) database, and interviews with villagers. Environmental factors, such as weather conditions and lighting during the incident, were gathered through interviews with drivers and bystanders.

Haddon's matrix was used to classify risk factors across human, vehicle, road, and environment during pre-crash, crash, and post-crash periods.¹³ The consensus of the JIT determined each factor.

Results

Accident Site and Surrounding Healthcare Facilities

The accident occurred at 7:10 AM on 10 Feb 2025, on Jarod Withee Thong Road (Highway No. 12, Tak–Sukhothai route) between km 132+250 and km 133. The pickup truck (index vehicle) had traveled 57 km from Tak toward Sukhothai (Figure 1A). The nearby facilities include Ban Dan Lan Hoi Hospital, a 30-bed community hospital, located approximately 15 km from the accident site and Sukhothai Hospital, a 300-bed general hospital 27 km away. According to ThaiRSC, two incidents were reported at the same general location in 2022 and three in 2023, involving a total of eight individuals (two deaths and six injuries).

Event Description and Drivers' Behaviors

The collision diagram illustrated a northeast-bound passenger vehicle was traveling at approximately 50–70 km/h in the left-hand lane (Figure 1B). As the

vehicle approached a temple, the driver reduced speed, intending to turn into the temple's driveway to pick up more students. A pickup truck, travelling in the same direction but in the right-hand lane, at an estimated

speed of 100–120 km/h, made a sudden lane change to avoid traffic poles and subsequently made a rear-end collision with the passenger vehicle. The passenger vehicle then overturned and rolled into a roadside ditch.

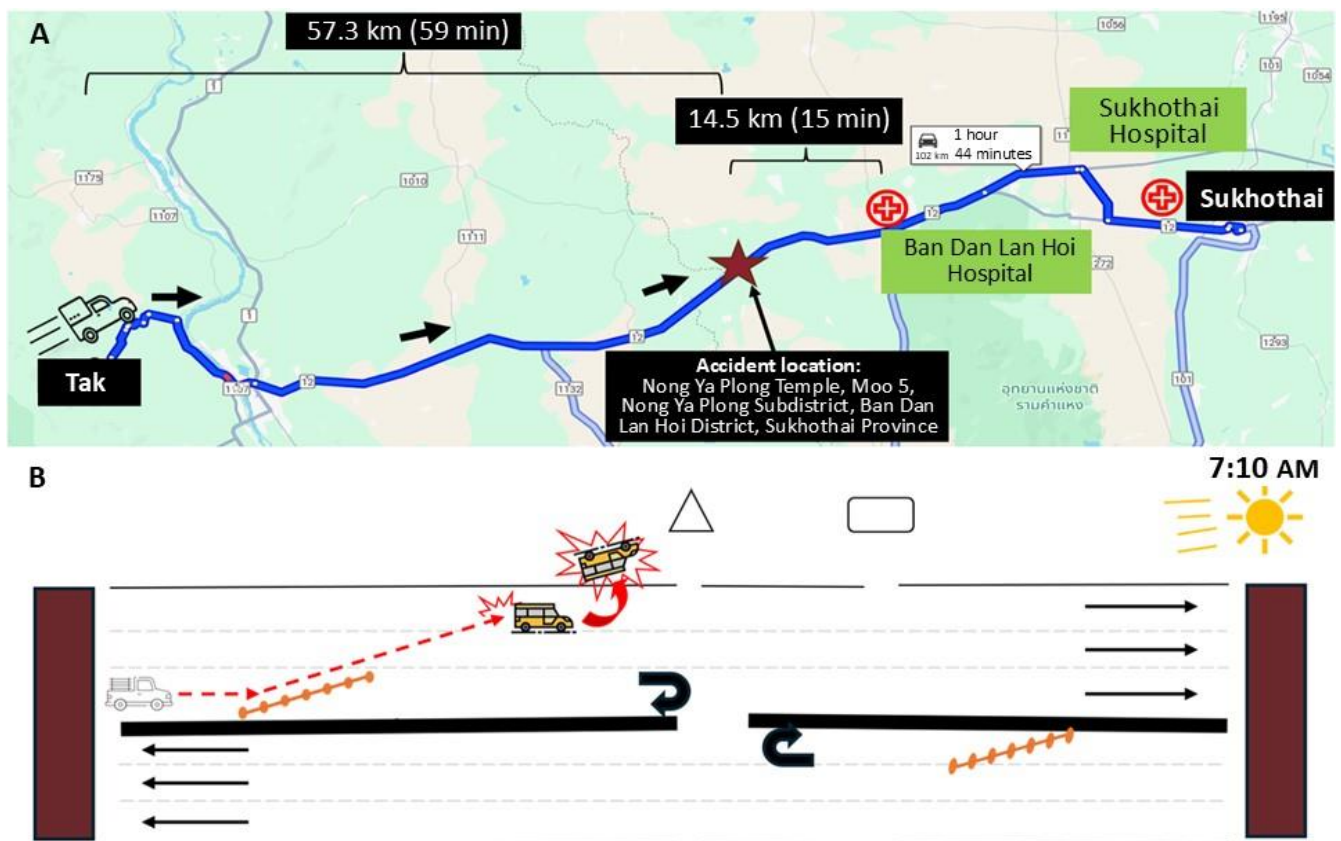


Figure 1. (A) Map showing the pickup truck's route from departure (Tak Province) to destination (Sukhothai Province), the accident location, and the nearest hospital for the road traffic accident in Sukhothai Province on 10 Feb 2025. (B) A collision diagram illustrating the pickup truck rear-ending the school transport vehicle. The red dashed arrow indicates the path of the pickup truck as it abruptly moved to the left lane to avoid traffic poles.

Both drivers held valid licenses, and were familiar with the route (Table 1). The pickup truck driver had been driving for about one hour without a break. A breathalyzer test revealed a blood alcohol level of 133 mg/dL. No alcohol was detected in the passenger vehicle driver.

The pickup driver is a social drinker and has no history of traffic accidents. Before the event, he attended a work dinner party in Tak province that began at around 7:00 PM. He consumed at least two large bottles of beer before midnight. He continued drinking beer with his colleagues until approximately 4:00 AM. He had only one to two hours of sleep before the incident.

Characteristics of Injuries

Twenty individuals sustained injuries from the crash. The pickup truck driver, a 31-year-old male, sustained a minor superficial thoracic injury. The passenger vehicle driver, a 39-year-old male, sustained a superficial injury to his right elbow. Among the 18 passengers, 6 were male and 12 were female, and the

median age was 14.5 years (range 13–18 years). Nine (50%) were categorized as urgent. Of the nine urgent cases, two had puncture wounds, one had a laceration, and two had abrasions; the remaining four reported only pain. Among the non-urgent cases, four had abrasions, with no puncture wounds or lacerations reported. One was referred to Sukhothai Hospital due to a laceration wound to the right upper eyelid with suspected involvement of the lacrimal duct and levator muscle, with a closed nasal bone fracture, requiring ophthalmologist evaluation.

The passenger vehicle had been modified to include a third row of seats. This additional row lacked both seatbelts and handrails, features not permitted. The passenger who was admitted to hospital was seated in row 2, position 3 (Figure 2). The proportion of urgent cases was highest in rows 1 and 2 (67%; 2/3 and 4/6, respectively). The distribution of injury locations revealed the highest proportion of injuries to extremities (41%), followed by external body surface (26%), and head and neck (15%) (Supplementary Figure 1).

Table 1. Driver behavior and related factors in a road traffic accident in Sukhothai Province, Thailand, on 10 Feb 2025

Variable	Pickup driver	Passenger vehicle driver
Driver details	Male, 31 years old. No underlying diseases.	Male, 39 years old. No underlying diseases.
License & experience	<ul style="list-style-type: none"> Held a Type 3 driver's license (issued in 2019) with over 5 years of driving experience. Familiar with this route, due to his job. 	<ul style="list-style-type: none"> Held a Type 2 driver's license (issued in 2018) with over 5 years of driving experience. Familiar with this route.
Occupation	Deliveryman for agricultural products	Driver and general employee at a school
Driving behavior	<ul style="list-style-type: none"> Drove at approximately 100–120 km/h. Wore a seatbelt. 	<ul style="list-style-type: none"> Drove at approximately 50–70 km/h. Did not wear a seatbelt.
Incident details	<ul style="list-style-type: none"> Drove for approximately one hour without a break, departing around 6:00 AM. Changed lane suddenly before the accident and suspected drowsiness. Attempted to avoid traffic poles, which were installed to narrow the lane and slow down vehicles before a U-turn area near Nong Ya Plong Temple. Drank yogurt immediately after the crash. 	<ul style="list-style-type: none"> Departed home in Nong Ya Plong Subdistrict, Ban Dan Lan Hoi District around 6:00 AM. Traveled from Nong Ya Plong Subdistrict to Ban Dan Lan Hoi Kindergarten and Ban Dan Lan Hoi Wittaya School. Turning near the entrance of Nong Ya Plong Temple, approximately 500–700 meters from the crash site, to pick up more students from the village behind the temple. At the time of the accident, 18 students were on board. The vehicle can carry up to 30 passengers.
Alcohol test	Post-accident breathalyzer test showed a blood alcohol content of 133 mg/dL (converted).	No alcohol detected on breathalyzer test.

Road and Surrounding Environment

The road at the incident site is a straight, asphalt-paved four-lane highway with a recently constructed (June 2024) concrete barrier median installed to prevent cross-lane collisions (Figure 3). Approximately one month after construction, villagers requested that a U-turn be created near the entrance to the temple. During the incident, road conditions were dry with clear lane markings and no visual obstructions. The roadside included a dry ditch situated below road level. Visibility was adequate in the morning. The pickup

truck driver reported mild sun glare; however, it did not impair his visibility of other vehicles, traffic lane markers, or traffic poles. Warning signs and speed limit indicators were small and placed only after the U-turn, with none located within 100 meters before the U-turn. Specifically, four deviations from the GD-402 guideline specified by the Department of Highways, Thailand, for U-turns at a median barrier were identified: absence of a road shoulder, insufficient width (<3.5 meters) of yellow cross-hatchings, lack of post-U-turn cross-hatchings, and lack of pre-U-turn warning signs (Supplementary Figure 2).¹⁴

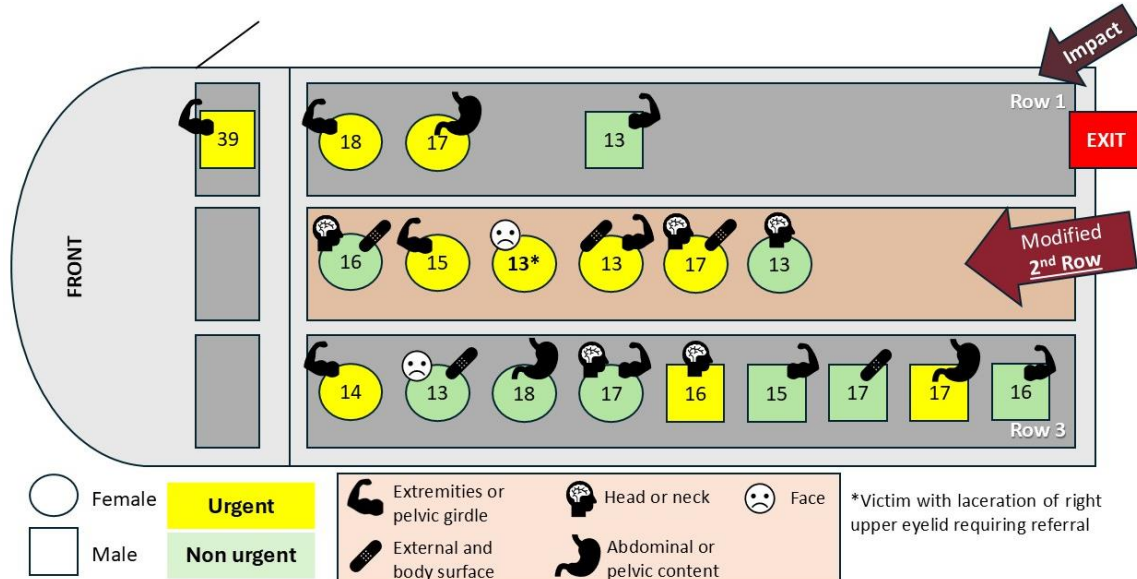


Figure 2. Seating arrangement in the passenger vehicle and corresponding injury characteristics of the road traffic accident in Sukhothai Province on 10 Feb 2025. The numbers within each shape denote the passenger's ages.



Figure 3. Images of the accident site on Jarod Withee Thong Road (Highway No. 12, Tak–Sukhothai route) between km 132+250 and km 133, in front of Nong Ya Plong Temple. (A) Google Earth image showing the previous road layout with no median barrier and only two lanes each way. (B) Photo taken on February 14, 2025, showing the newly constructed median barrier and approach containing orange traffic poles leading up to the U-turn bay, expanding the road to three lanes. (C) Image highlighting narrow yellow cross-hatching and unclear warning signs. (D, E) Photos taken on the day of the accident (10 Feb 2025) showing adequate visibility, visible tire marks from the passenger vehicle (upended), and a narrow road shoulder.

Vehicle Assessments

The pickup truck was a two-door truck with a modified metal cargo frame registered as a private passenger vehicle under the Motor Vehicle Act. It was covered by compulsory insurance through ERGO Insurance (18 Apr 2024–18 Apr 2025); no voluntary insurance was found with a recent inspection in April 2024. Post-crash inspection revealed front-end collapse on the passenger side, a detached grille, an open hood, and misaligned wheels, with greater damage on the passenger side (Figures 4A and 4B).

The modified passenger vehicle was a six-wheel vehicle registered for public transport use. It was covered by compulsory insurance from Viriyah Insurance (31 Dec 2024–31 Dec 2025), with no voluntary insurance. The vehicle featured reinforced steel framing, three rows of metal-framed bench seats fixed to the body, and no seat belts. Each row could accommodate approximately 10 passengers. The vehicle passed its most recent inspection in December 2024. However, the third row of seats had been removed prior to the inspection and was reinstalled afterward. Post-crash

damage included a collapsed roof on the driver's side, a crushed driver's door, and a detached seat from the metal frame (Figures 4C and 4D).



Figure 4. Post-crash images of the pickup truck and passenger vehicle. (A) Front view of the pickup truck; (B) side view of the pickup truck; (C) side view of the passenger vehicle; and (D) rear view of the passenger vehicle.

Rescue Timeline, Management and Barriers

The incident occurred at approximately 7:10 AM and was reported to the police by a bystander. At 7:17 AM, the Emergency Room at Ban Dan Lan Hoi Hospital received notification from the EMS command center. An advanced life support vehicle was dispatched at 7:20 AM (activation time: 3 minutes). Concurrently, the EMS nurse requested support from the subdistrict administrative organization and coordinated traffic control with the police. Both EMS teams arrived at the scene by 7:28 AM. The first urgent case arrived at the hospital at 7:35 AM (Figure 5). Although the dispatch time was only one minute, an additional two minutes were required to collect complete incident details before deployment (Table 2).

Table 2. Time frame for Emergency medical services at a road traffic accident in Sukhothai Province on 10 Feb 2025

Time elements	Actual duration (minutes)	Standard time* (minutes)
Dispatch time	1	1
Activation time	3	2
Response time	11	8
Scene time	2	10
Transfer time	8	-
Total time	24	

*According to Provincial Emergency Medical Services Performance Scoring Index, 2023

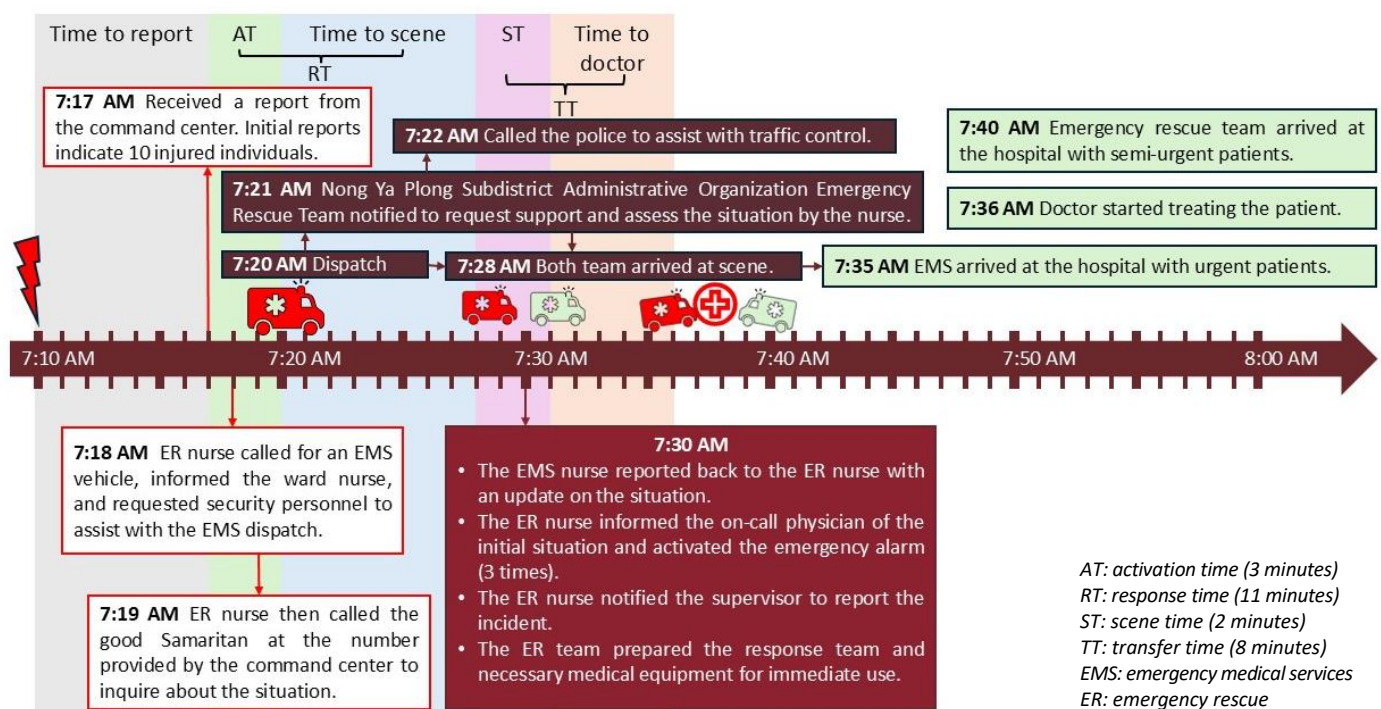


Figure 5. Emergency medical services (EMS) timeline, including notification, rescue process, and time frame, based on the 2023 Provincial EMS Performance Scoring Index (PEPSI), for the road traffic accident in Sukhothai Province on 10 Feb 2025

Pre-hospital care at the accident site faced several challenges, including the absence of initial scene management due to the EMS team's lack of confidence and an unclear command structure. This led to no formal scene safety assessment or traffic control, despite a recent rescue training workshop in January 2025. Crowd control was limited by an insufficient number of authorities at the scene, the large size of the crowd, and the restless behavior of bystanders. Additionally, some victims' relatives moved injured individuals before the EMS arrived. The lack of designated triage zones hindered accurate casualty assessment. Pre-arranged support from the Nong Ya Plong Subdistrict Administrative Organization EMS enabled the timely transfer of patients to the hospital.

Possible Risk Factors

Haddon's matrix is shown in Table 3. The primary pre-crash human factor was attributed to the pickup truck driver intoxication and a lack of sleep following a work-related social event, resulting in drowsiness, possible speeding, and a delayed response to road traffic poles. Road-related risks included inappropriate placement of warning and speed limit signs, narrow road shoulder, and narrow yellow cross-hatchings. The modified passenger vehicle also posed safety concerns due to non-standard seating configurations. Post-crash, the absence of a confident leader from the EMS team contributed to insufficient scene safety management and crowd control.

Table 3. Haddon's matrix model to assess risk in a road traffic accident in Sukhothai Province, Thailand, on 10 Feb 2025

Period	Human	Vehicle	Environment
Pre-crash	<ul style="list-style-type: none"> Both drivers have adequate driving experience. Pickup truck driver: <ul style="list-style-type: none"> Consumed alcohol (breathalyzer: 133 mg/dL). Drove at high speed. Experienced drowsiness or microsleep. Slept 1-2 hours before driving. 	<ul style="list-style-type: none"> Passenger vehicle: <ul style="list-style-type: none"> Did not meet school transport vehicle safety standards. Roof frame was modified from wood to metal. 	<ul style="list-style-type: none"> Downhill slope. Modified U-turn near temple entrance for local access, causing lane narrowing. Lane reduction from three to two lanes with markings and flexible traffic posts. Absence of speed limit signs. No road shoulder. Insufficient width of yellow cross-hatching.
Crash	<ul style="list-style-type: none"> Pickup truck driver: <ul style="list-style-type: none"> Changed lanes suddenly. Attempted to avoid traffic poles. Passenger vehicle driver: <ul style="list-style-type: none"> Did not wear a seatbelt. 	<ul style="list-style-type: none"> Passenger vehicle: <ul style="list-style-type: none"> Lacked backrests and handholds in the second row. No fitted seatbelts. 	<ul style="list-style-type: none"> Passenger vehicle overturned into a 1-meter-deep roadside ditch (~60° incline). Mild sun glare was present but did not impair the pickup truck driver's visibility.
Post-crash	<ul style="list-style-type: none"> No formal scene safety assessment. Delayed traffic control, increasing risk of secondary accidents. Faced poor crowd control due to large number of bystanders and presence of concerned relatives. Moved injured individuals before EMS arrived, limiting injury assessment. Lacked knowledge of how to activate an EMS call. No compensation due to lack of voluntary insurance. 	<ul style="list-style-type: none"> The roof of the passenger vehicle collapsed on the driver's side. 	<ul style="list-style-type: none"> The road surface was elevated by approximately 1 meter above the roadside with a 60-degree incline, hampering rescue efforts.

EMS: emergency medical services.

Action Taken

A stakeholders meeting was convened to assess risks, implement preventive measures, and guide further investigations. A centralized and standardized system for school transport vehicles was established through collaboration among the Primary and Secondary Educational Service Area Offices of Sukhothai, the Sukhothai Provincial Education Office, and the Provincial Transport Office. This system includes random inspections to identify unfit drivers and non-compliant vehicles, particularly those with unauthorized seat modifications. A social network-based communication platform was established to facilitate reporting of any misconduct, enabling direct communication between authorities and parents. Ban Dan Lan Hoi Hospital was recommended to strengthen emergency response training, emphasizing team leader roles and preparedness of all members.

As of 1 Apr 2025, the traffic in front of Nong Ya Plong Temple has been monitored. Two minor motorcycle accidents occurred, attributed solely to human factors. Recommended road changes—warning signs, speed limits, and median barrier closure—are under consideration by the Department of Highways and expected to be implemented in the next fiscal year.

Discussion

This event demonstrates how several risk factors converged and subsequently led to RTIs, resulting in numerous casualties. The combination of the risk factors makes this study unique compared to many previous studies on RTIs, which have typically identified only a single or a few risk factors.^{11,15–17}

The pickup driver's intoxication and sleep deprivation were key contributing factors in this incident. Drunk driving is a leading cause of RTIs on Thai highways, with the risk of fatal crashes increasing notably at

blood alcohol concentrations above 50 mg/dL.^{4,18} A national survey reported that 40% of respondents had driven under the influence in the past year, particularly during special occasions, consistent with the present case.^{6,19} However, evidence suggests that drunk driving is less prevalent in Bangkok, likely due to greater public awareness, stricter law enforcement, and better access to public transportation options.^{6,20}

The passenger vehicle, registered as a public transport vehicle, violated several school transportation safety regulations. It lacked the required large orange “school vehicle” sticker and absence of handholds and seatbelts in the modified middle row. These omissions compromise passenger safety, as both handholds and seatbelts are proven to reduce injury severity.²¹ In 2021, 51%–61% of U.S. crash fatalities among teens and adults involved unrestrained passengers.²² Nevertheless, standard seatbelts may offer limited protection in non-conventional seating arrangements, such as rear- or side-facing seats.²³ A previous case in Khon Kaen Province linked modified seating in a passenger van with a side-facing position to increased injury risk.¹⁵

In this incident, although the modified passenger vehicle overturned, neither the driver nor the passengers sustained life-threatening injuries. This outcome may be attributed to several factors. First, the reported speed of the pickup truck by the bystanders may have been exaggerated.²⁴ Second, the passengers were primarily teenagers, a group generally at lower risk of severe injury compared to young children or the elderly.²⁵ Finally, the modified passenger vehicle had reinforced steel framing, which likely prevented the roof from collapsing.

At the request of local villagers, a new median barrier was installed at the section of road near Nong Ya Plong Temple, followed by a lane reduction. However, the abrupt lane reduction and absence of adequate warning signs or speed limits posed a significant safety risk. Abrupt lane changes have been linked to increased crash risk, contributing to 33% of all road collisions in the U.S.^{26,27} Consistent with the present study, inadequate signage and speed control measures are well-documented environmental factors contributing to RTIs.²⁸

The steep roadside and narrow shoulder likely contributed to the increased risk and severity of the incident. Although most of the affected could walk unaided, the terrain posed challenges for rescuers during their extraction from the damaged vehicle. Narrow shoulders limit vehicle recovery space, reduce lateral clearance, and increase the risk of run-off-road crashes and abrupt maneuvers.^{29,30} Studies show that

broader road shoulders, up to 2.7 meters, significantly reduce crash severity, while paved shoulders of 0.9–1.2 meters are cost-effective for rural roads.^{30,31}

Post-crash challenges included the absence of an initial scene management. Although EMS personnel are trained to be incident commanders, the position was not effectively assumed in this event due to a lack of confidence by the team leader and an unclear command structure. The lack of scene control increases the risk of secondary crashes and interference by untrained bystanders, potentially worsening injuries.³² Public education on road safety and appropriate bystander behavior can help mitigate such risks.³³ Moreover, while police often act as first responders, a survey in Northeastern Thailand found that only 56% of traffic police had comprehensive emergency medical training, potentially delaying effective care.³²

Limitations

To avoid potential psychological distress, the injured students were not interviewed. Instead, their behavioral information was obtained from the driver of the passenger vehicle and two nursing staff. The scene survey occurred four days after the accident, which prevented an accurate assessment of real-time conditions, and no CCTV or dashcam footage was available. Although a stakeholder meeting provided helpful information, speed and collision analysis was limited by the absence of mechanical or traffic engineering expertise.

Recommendations

The Provincial Transport Office should enforce school vehicle registrations, seatbelt use, passenger limits, and driver licenses, and conduct random inspections in collaboration with schools and police. Inspections should specifically verify seat configurations, as the addition of a third row, found in this case, may violate regulations. The Department of Highways should review the U-turn area for compliance with GD-402. Ban Dan Lan Hoi Hospital should regularly conduct mass casualty drills focusing on the command structure. For a long-term plan, schools should formalize agreements with transportation operators to ensure that they use appropriately licensed vehicles and establish channels for parents to report any unsafe behavior. Public campaigns should raise awareness of appropriate bystander roles in trauma situations. Lastly, employers should end celebratory events before midnight, limit alcohol consumption, and screen drivers for fitness before duty. Moreover, this case also highlights the need for other jurisdictions to proactively assess their highways for hazardous road designs.

Conclusion

This investigation of a road traffic injury in Sukhothai, involving a pickup truck rear-ending a modified passenger vehicle, resulted in 20 injuries, one severe and 19 minor. The primary cause was driver intoxication and drowsiness following a celebratory event by a typically non-drinker. Contributing modifiable risks included an unsafe school transport vehicle, poor road infrastructure, and the absence of initial scene management. Preventing similar incidents requires coordinated efforts across sectors, including monitoring driver fitness, enforcing school vehicle regulations, improving road safety features, and enhancing RTI training for healthcare and law enforcement personnel.

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Author Contributions

Sethapong Lertsakulbunlue: Conceptualization, data curation, formal analysis, methodology, project administration, validation, visualization, writing—original draft, writing—review & editing. **Sirirat Tunsawai:** Conceptualization, data curation, validation. **Chatuphon Sanseela:** Conceptualization, data curation, validation. **Runghana Kamkhae:** Conceptualization, data curation, validation. **Rapeepong Suphanchaimat:** Methodology, resources, supervision, validation, writing—review & editing. **Peeriya Watakulsin:** Conceptualization, resources, supervision, validation. **Pitiphon Promduangsi:** Conceptualization, resources, supervision, validation, writing—review & editing.

Ethical Approval

This study was a part of routine investigation and response activities of the Thai Department of Disease Control, Ministry of Public Health. Ethics approval was not required.

Informed Consent

Not applicable. This study used fully de-identified secondary data obtained from routine outbreak surveillance and reporting systems. No identifiable personal information was collected or used, and the data cannot be linked back to individual participants.

Data Availability

The datasets used and/or analyzed in this study are available from the author on reasonable request (via Sethapong.ler@pcm.ac.th).

Conflicts of Interest

The authors declare no conflicts of interest.

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

We utilized ChatGPT-4.0 to assist with grammar editing of the manuscript; however, the authors remain fully responsible for the accuracy and integrity of the content.

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