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Systematic Review

Truck Driver Safety: Factors Influencing Risky Behaviors on the Road—A Systematic Review

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Abstract

Truck drivers play a pivotal role in global freight transport systems, yet their occupational and behavioral risk exposures make them a priority population in road safety research. This systematic review examines the factors influencing risky driving behaviors among truck drivers and their impacts on road safety outcomes. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines, the review aimed to identify hazardous driving behaviors, the internal and external factors contributing to these behaviors, and their consequences for traffic safety. Inclusion criteria targeted original research published in English between 2009 and 2024 specifically focused on truck driver behavior and road safety outcomes. Systematic searches across PubMed, Scopus, Web of Science, and IEEE Xplore yielded 104 studies meeting these criteria. The synthesis revealed prevalent risky behaviors—such as speeding, fatigue-related impairments, distracted driving, and substance use—driven by internal factors (e.g., health conditions, psychological stress) and external pressures (e.g., occupational demands, regulatory constraints). These behaviors were consistently associated with increased crash risk. Nonetheless, limitations including the exclusion of non-English studies, reliance on self-reported data, and lack of standardized metrics constrained cross-study comparability and generalizability. Effective interventions identified include fatigue management programs, driver monitoring technologies, and positive safety climates. Findings underscore the urgent need for evidence-based, multifaceted strategies to enhance truck driver safety and inform policy, industry practices, and future research.

Keywords: road traffic accident; driver behavior; risk factor; truck driver; road safety

Academic Editor: Douglas O'Shaughnessy

Received: 14 July 2025
Revised: 29 August 2025
Accepted: 30 August 2025
Published: 2 September 2025

Citation: Fonseca, T.; Ferreira, S. Truck Driver Safety: Factors Influencing Risky Behaviors on the Road—A Systematic Review. *Appl. Sci.* **2025**, *15*, 9662. https://doi.org/10.3390/app15179662

1. Introduction

Road traffic accidents remain a global challenge, resulting in significant human and economic costs. Each year, over 1.19 million people lose their lives to road accidents, while millions more sustain injuries with long-term consequences [1]. The economic impact is equally severe, often exceeding 3% of a country's gross domestic product, particularly in developing economies where resources to address these issues are limited [2]. Within this critical context, professional drivers—especially truck drivers—stand out as a group requiring specialized attention due to their unique occupational, behavioral, and environmental challenges.

Truck drivers play an essential role in the global freight and logistics system. However, their work environment is rife with risk factors that jeopardize road safety. Long hours,

irregular sleep schedules, and extended highway driving frequently lead to fatigue, cognitive impairments, and slower reaction times [3,4]. Combined with tight delivery schedules and economic pressures, these conditions increase the likelihood of risky behaviors such as speeding, distracted driving, and stimulant use [5,6]. Studies attribute up to 90% of road accidents to driver-related factors, underscoring the critical role of human behavior in traffic safety [7,8].

Despite the extensive body of research on driver behavior, studies focusing specifically on truck drivers remain fragmented. The trucking profession poses unique challenges that set it apart from other driving contexts, including longer working hours, the transportation of heavy or hazardous loads, and the pressure of maintaining tight schedules under unpredictable environmental conditions [9–11]. These distinctive stressors not only shape driving behaviors but also amplify the consequences of errors, highlighting the need for tailored research. While general studies on driver behavior provide valuable insights, they often fail to account for the occupational, psychosocial, and environmental factors specific to truck drivers [12].

This systematic review aims to address these gaps by synthesizing evidence on factors influencing risky driving behaviors among truck drivers and their impact on road safety outcomes. Three key research questions (RQ) guide this review:

RQ1: What are the predominant hazardous driving behaviors exhibited by truck drivers that critically compromise road safety?

RQ2: Which internal and external factors most significantly contribute to the prevalence of these hazardous driving behaviors among truck drivers?

RQ3: What are the impacts of these hazardous driving behaviors on road safety outcomes for truck drivers, including incident frequency, near-miss occurrences, and injury severity?

Building on recent work by Rashmi and Marisamynathan [12], this review provides an updated and comprehensive framework for understanding truck driver behaviors and their implications for road safety. By integrating empirical evidence, it offers actionable insights for policymakers, transportation companies, and safety advocates. The findings are expected to inform the development of targeted interventions, including fatigue management programs, in-vehicle monitoring technologies, and organizational policies aimed at reducing risks and enhancing safety in the trucking industry.

The remainder of this paper is organized as follows: Section 2 describes the systematic review methodology, including the criteria and processes for selecting relevant studies from the literature. Section 3 presents the results, emphasizing key findings and themes identified in the reviewed studies. Section 4 provides a comprehensive discussion, highlighting the significance of the findings, their strengths, and limitations, while offering actionable recommendations and proposing directions for future research to improve truck driver safety. Finally, Section 5 concludes by summarizing the key insights and implications drawn from the reviewed studies.

2. Methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [13] to ensure methodological transparency and reproducibility. A predefined protocol, systematic search strategy, and clearly specified inclusion and exclusion criteria were employed to ensure methodological rigor and maintain objectivity throughout the review process. Further details are provided in the PRISMA 2020 checklist (see Supplementary Materials, Document S1). The specific methods applied in this review are outlined below.

2.1. Protocol

A structured protocol was developed at the outset of the review to define the objectives, research questions, eligibility criteria, and methodological approach. The protocol was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO) under reference CRD420250627553 [14], thereby reinforcing transparency, minimizing bias, and promoting consistency throughout the review process.

The review followed a systematic four-stage process: identification of relevant studies through database searches, screening of titles and abstracts to evaluate their relevance, full-text assessment to confirm eligibility, and final inclusion of studies that met all predefined criteria. Inclusion and exclusion criteria were consistently applied at each stage, with all decisions documented to ensure transparency and reproducibility.

2.2. Eligibility Criteria

The review focused on professional truck drivers as the population of interest. Eligible studies examined the impact of internal factors (e.g., fatigue, stress) and external factors (e.g., road conditions, occupational demands) on driving behaviors and reported road safety-related outcomes, such as accident frequency, near-misses, and injury severity. Only original research articles published in peer-reviewed journals, written in English, and published between January 2009 and October 2024 were included to ensure the relevance and quality of the evidence.

Studies were excluded if they target populations other than professional truck drivers, such as passenger vehicle or bus operators. Research addressing outcomes not directly tied to road safety, such as vehicle performance or driver comfort, was also excluded. Furthermore, review articles, editorials, opinion pieces, conference abstracts, and grey literature (i.e., theses, reports, or governmental documents) were rejected to maintain a focus on primary, scientifically validated evidence.

2.3. Search Strategy

A systematic search was conducted in November 2024 across four major electronic databases: PubMed, Scopus, Web of Science, and IEEE Xplore. These databases were selected for their coverage of research in occupational health, transportation, and road safety. The search utilized Boolean operators with the following keyword combination: “driver” or “truck” or “professional” or “commercial” or “freight” and “health” or “fatigue” or “stress” or “drug” or “pressure” or “distraction” or “ergonomics” or “mental” or “alcohol” and “safety” or “accident” or “incident” or “crash” or “risk” or “behavior”.

No supplementary techniques, such as citation tracking or snowballing, were used. This focused approach ensured a systematic and replicable identification of eligible studies while minimizing potential biases associated with non-standardized search methods.

2.4. Data Collection and Extraction

Data collection and extraction were carried out by a single reviewer using a standardized protocol to uphold methodological consistency and reduce potential bias. Following the completion of database searches, all retrieved records were imported into the Rayyan platform for systematic reviews (Rayyan Systems Inc., Cambridge, MA, USA, 2025), which facilitated automatic duplicate removal. Title and abstract screening were conducted within Rayyan, applying predefined inclusion and exclusion criteria to assess each record’s relevance. Studies that passed this initial screening proceeded to full-text evaluation for final eligibility determination. This rigorous and transparent workflow ensured that only studies aligned with the review’s research questions were included in the synthesis.

To extract data, a structured Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, WA, USA, Version 16.77.1, 2025) was created to systematically capture essential details from each eligible study. The process was supported by ChatGPT (OpenAI, San Francisco, CA, USA, GPT-4, 2025), which assisted in identifying and organizing relevant elements such as study objectives, methodological design, variables analyzed, and principal findings. All extracted data were manually reviewed and cross-checked against the original publications by the reviewer to ensure accuracy and consistency.

2.5. Data Synthesis

Data synthesis was conducted as a narrative summary of the evidence on factors influencing risky driving behaviors among truck drivers, categorized by the type of factor analyzed. The synthesis is structured into sections addressing internal factors, external factors, and hazardous driving behaviors. Although other elements, such as vehicle design, may also influence driver behavior, the selected categories reflect the aspects most frequently examined within the scope and timeframe of the reviewed studies.

Appendix A Table A1 provides a detailed summary of the included studies, covering authorship, geographic context, objectives, data collection processes, analytical techniques, key variables, and primary findings. This comprehensive overview highlights both the breadth of the evidence base and the methodological diversity across studies.

Study quality was assessed using a streamlined framework developed for this review, drawing on domains from the Joanna Briggs Institute critical appraisal tools [15] and the National Heart, Lung, and Blood Institute (NHLBI) quality assessment tools [16]. Four domains were evaluated: selection bias, measurement bias, confounding, and reporting bias. Each included study was rated as low risk, some concerns, or high risk, following a traffic light classification system. An overall quality rating was subsequently assigned based on the domain-specific evaluations. This approach provided a transparent and consistent appraisal of study quality, enabling the qualification of evidence strength in the synthesis. The results of this assessment are presented in Appendix A Table A2.

3. Results

This section presents an overview of the findings from the systematic review, focusing on the key themes and evidence synthesized. It is organized into three subsections: study selection, detailing the processes of study identification and inclusion; factors influencing truck drivers' behavior, which examines the internal and external influences shaping driver behaviors; and aberrant driving behavior, which explores specific high-risk practices and their implications for road safety.

A total of 104 studies were included in the analysis. These studies provide valuable insights into the complex interplay of factors affecting truck driver behaviors and their associated safety outcomes. The subsections further elaborate on these findings, offering a foundation for the discussions and implications addressed in the subsequent section.

3.1. Study Selection

The study selection process, including identification, screening, and inclusion of eligible studies, is presented in the PRISMA flow diagram (see Figure 1). A total of 8226 records were identified using systematic searches conducted across four major electronic databases: PubMed, Scopus, Web of Science, and IEEE Xplore. No additional records were retrieved from other sources or registers.

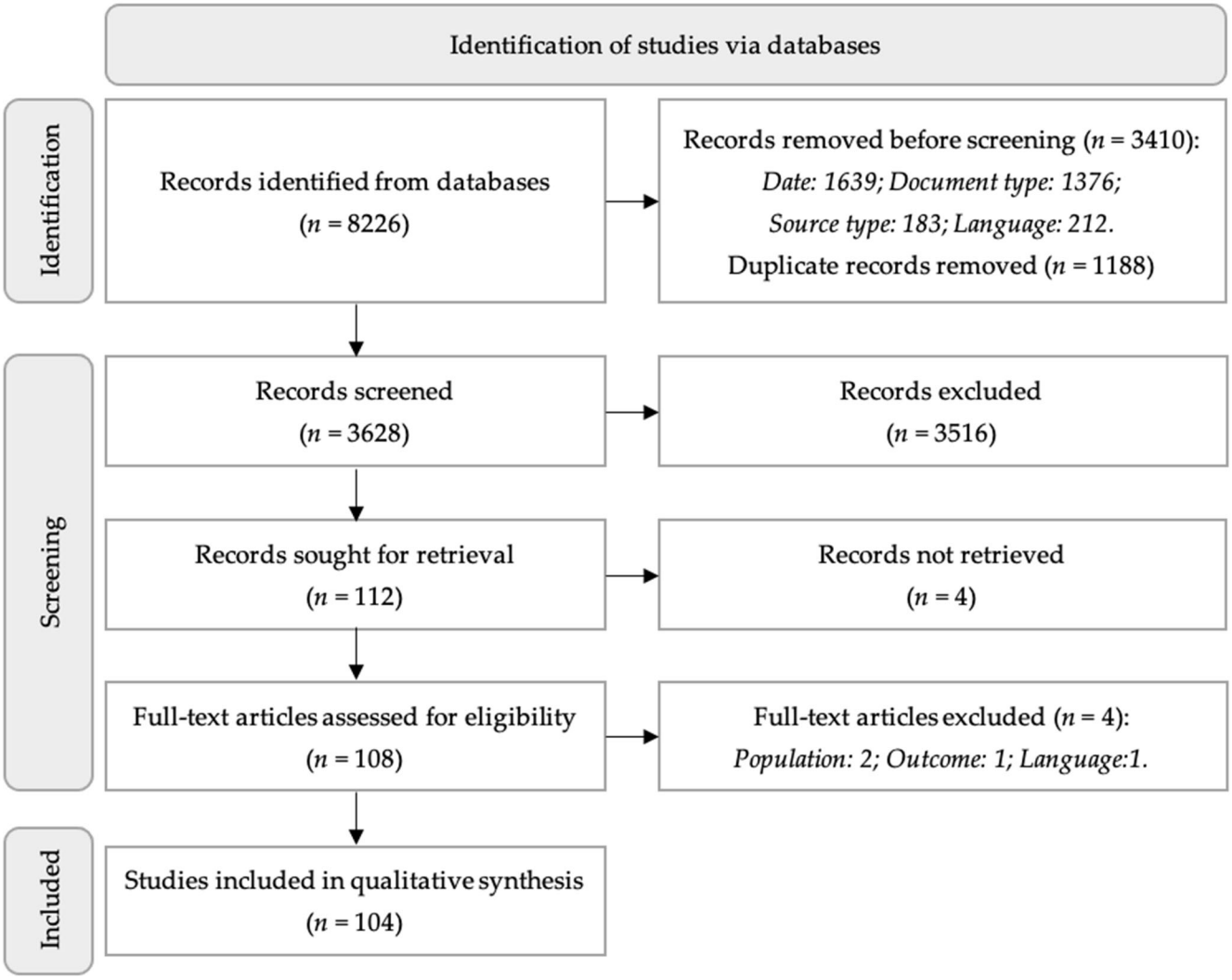

Figure 1. The identification, screening, and inclusion process of eligible studies using PRISMA 2020.

During the initial identification phase, 3410 records were excluded based on predefined criteria to ensure alignment with the review's objectives. These exclusions included 1639 records published outside the specified date range, 1376 due to document type, 183 based on source type, and 212 for language reasons. Additionally, 1188 duplicate records were removed, resulting in 3628 unique records eligible for title and abstract screening.

In the screening phase, the titles and abstracts of the remaining records were analyzed to determine their alignment with the inclusion criteria. A total of 3516 records were excluded for failing to meet criteria related to the population, methodology, or outcomes. These records either did not focus on professional truck drivers, lacked an examination of internal or external factors influencing driving behavior, or addressed outcomes unrelated to road safety. Following this screening, 112 records were selected for full-text review.

Of the 112 records identified for full-text retrieval, 108 articles were successfully obtained. Despite efforts to access them through institutional resources, four records could not be retrieved. The 108 full-text articles underwent an eligibility assessment, resulting in the exclusion of four studies. Two studies did not focus on professional truck drivers, one examined outcome unrelated to road safety, and one was not published in English.

A total of 104 studies met the predefined inclusion criteria and were included in the qualitative synthesis. These studies offered valuable insights into the multifaceted factors influencing truck driver behaviors, spanning a wide range of geographical regions,

methodological approaches, and research designs. Notably, the academic quality of the included literature was high, as evidenced by journal quartile rankings based on the Scimago Journal Rank (SJR) system, which categorizes journals into quartiles (Q1–Q4) according to their relative impact within subject areas. Of the 104 studies, 73 (70.2%) were published in Q1 journals. An additional 23 studies (22.1%) appeared in Q2 journals, while only four studies each were published in Q3 and Q4 journals (3.8% each), as presented in Table 1. This distribution highlights the predominance of high-impact, peer-reviewed sources in the synthesis, reinforcing the robustness and credibility of the evidence base analyzed in this review.

Table 1. Number of selected studies per quartile.

Quartile Ranking	Number of Studies
Q1	73
Q2	23
Q3	4
Q4	4

Research on truck driver behavior has demonstrated a steady and accelerating growth trajectory over the past 15 years, reflecting increasing scholarly attention to occupational road safety. The number of relevant publications rose from just 2 studies in 2009 to a cumulative total of 104 by 2024 (see Figure 2). Key inflection points occurred between 2015 and 2018, when the number of studies doubled from 20 to 41, and again between 2018 and 2021, with a sharp increase from 41 to 82 studies. This upward trend suggests a growing recognition of the importance of understanding and mitigating risky driving behaviors among truck drivers, likely driven by advances in monitoring technologies, the emergence of fatigue and distraction as major safety concerns, and broader global efforts to reduce transportation-related injuries and fatalities.

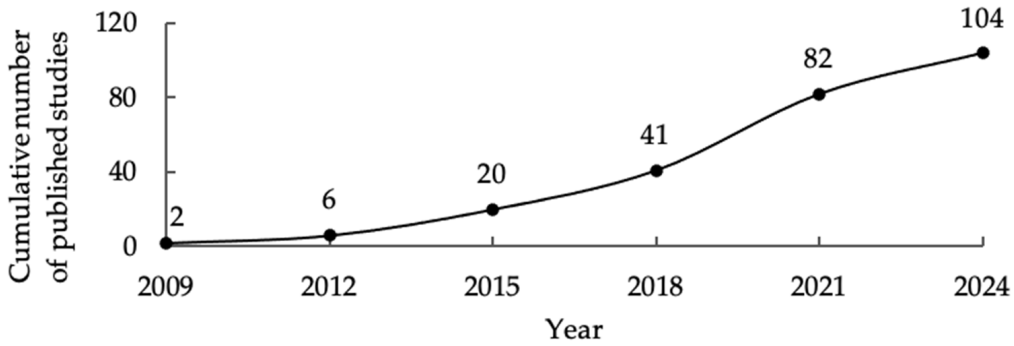

Figure 2. Cumulative number of published studies on truck driver behavior.

Geographically, most included studies were conducted in the United States, accounting for 36% of the total (see Figure 3). China contributed 10% of the studies, followed by Iran with 8%, Brazil with 7%, and Australia, Japan, and India each representing 6%. The remaining 21% of studies were conducted in other countries. This distribution indicates a wide range of international contributions to the literature on truck driver behavior and road safety.

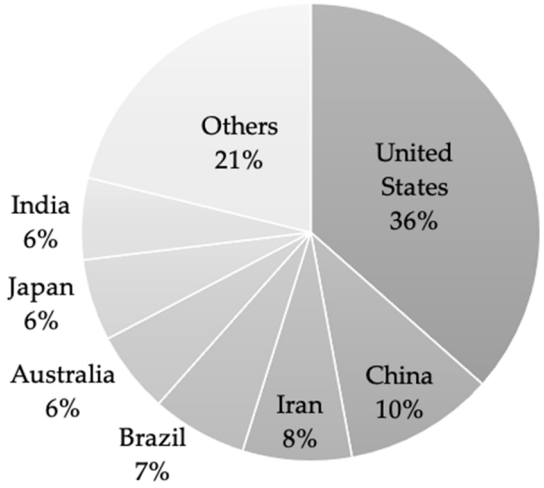

Figure 3. Country wise distribution of selected studies.

3.2. Factors Influencing Truck Drivers' Behavior

Understanding the complex interplay of factors that influence truck drivers' behavior is essential for improving road safety outcomes. Truck driving is a demanding occupation that exposes drivers to various stressors, ranging from occupational demands to individual and environmental characteristics. These factors do not operate in isolation but interact dynamically to shape behaviors that may enhance or compromise safety. Identifying and addressing these influences can lead to targeted interventions and policies aimed at mitigating risky behaviors and fostering safer driving practices.

This section examines the influential factors that significantly affect truck drivers' behavior, focusing on the internal and external elements that interplay with driving safety. Internal factors such as age, gender, health conditions, and psychological traits shape individual tendencies and responses behind the wheel. External influences include occupational demands, vehicle characteristics, road conditions, and regulatory frameworks that create the broader context within which drivers operate. By exploring these dimensions, this section seeks to provide a comprehensive overview of the determinants of truck driver safety and risk behavior.

3.2.1. Age

The relationship between age and truck driver safety is multifaceted, reflecting both the benefits of experience and the challenges of aging. Older truck drivers, typically aged 50 and above, demonstrate risk-averse behaviors, such as reduced engagement in speeding or abrupt lane changes, likely due to accumulated experience and awareness of risks [17,18]. However, aging introduces physical and cognitive limitations, including slower reaction times and diminished visual acuity, which increase vulnerability in demanding driving environments, such as adverse weather or curving roadways [19,20].

Fatigue and sleep-related issues further compound these risks among older drivers. Excessive daytime sleepiness, exacerbated by long hours and irregular schedules, impairs attentiveness and increases crash likelihood [21,22]. Although older drivers are involved in fewer accidents overall, the severity of crashes tends to be higher due to reduced physical resilience and pre-existing health conditions [17,23].

Protective factors mitigate some of these risks. For instance, the presence of passengers has been found to reduce stress and improve attentiveness, highlighting the role of social support in enhancing safety [24]. Regulatory measures, such as mandated rest breaks and health screenings, further contribute to safer outcomes [25].

As the trucking workforce ages, implementing targeted interventions becomes increasingly essential. Strategies such as fatigue management programs, advanced driver-assistance systems, and age-tailored safety training effectively address the specific challenges older drivers face, helping to maintain high road safety standards [17,20]. These initiatives emphasize the importance of leveraging the unique strengths of an aging driver population while addressing their specific vulnerabilities.

3.2.2. Gender

Gender plays a notable role in influencing truck driver behavior and crash risk, with significant differences observed between male and female drivers. Male drivers dominate the trucking workforce, comprising over 90% of commercial truck drivers. This overwhelming majority skews available data and analyses toward male behavioral patterns [26,27]. Male drivers are more frequently associated with high-risk behaviors, including speeding, driving under the influence, and fatigue-related driving, all of which significantly increase their likelihood of severe crashes, particularly under challenging conditions such as nighttime or adverse weather [27,28].

In contrast, female truck drivers, though underrepresented, exhibit safer driving behaviors. Research indicates that female drivers are less likely to engage in risky actions such as tailgating or aggressive maneuvers, which may contribute to their lower rates of crash involvement [19,24]. However, findings regarding injury severity among female drivers remain inconclusive. Some studies suggest that female drivers might face higher injury risks due to physiological factors or crash dynamics, but the reviewed articles do not provide sufficient evidence to substantiate these claims [27,29].

The observed differences in male and female driving patterns highlight the importance of gender-specific insights into truck driver safety. However, the limited representation of female drivers in both the workforce and research underscores the need for more inclusive studies to better understand and address gendered differences in crash risk and safety outcomes.

3.2.3. Driving Experience

Empirical evidence indicates that novice drivers, particularly those with fewer than three years of professional experience, are significantly more likely to engage in high-risk behaviors [30]. These behaviors increase the likelihood of severe accidents, particularly under challenging conditions such as nighttime driving, adverse weather, and complex road geometries, where limited experience impairs hazard perception and decision making [30]. Additionally, novice drivers are more vulnerable to fatigue-related impairments, including delayed reaction times and reduced attention [26].

In contrast, drivers with more than 10 years of professional experience are significantly less likely to report involvement in accidents or near-misses [31]. Girotto et al. [32] demonstrated a strong inverse relationship between longer professional experience and crash involvement, independent of factors such as age, substance use, working conditions, or traffic behaviors. This reduced risk correlates with the accumulation of experience, although the specific mechanisms underlying this protective effect remain unclear.

3.2.4. Health Condition

Truck drivers experience a variety of health challenges that significantly affect their driving behavior. Among these, sleep disorders, particularly insomnia, are common and associated with a marked increase in crash risks. Garbarino et al. [33] found that insomnia nearly doubles the likelihood of motor vehicle accidents and raises the risk of near-miss incidents by more than threefold, even after accounting for other sleep-related conditions such as obstructive sleep apnea and excessive daytime sleepiness. Fatigue, especially when

induced by acute stress during driving, further exacerbates these risks. Minusa et al. [34] identified heightened sympathetic nervous system activity, a physiological marker of stress-induced fatigue, as a significant contributor to rear-end collisions. Disrupted circadian rhythms and poor sleep quality also impair vigilance and reaction times, particularly during nighttime driving and extended shifts, further reducing driving performance [3,35].

Chronic health conditions are another critical factor influencing truck driver safety. A large cohort study involving 38,184 drivers demonstrated that individuals with three or more chronic conditions, including hypertension, diabetes, and cardiovascular disease, face significantly higher risks of preventable crashes and injury-related incidents compared to those without such conditions [36]. The poor management of these health conditions is often compounded by systemic barriers. Thiese et al. [36] emphasized that commercial drivers frequently rely on emergency and urgent care services due to limited access to regular healthcare providers, which restricts preventive care and effective treatment. The combination of multiple unmanaged health conditions and insufficient healthcare access substantially increases the likelihood of unsafe driving behaviors.

3.2.5. Social Context

The social context of truck drivers, including education level, marital status, and income, significantly influences risky driving behaviors and road safety outcomes. Education appears to exert a dual influence: higher education levels are paradoxically associated with increased psychoactive substance use, potentially reflecting modernization and work-related pressures [25]. In contrast, lower education levels are linked to reduced safety awareness and a greater likelihood of being at fault in crashes [37,38]. Marital status also plays a critical role, with married drivers less likely to be involved in accidents [38]. Familial responsibilities may act as a preventive factor, as drivers from larger families report lower rates of substance use compared to single or childless counterparts [25].

Income levels further compound these dynamics, significantly influencing safety-related behaviors. Financial incentives tied to productivity, such as payments for on-time deliveries or trip completion, often lead to longer working hours and reduced rest periods. This results in increased fatigue and compromised driving performance. For example, a study on Indian long-haul truck drivers found that economic pressures to earn additional income were associated with higher rates of sleep deprivation and drowsy driving [39]. Socioeconomic disparities, including lower household incomes, have been linked to higher probabilities of at-fault crashes. Drivers from less affluent communities often face greater stress and are more likely to be involved in crashes due to human errors [37].

3.2.6. Job Characteristics

The occupational characteristics of truck drivers, including work schedules, compensation structures, and organizational safety climates, significantly influence driving behaviors and road safety outcomes. Shorter rest periods, such as seven hours compared to eleven hours, are associated with reduced sleep duration, heightened fatigue, and an increased likelihood of drowsy driving crashes [39,40]. Irregular schedules and extended work hours further exacerbate these risks, particularly during night shifts, when circadian rhythms are at their lowest, leading to impaired performance and elevated accident rates [41].

Compensation systems also play a critical role in shaping driver behavior. Higher financial incentives, such as pay-per-mile rates, are associated with improved safety outcomes by reducing moving violations and encouraging compliance with regulations. These incentives allow drivers to achieve earnings targets more efficiently, minimizing the need for prolonged driving hours and mitigating fatigue-related risks [42,43]. Non-financial incentives, such as supportive management practices and fostering positive work envi-

ronments, complement these effects by enhancing job satisfaction and reducing unsafe behaviors, such as shortening mandated rest periods, which are strongly linked to increased accident risks [43].

The safety climate within organizations is another critical determinant of safe driving behaviors. Positive safety climates, characterized by strong managerial commitment, frequent communication of safety priorities, and clear protocols, are associated with reduced distracted driving and greater adherence to safety regulations [44,45]. Furthermore, studies demonstrate that safety climate not only directly influences driving safety behaviors but also mediates the relationship between safety practices and near-miss events, underscoring its protective role in reducing risks [46].

Importantly, occupational tenure moderates the influence of safety climate. Drivers with longer tenure tend to rely more on personal experience and knowledge, which can attenuate the impact of organizational safety measures [46]. Despite this, safety climate remains a dominant factor in promoting safe driving behaviors, highlighting its critical role in organizational efforts to enhance road safety.

3.2.7. Vehicle and Freight Characteristics

Vehicle and freight characteristics significantly influence truck driver behavior and road safety. Improperly balanced or unsecured loads increase the risk of rollovers, particularly when navigating curves. Such loads amplify lateral forces, destabilizing the vehicle and heightening the probability of crashes [47]. Overloading further exacerbates these risks by impairing braking efficiency and reducing maneuverability, leading to longer stopping distances and compromised vehicle stability. Conversely, driving with an empty load is associated with nearly threefold higher crash risks compared to transporting general freight. This elevated risk is attributed to altered handling dynamics and reduced traction, making empty trucks harder to control under varying conditions [30,31].

Vehicle age and maintenance also play a critical role in road safety. Older trucks, often lacking modern safety features such as anti-lock braking systems, exhibit an increased likelihood of crashes. Advanced systems like anti-lock brakes improve vehicle control during emergency braking or on slippery roads, and their absence substantially increases risk [48]. Additionally, mechanical issues such as defective brakes frequently contribute to crashes, particularly in single-vehicle incidents [20]. These deficiencies emphasize the critical role of routine maintenance in ensuring vehicle safety and preventing accidents.

3.2.8. Temporal Characteristics

Temporal characteristics have a measurable impact on truck drivers' behavior and the risk of accidents. Nighttime driving, particularly between midnight and 6:00 AM, is consistently associated with elevated crash risks due to increased fatigue, reduced alertness, and slower reaction times [20,31]. Furthermore, the lower traffic volumes typical of nighttime driving encourage higher speeds, which amplify the severity of injuries in the event of a crash [19].

Crash risks also vary by time of day and lighting conditions. Dark mornings, especially during late fall and winter when daylight hours are shorter, are associated with more severe crash outcomes compared to mornings with daylight. In contrast, daylight conditions during the morning significantly reduce the likelihood of severe injuries, particularly in early hours [49].

Day-of-week patterns reveal additional differences. Morning crashes on weekdays are generally less severe than those occurring on weekends, with a higher likelihood of no injuries and a lower likelihood of minor or severe injuries. However, weekday crashes in

the afternoon tend to result in more severe outcomes compared to weekends, potentially due to work-related pressures and increased traffic volumes during these hours [49].

3.2.9. Road and Environmental Characteristics

Road and environmental conditions are crucial determinants of truck driver safety and crash severity. Road geometry, particularly in mountainous and rural areas, significantly influences crash risk. Sharp curves and steep downgrades have been identified as primary contributors to rollovers and loss-of-control incidents. The high center of gravity and braking limitations of heavy trucks further increase their vulnerability on such road features. Misjudgment of speed on these roads frequently results in severe crashes, emphasizing the importance of designing infrastructure suited to the operational characteristics of heavy vehicles [26,30,47].

Adverse weather conditions, such as rain, snow, and fog, further elevate crash risks by reducing visibility and road traction. These hazards are particularly severe in tunnels, poorly lit areas, and on roads with complex geometries. The combination of adverse weather and challenging road designs greatly increases the probability of severe incidents [19,30].

3.2.10. Regulatory Environment

The regulatory environment in the United States, particularly Hours of Service (HOS) regulations, aims to mitigate fatigue-related risks by limiting the maximum duty and driving hours for truck drivers. Despite these efforts, the regulations have shown no significant impact on improving safety outcomes, such as reducing crashes or fatalities [50]. Noncompliance with HOS regulations is widespread, driven by economic pressures such as mileage-based pay and tight delivery schedules, which incentivize drivers to exceed legal limits [51].

Efforts to enforce compliance have introduced unintended consequences, including increased daytime traffic congestion caused by shifts in driving schedules, which complicate safety dynamics [50]. While technological advancements, such as electronic logging devices (ELDs), have enhanced enforcement, they have not resolved systemic issues such as pay structures and compensation rates [52].

In contrast, other regions have adopted alternative approaches. In the European Union, driving time rules are more restrictive, imposing tighter limits on daily and weekly driving hours. Meanwhile, Australia adopts a more flexible approach, stipulating work and rest periods while offering tailored exemptions through fatigue management plans [51].

3.2.11. Psychological Dimension and Personality Traits

The psychological and personality dimensions of truck drivers are pivotal in shaping their driving behaviors and influencing road safety outcomes. Evidence from the included studies highlights the impact of stress, mental health challenges, and personality traits on risky driving behaviors and elevated crash risks [53–57].

Stress emerges as a key determinant of unsafe driving practices among truck drivers. Common occupational stressors, such as tight delivery schedules, long working hours, and insufficient rest, contribute to fatigue and impair cognitive functions, leading to behaviors such as speeding and distractions [53]. Prolonged exposure to stress may result in emotional exhaustion, which further compromises decision-making abilities and increases the likelihood of road accidents [54].

Mental health challenges, particularly depression, have also been identified as significant contributors to risky driving behaviors. Depression, characterized by symptoms such as sadness, fatigue, and restlessness, impairs reaction times and diminishes hazard perception, both essential for safe driving. Furthermore, the occupational realities of long-haul

trucking, including extended periods of social isolation, exacerbate psychological strain. This isolation undermines drivers' resilience to occupational stressors, heightening the risk of unsafe driving behaviors [55].

Personality traits exert an additional influence on driving behavior, adding complexity to the assessment of risks associated with truck driving. Traits such as high neuroticism and low conscientiousness have been linked to an increased prevalence of risky behaviors, including speeding, abnormal stays, and hard acceleration. Conversely, conscientiousness has been identified as a significant predictor of safer practices, such as avoiding driving overtime, demonstrating greater adherence to rules and safer driving habits [56]. Moreover, optimism bias, where drivers overestimate their abilities, has been associated with less cautious driving behaviors, further increasing the risk of unsafe practices [57].

3.3. Hazardous Driving Behavior

Building on the previous discussion of factors shaping driver behavior, this section examines the predominant hazardous driving behaviors exhibited by truck drivers and their impact on road safety outcomes.

The analysis begins by investigating the prevalence and characteristics of these behaviors, focusing on how occupational pressures, external demands, and individual vulnerabilities contribute to their occurrence. It then explores the broader implications, detailing how these behaviors influence crash dynamics and the severity of outcomes. By synthesizing evidence, this section situates these driving practices within the unique context of the trucking profession, providing a foundation for understanding the safety challenges faced by truck drivers and the wider implications for road safety.

3.3.1. Speeding and Illegal Overtaking

Speeding and illegal overtaking behaviors are among the most critical risky driving practices reported among truck drivers, contributing significantly to crash frequency and severity. These behaviors often stem from occupational pressures, road conditions, and individual tendencies, highlighting their multifaceted nature.

Speeding is the most frequently cited risky behavior among truck drivers and is closely associated with occupational pressures such as tight delivery deadlines and financial incentives based on productivity. Research has shown that such pressures push drivers to prioritize efficiency over safety, particularly on highways and rural roads where law enforcement is less visible. For example, in India, approximately 41.7% of crashes involving trucks were attributed to speeding, exacerbated by the drivers' tendency to disregard safer practices under time constraints [58,59]. Demographics and personal traits also influence speeding. Evidence regarding younger drivers is mixed: some studies suggest they may avoid certain risky behaviors like speeding due to inexperience, while others report that younger and less experienced drivers are more likely to engage in unsafe practices, often associated with overconfidence or limited risk perception. Conversely, older drivers, particularly those with poor sleep quality, appear more prone to speeding offenses, potentially linked to mental and physical fatigue [45,60–62].

Illegal overtaking, another high-risk behavior, is often motivated by the same occupational pressures that drive speeding. It is particularly dangerous on roads with limited visibility, sharp curves, or insufficient passing zones. Drivers frequently misjudge the time and space required for safe overtaking, leading to severe collisions such as head-on or sideswipe crashes. These crashes often occur in high-risk environments, such as early mornings when reduced visibility and law enforcement exacerbate the risks [29,60].

The consequences of these behaviors are severe. Speeding significantly increases the kinetic energy in a collision, amplifying the severity of injuries and fatalities. Trucks' unique

operational characteristics, such as higher mass and longer stopping distances, further elevate the risks associated with excessive speeds [29,61]. Illegal overtaking behaviors compound this danger by introducing unpredictable maneuvers that lead to direct collisions with oncoming traffic, which are associated with higher rates of fatalities and severe injuries [60,61].

3.3.2. Fatigue Driving and Poor Sleep Quality

Truck drivers frequently face irregular schedules, extended working hours, and limited opportunities for rest, all of which significantly contribute to fatigue. Ahlström and Anund [63] found that nighttime driving presents even greater challenges, as drivers report significantly higher levels of sleepiness compared to daytime driving. Fatigue intensifies rapidly during longer nighttime trips, compounded by disruptions to circadian rhythms that diminish drivers' alertness and reaction times. These occupational demands are further exacerbated by economic pressures such as mileage-based pay and tight delivery schedules, which compel many drivers to prioritize productivity over rest, resulting in chronic sleep deprivation [39,64].

Beyond occupational demands, external factors such as road quality and traffic conditions further magnify the risks of fatigue. Mizuno et al. [65] demonstrated that fatigued drivers exhibit impaired autonomic responses, directly correlating with increased rear-end collision risks. Poor road infrastructure and heavy traffic exacerbate driver stress while limiting opportunities for adequate rest, creating a vicious cycle of fatigue and compromised safety [39,66].

Individual vulnerabilities also play a pivotal role in exacerbating fatigue. Health conditions, lifestyle choices, and insufficient rest significantly impair cognitive performance, reaction times, and visual attention. For instance, Cui et al. [67] found that fatigued drivers display reduced visual scanning and increased forward fixation, both of which signal diminished alertness and heightened crash risks. Furthermore, poor sleep quality, often linked to uncomfortable rest environments and noisy truck stops, further degrades driving safety [52].

The broader implications of fatigue-induced behaviors are profound, as they directly influence crash dynamics and severity. Behaviors such as maintaining shorter headways and slower reaction times significantly heighten collision risks. Afghari et al. [68] found that fatigued drivers often reduced headway distances, which increased the likelihood of collisions. Similarly, Mizuno et al. [65] identified a strong correlation between elevated fatigue levels and rear-end collisions. Structured rest breaks, as highlighted by C. Chen and Xie [69], are an effective intervention to mitigate these risks, underscoring the critical importance of fatigue management in promoting road safety.

3.3.3. Drug Use and Drunken Driving

Truck drivers often resort to psychoactive substances such as amphetamines and cocaine to combat fatigue resulting from prolonged work hours and irregular schedules. A study conducted in São Paulo, Brazil, revealed that 5.2% of truck drivers tested positive for drugs, with cocaine being the most common (2.7%), followed by amphetamines (2.1%) and tetrahydrocannabinol (THC) (1.0%) [70]. Additionally, Sinagawa et al. [71] highlighted a strong association between longer travel distances and amphetamine use, as drivers sought to stay alert during extended shifts.

Alcohol consumption further exacerbates risky driving behaviors. Binge drinking and the use of alcohol mixed with energy drinks have been linked to increased driving violations, such as unbelted driving and aggressive maneuvers [72]. Moreover, alcohol negatively impacts sleep quality, impairing next-day alertness and increasing the likelihood

of accidents [21]. These findings underscore the dual impact of substance use on both immediate driving performance and overall road safety.

Economic and occupational stressors significantly amplify these risky behaviors. Autonomous truck drivers, who bear the financial burdens of maintenance, fuel, and other travel-related expenses, are particularly vulnerable to stimulant use as they strive to maximize their earnings by extending driving hours [73,74]. Similarly, compensation models that reward distance traveled often encourage drivers to forego rest, further increasing their reliance on stimulants like amphetamines [71].

The broader consequences of these behaviors are evident in crash statistics. Although stimulants are intended to enhance wakefulness, they often impair cognitive functions, leading to unsafe maneuvers and a higher likelihood of crashes. For instance, stimulant-positive truck drivers were found to have a 78% greater probability of engaging in unsafe driving actions in fatal crashes [75]. Similarly, alcohol consumption, especially when combined with cannabis, has been shown to double the risk of crashes due to compounded impairment effects [74].

3.3.4. Risky Lane Change

Occupational pressures, including tight delivery schedules and compensation models such as mileage-based pay, compel truck drivers to prioritize efficiency over safety. These pressures often result in hurried and unsafe lane-changing maneuvers as drivers rush to meet deadlines or maximize earnings, increasing the risk of errors [76].

External factors further amplify the dangers of unsafe lane changes. Poor road infrastructure, such as narrow lanes and inadequate markings, significantly heightens the likelihood of errors during lane transitions. Notably, deviations to the left, a behavior closely tied to lane changes, have been shown to contribute to severe crash outcomes, particularly on two-way highways where stressful driving conditions prevail [76].

Individual vulnerabilities also play a critical role in risky lane changes. Fatigue, for example, reduces driver alertness and vehicle stability, often resulting in abrupt or unsafe maneuvers. Ronen et al. [77] demonstrated with driving simulation studies that fatigued drivers experience greater lane position deviations and steering instability, especially during prolonged driving sessions. Similarly, distractions such as mobile phone use divert attention from essential driving tasks, significantly increasing the probability of errors during lane changes [76].

The consequences of risky lane changes are often severe, leading to multi-vehicle collisions, side-impact crashes, or rollovers. Such incidents are associated with higher fatality rates and more complex crash dynamics. Nighttime driving exacerbates these risks, as reduced visibility and delayed reaction times make lane changes even more perilous [40,76].

3.3.5. Distracted Driving

Distracted driving among truck drivers is a pressing concern in road safety that is attributed to the unique occupational demands and working conditions of this profession. The convergence of long driving hours, monotonous routines, and economic pressures creates an environment conducive to risky behaviors such as mobile phone use while driving (MPWD). This behavior not only endangers the drivers themselves but also amplifies risks for other road users. Understanding the multifaceted factors contributing to distracted driving is essential for developing effective interventions to mitigate these risks and enhance road safety.

Occupational pressures are a key factor driving distracted behaviors among truck drivers. The necessity of maintaining communication with dispatchers and clients often

leads to MPWD. Long and monotonous driving hours exacerbate this behavior, as drivers engage in secondary tasks to alleviate boredom or maintain alertness [78,79]. Furthermore, tight delivery schedules and economic pressures compel multitasking, even in situations where distraction elevates safety risks [80].

External environmental conditions also shape distraction patterns. Studies reveal that MPWD is more prevalent during low-traffic conditions and on highways, where drivers perceive a reduced immediate crash risk [81,82]. Conversely, complex traffic scenarios or challenging road conditions demand greater cognitive focus, reducing the likelihood of distractions [83].

Individual characteristics significantly influence distraction tendencies. Younger drivers and those with less experience are more likely to engage in distractions, possibly due to overconfidence or a lack of risk awareness [45,62]. Additionally, lifestyle factors, such as stress and smoking, are associated with increased distraction behaviors [80]. The solitary and demanding nature of long-haul trucking also contributes to engagement in secondary tasks, as drivers seek to mitigate stress or drowsiness [79].

Distracted driving substantially impacts crash dynamics and the severity of outcomes. Visual-manual tasks, such as texting, are particularly hazardous, increasing the likelihood of safety-critical events by up to 163 times compared to non-distracted driving [81]. These behaviors impair situational awareness and delay reaction times, significantly heightening the probability of crashes or near-crashes [83]. However, distraction risk varies by type. Auditory tasks, such as hands-free phone use, are associated with lower risks compared to visual-manual distractions, reflecting the complexity of the relationship between distraction types and safety outcomes [79].

Efforts to mitigate distracted driving among truck drivers have focused on multifactorial interventions. Stricter enforcement of laws against high-risk behaviors, such as texting, combined with technological solutions like in-vehicle monitoring systems, show promise. Organizational strategies, including improving safety climates through better communication, management commitment, and reduced work pressures, further contribute to reducing distractions [45]. Educational programs targeting younger and less experienced drivers also hold potential for promoting safer behaviors [62]. These interventions, addressing the interplay among occupational, individual, and environmental factors, represent critical steps toward reducing distracted driving behaviors among professional truck drivers.

3.3.6. Tailgating

The study conducted by Hosseinzadeh et al. [76] examines tailgating as a critical factor influencing the severity of crashes involving large trucks. By categorizing crashes into three distinct types—multivehicle crashes where truck drivers are at fault, multivehicle crashes where non-truck drivers are at fault, and single-vehicle truck crashes—the research provides a nuanced analysis of how tailgating impacts crash outcomes across different scenarios.

In multivehicle crashes where truck drivers were identified as at fault, tailgating was found to significantly increase the likelihood of fatal outcomes. This underscores the pronounced risks associated with insufficient following distances in situations where truck drivers are unable to maintain adequate control. The hazard is exacerbated by the unique braking dynamics and extended stopping distances required by heavy vehicles, which amplify the severity of collisions when tailgating occurs.

Conversely, in multivehicle crashes where non-truck drivers were at fault, tailgating was associated with a decreased probability of fatalities. This finding highlights the contextual variability in how tailgating influences crash dynamics, contingent on the at-fault

party. The authors suggest that differences in vehicle types and driver behaviors between trucks and other vehicles may account for these divergent effects.

4. Discussion

The discussion section synthesizes the findings of this review, evaluates their broader implications, and identifies gaps and opportunities for future work. Building on the evidence presented in the results, it critically examines the factors influencing truck driver safety and highlights interventions and policies needed to mitigate these risks. By integrating insights across disciplines and geographical contexts, the section aims to provide a holistic perspective on improving safety outcomes for truck drivers and other road users.

4.1. Key Findings

This review identified a set of hazardous driving behaviors that compromise road safety, most prominently speeding, fatigue-related impairments, distracted driving, and substance use. These behaviors were shaped by both internal influences, such as fatigue, health conditions, and stress, and external pressures, including occupational demands, road conditions, and economic incentives. The recurrent overlap between these domains illustrates the difficulty of attributing causation to a single factor. For example, economic pressures may simultaneously extend working hours (external) and increase fatigue (internal), underscoring the interconnected nature of these risks.

To consolidate the evidence base, Table 2 summarizes the number of supporting studies, overall direction of associations, data sources, and geographic coverage for the most prominent risk factors. Fatigue and poor sleep quality were the most consistently studied and strongly associated with adverse outcomes, while speeding, distracted driving, and substance use also showed robust associations across multiple contexts. In contrast, risky lane change and tailgating were less frequently examined, with limited or mixed findings. Crash records dominated as a data source, though many studies also used objective measures (e.g., eye-tracking, physiological monitoring, toxicology) or self-reports. Geographically, most studies were concentrated in Asia and the Americas, with fewer contributions from Europe and Oceania, reflecting uneven global coverage.

Table 2. Summary of major risk factors for hazardous behaviors among truck drivers.

Risk Factor	Studies Reporting Association	Overall Direction of Association	Primary Data Sources	Geographic Distribution of Studies
Speeding and illegal overtaking	8	Positive association	Administrative records (crash data); Self-report (interviews, questionnaires)	Asia; North America; South America
Fatigue driving and poor sleep quality	22	Positive association	Administrative records (crash data, company records); Objective (heart rate, eye-tracking, driving performance); Self-report (interviews, questionnaires)	Asia; Europe; North America; Oceania; South America
Drug use and drunken driving	6	Positive association	Administrative records (crash data, driving history); Objective (toxicology, cognitive tests); Self-report (questionnaires)	Asia; North America; South America
Risky lane change	2	Positive association	Administrative records (crash data); Objective (eye-tracking, vehicle metrics); Self-report (questionnaires)	Asia; Oceania
Distracted driving	6	Positive association	Administrative records (crash and penalty records); Objective (device use, driving performance, eye-tracking); Self-report (interviews, questionnaires)	Asia; North America
Tailgating	1	Mixed/uncertain	Administrative records (crash data)	Asia

Correlations between these behaviors and safety outcomes—such as crash frequency, near-miss occurrences, and injury severity—were consistently reported. However, methodological limitations, including small sample sizes and reliance on self-report, constrained causal inference. Furthermore, evidence on moderating factors such as organizational safety climate, regulatory adherence, and vehicle technologies remains sparse, limiting understanding of their mitigating potential.

Despite these gaps, the review highlights several promising interventions. Structured rest breaks, advanced driver-assistance systems, and fatigue-monitoring technologies consistently reduced risk. Educational initiatives targeting safety awareness and stress management also showed potential benefits. These findings underscore the importance of integrated, evidence-based approaches that simultaneously address behavioral, occupational, and technological dimensions of truck driver safety.

4.2. Strengths and Limitations

A key strength of this review lies in its comprehensive integration of findings across occupational health, behavioral sciences, and transportation safety, enabling a multidimensional understanding of how internal and external factors interact to shape risky driving behaviors. The inclusion of diverse geographical contexts further enhances applicability, revealing both global patterns and region-specific challenges. Categorizing risk factors into actionable themes strengthens the review's ability to inform targeted interventions.

However, limitations must be acknowledged. The exclusion of non-English studies and the grey literature may have introduced selection bias. Heterogeneity in study designs, populations, and measurement tools limited comparability and precluded meta-analysis.

Many studies relied on self-reported measures of fatigue, distraction, or substance use, which are vulnerable to recall and social desirability biases. The absence of standardized behavioral metrics further hindered generalization across contexts, highlighting the need for more rigorous and harmonized methodologies in future research.

The confidence placed in the conclusions of this review should also be considered in relation to study quality. As presented in Appendix A Table A2, most included studies were rated as moderate in overall quality, with frequent concerns in the measurement and confounding domains. Only a minority achieved consistently high ratings across all domains. These findings indicate that although the evidence points toward clear and consistent risk patterns, the strength of the conclusions varies, underscoring the need for more methodologically robust research in this field.

4.3. Policy Implication

The findings of this review underscore the need for comprehensive and multifaceted policy reforms to enhance truck driver safety. Key recommendations include shifting from a purely regulatory approach to a supportive framework that promotes compliance through incentives and accessible resources. For instance, while enforcing HOS regulations remains essential, integrating supportive mechanisms such as subsidized rest areas and flexible scheduling policies can reduce non-compliance stemming from economic pressures.

Reforming compensation structures is critical. Current productivity-linked pay models often prioritize speed and efficiency over safety, indirectly encouraging risky behaviors like extended driving hours and speeding. Alternative pay structures, such as fixed salaries or safety-based bonuses, can align economic incentives with safer practices.

The adoption of advanced safety technologies should be mandated across the trucking industry. Fatigue-monitoring systems, telematics, and behavioral analytics not only detect but also prevent unsafe behaviors in real time. By making these technologies accessible and cost-effective, policymakers can encourage widespread adoption, particularly among small- and medium-sized trucking companies.

Infrastructure investment is another vital area. Expanding and improving rest facilities tailored to the unique needs of truck drivers, such as noise-controlled sleeping areas and secure parking, can significantly mitigate fatigue-related risks. Road infrastructure, including dedicated truck lanes and enhanced signage, should also be prioritized to address safety challenges specific to heavy vehicles.

Educational initiatives must be tailored to address the psychosocial and demographic diversity within the trucking workforce. Programs targeting stress management, substance abuse, and adherence to safety protocols can help drivers manage external pressures and internal challenges. These initiatives should be supported by ongoing organizational efforts to foster a safety-oriented culture, emphasizing transparency, leadership involvement, and continual training.

Ultimately, these policy interventions require collaboration between government agencies, trucking companies, and driver advocacy groups to ensure implementation feasibility and long-term impact. By addressing systemic issues and integrating technology and education, policymakers can create a safer environment for truck drivers and other road users.

4.4. Future Research

Future research should address existing knowledge gaps by employing robust longitudinal designs that can elucidate causal relationships between risk factors and safety outcomes. The development and adoption of standardized metrics for evaluating haz-

ardous driving behaviors and their impacts will be critical for improving comparability across studies and ensuring methodological consistency.

Exploring the effectiveness of advanced interventions, such as AI-driven monitoring systems, adaptive fatigue management programs, and telematics-based safety feedback, is paramount. Additionally, research should prioritize underrepresented populations, including female truck drivers and those operating in diverse geographical and cultural contexts, to enhance the inclusivity and generalizability of findings. Investigations into the psychological underpinnings of risky driving, including the role of personality traits and stress, will further refine understanding of driver behavior.

Interdisciplinary collaborations are essential to advance the field. Partnerships between transportation engineers, public health researchers, psychologists, and policymakers will enable the development of comprehensive, evidence-based strategies to improve truck driver safety. Such collaborations should also focus on evaluating the long-term effectiveness of policy changes and technological interventions to ensure sustainable improvements in road safety.

5. Conclusions

This systematic review highlights the critical importance of addressing truck driver safety using a focused and evidence-based approach. It synthesizes existing knowledge to provide a deeper understanding of the systemic, occupational, and behavioral dimensions contributing to risky driving. The findings emphasize the complexity of the challenges faced by truck drivers and the need for multifaceted interventions to address these risks effectively.

While the review identified promising strategies, it also revealed substantial gaps in the current literature, particularly in the areas of causal analysis, diverse representation, and standardized assessment methods. These gaps present opportunities for advancing research that is both inclusive and practical, ensuring that interventions are not only evidence-based but also adaptable across different contexts.

In closing, enhancing truck driver safety requires coordinated efforts from researchers, policymakers, and industry stakeholders. A commitment to continuous learning, innovation, and collaboration will be essential in creating sustainable solutions that protect truck drivers and improve overall road safety. By addressing these challenges holistically, this systematic review provides a foundation for future advancements in this critical area.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/app15179662/s1, Document S1: PRISMA 2020 checklist.

Author Contributions: Conceptualization, T.F. and S.F.; methodology, T.F.; validation, S.F.; formal analysis, T.F.; investigation, T.F.; resources, S.F.; data curation, T.F.; writing—original draft preparation, T.F.; writing—review and editing, S.F.; visualization, T.F. and S.F.; supervision, S.F.; project administration, T.F. All authors have read and agreed to the published version of the manuscript.

Funding: This work is financially supported by national funds through the FCT/MCTES, under the project 2023.15776.PEX-uRisK—Understanding risky behaviors at the wheel using a driving simulator.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Acknowledgments: The authors would like to acknowledge the Doctoral Program in Occupational Safety and Health at the University of Porto for providing access to digital library resources, which enabled the retrieval of the studies included in this review. This study was also supported by the exploratory research project uRisk: Understanding risky behaviors at the wheel using a driving simulator, led by the Faculty of Engineering of the University of Porto. During the preparation of this

review, the authors used ChatGPT for the purposes of preliminary data extraction and text drafting. The authors have reviewed and edited the output and take full responsibility for the content of this publication.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

AI	Artificial intelligence
ELD	Electronic logging device
HOS	Hours of service
MPWD	Mobile phone use while driving
NHLBI	National Heart, Lung, and Blood Institute
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-analyses
PROSPERO	International Prospective Register of Systematic Reviews
RQ	Research question
THC	Tetrahydrocannabinol
WHO	World Health Organization

Appendix A

The Appendix includes two supplementary tables that provide additional detail on the studies included in the qualitative synthesis. Table A1 summarizes, for each study, the author and year, country, objective, data collection method, data analysis technique, key variables, and main findings. This table complements the main text by offering a structured overview of the methodological characteristics and thematic focus of the reviewed literature. Table A2 presents the quality assessment of the included studies across four domains, including Selection, Measurement, Confounding, and Reporting, together with an overall quality rating. The assessment follows a traffic light classification (low risk, some concerns, high risk) to provide a transparent and concise appraisal of study quality, thereby qualifying the strength of the evidence synthesized in this review.

Table A1. Summary of included studies.

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Afghari et al. (2022) [68]	Belgium	To investigate the effects of driver sleepiness on headway (the distance between vehicles) using heart rate data to classify sleepiness and an instrumental variable model to account for endogeneity and unobserved heterogeneity.	DSE	Instrumental variable model and grouped random parameters	Sleepiness, headway, age, gender, years of driving experience, type of road, type of truck, weekly distance traveled, night-time shift.	Sleepiness negatively affected headway, with 30.5% of drivers reducing their headway due to sleepiness, while the remaining 69.5% increased it, indicating risk-compensating behavior. The factors influencing sleepiness included age, years of experience, road type, and type of truck. Night-time shifts were associated with higher sleepiness levels, which affected headway differently across drivers.
Ahlström & Anund (2024) [63]	Sweden	To investigate how sleepiness develops in professional truck drivers during real-road driving conditions and to evaluate a test procedure for validating driver drowsiness and attention warning systems (DDAWs) according to EU regulations.	ND	ANCOVA, ANOVA, and descriptive statistics	Sleepiness, driving performance (standard deviation of lateral position), heart rate, blink duration, sleep deprivation, time of day (day/night).	Truck drivers experienced significantly higher levels of sleepiness during nighttime driving compared to daytime driving. Sleepiness increased more rapidly with the distance driven at night, with 70% of the drivers reaching the threshold for drowsiness (KSS $\geq$ 8) during the nighttime sessions. The results corroborated subjective sleepiness reports with psychomotor vigilance task performance, showing increased reaction times and more lapses during nighttime driving.
Anam et al. (2022) [29]	United States	To investigate the factors influencing the severity of large-truck wrong-way driving (WWD) crashes in Florida, focusing on driver, roadway, weather, and traffic-related characteristics.	CD	Random parameter ordered logit model	Seatbelt use, drug use, driving speed, crash location, airbag deployment, gender, crash time, roadway type, and weather conditions.	Speeding (50–74 mph), not using a seatbelt, and driving under the influence of drugs were strongly associated with higher crash severity. Female drivers, private roadways, and sideswipe collisions had lower severity outcomes. Interaction effects revealed that younger and middle-aged drivers had lower crash severity when driving at speeds of 25–49 mph. Early-morning crashes on county roads showed less severe outcomes.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Anderson et al. (2017) [50]	United States	To examine the impact of changes in the Hours of Service (HOS) regulations on truck driver and motorist safety, specifically focusing on the 1 restart per 168-h restriction and the 1 a.m. to 5 a.m. provision implemented in 2013.	CD	Parametric and non-parametric statistical analysis and regression analysis	Accident types (fatalities, injuries, property damage), truck driver involvement, HOS regulation changes (pre- and post-HOS).	The study found no significant improvement in safety following the HOS changes. The number of accidents, fatalities, and injuries remained statistically unchanged, with an increase in truck drivers being at fault for accidents post-HOS changes.
Baikejuli et al. (2023) [78]	China	To explore the factors influencing mobile phone use while driving (MPWD) among commercial truck drivers in China using an extended version of the Theory of Planned Behavior (TPB), including driving exposure as an additional factor.	QS	Structural equation modeling	Attitude (ATT), subjective norm (SN), perceived behavioral control (PBC), behavioral intention (BI), driving exposure (DE), mobile phone use behavior (answering calls and using apps).	Truck drivers' behavioral intention was the strongest predictor of mobile phone use while driving. Driving exposure (DE) had a significant impact on attitudes and perceived control, indicating that drivers with higher DE were more likely to have positive attitudes toward MPWD and feel confident in performing the behavior. Attitudes and perceived behavioral control significantly influenced the intention to use mobile phones while driving. Subjective norm was found to have no significant effect on driving intentions.
Balthrop et al. (2024) [84]	United States	To examine the impact of marijuana legalization (both medical and recreational) on truck safety by analyzing heavy truck crash statistics from states that have legalized marijuana compared to those that have not.	CD	Difference-in-difference estimation and synthetic control method	Marijuana legalization status (medical and recreational), crash rates, state-level factors (e.g., population demographics, vehicle miles traveled).	Marijuana legalization did not significantly increase heavy truck crashes on average. In fact, some states, such as Colorado and Washington, showed a reduction in crashes, while others, like Connecticut and Virginia, saw an increase. The effects varied across states, suggesting that marijuana legalization does not have a straightforward relationship with truck safety.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Behnood & Al-Bdairi (2020) [85]	United States	To investigate the factors influencing injury severity in large truck crashes across weekdays and weekends using a random parameters logit model.	CD	Random parameter ordered logit model	Truck characteristics, driver actions, weather conditions, crash time, crash type, violation categories, driver demographics.	Injury severity determinants significantly vary across weekdays and weekends. Factors such as young drivers, at-fault drivers, rear-end crashes, and collisions with fixed objects affected injury severity in both models. However, variables like crash time and crash type showed different effects between weekdays and weekends.
Behnood & Mannering (2019) [49]	United States	To examine how the factors influencing injury severity in large-truck crashes vary across different times of the day (morning and afternoon) and from year to year, using data from crashes involving large trucks in Los Angeles over an eight-year period.	CD	Random parameter ordered logit model	Driver characteristics, truck characteristics, crash type (e.g., sideswipe, rear-end), road conditions, weather conditions, and time-of-day variables (morning vs. afternoon).	The study found temporal instability in the effects of factors influencing injury severity, with some variables consistently affecting injury outcomes across times of day and years. Notably, factors like driver ethnicity, crash type (e.g., sideswipe, hit-object), and truck-driver fault exhibited stable effects, while others, such as weather and road conditions, showed significant variability across time periods.
Bekelcho et al. (2024) [86]	Ethiopia	To assess the prevalence of near-miss road traffic accidents (NMAs) and the associated factors among truck drivers in Gamo zone, southern Ethiopia, using the contributory factors interaction model (CFIM).	QS	Binary and multivariate logistic regression	Age, education level, driving frequency per week, accident location, road conditions, weather conditions, sleep status, and accident history.	72.5% of truck drivers had experienced a near-miss accident. Factors significantly associated with higher near-miss accident prevalence included younger age, frequent driving per week, driving on major roads, and poor weather conditions (foggy weather).
Belzer (2018) [87]	United States	To explore the role of work-related stress factors, particularly economic pressures, in truck crashes using data from the U.S. Large Truck Crash Causation Study (LTCCS).	CD	Logistic regression	Work-related stress factors (e.g., shipping deadlines, quotas, extra loads, self-induced illegal pressures), driver characteristics (e.g., experience, safety bonuses), aggression counts, fatigue, and compensation methods (e.g., mileage pay).	Work-related pressures, such as shipping deadlines, quotas, and workload demands, significantly increased the likelihood of truck drivers being deemed responsible for crashes. Aggressive behaviors and fatigue also contributed to this outcome. Interestingly, longer driver experience, safety bonuses, and being paid by the mile were associated with lower crash responsibility, suggesting that economic pressures from certain compensation systems (e.g., piecework) could increase crash risk.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Belzer & Sedo (2018) [64]	United States	To understand the factors that lead long-haul truck drivers to work excessively long hours, particularly focusing on the influence of compensation methods, such as mileage-based pay and piece rates, on driver behavior and safety.	QS	Two stage least squares regression	Pay level (mileage rate), pay method (piece rates vs. time rates), driver hours, target earnings, safety, truck driving regulations (Hours of Service), and long-distance vs. short-distance driving.	Long-distance truck drivers work longer hours due to target earnings; they choose to work extra hours to meet their income goals, especially when paid by piece rates. Higher mileage rates lead to increased hours worked up to a certain point (approx. USD 0.395 per mile), after which drivers prefer more leisure time, thus reducing their working hours. This supports the target earnings hypothesis, which suggests that once drivers reach their earnings goals, they opt to trade labor for leisure, improving safety.
Benallou et al. (2023) [88]	Morocco	To develop a predictive model using Bayesian networks and fuzzy logic to evaluate the risk of accidents caused by truck drivers, focusing on driver-related factors.	Model-based computational approach	Bayesian networks, Fuzzy logic, and event tree analysis	Driver behaviors (alcohol consumption, driving style, reactivity), working conditions (fatigue, long hours, delivery pressure), in-vehicle safety systems, and accident occurrence.	The study revealed that alcohol and substance consumption, driving style, fatigue, and distraction were the most significant factors contributing to accident risk. The fuzzy Bayesian model predicted a high risk of accidents when drivers exhibited poor working conditions, high fatigue, and engaged in unsafe driving behaviors. The event tree analysis showed that in-vehicle safety systems could significantly reduce accident probabilities, with the highest success rate (55.08%) when all safety systems functioned correctly.
Bombana et al. (2017) [70]	Brazil	To estimate the prevalence of recent illicit drug use among truck drivers in the state of São Paulo, Brazil, by analyzing oral fluid samples for amphetamine, cocaine, and tetrahydrocannabinol (D9-THC).	Oral fluid sample and QS	Tobit and probit regression	Cocaine, amphetamine, D9-THC, sociodemographic data (age, marital status, education, etc.), working hours, and travel distance.	5.2% of drivers tested positive for drugs, with cocaine being the most prevalent (2.7%), followed by amphetamines (2.1%) and D9-THC (1.0%). Longer travel distances were associated with amphetamine use, while cocaine use was observed across all distance categories. No cannabis use was detected among drivers with long travel distances.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Bunn et al. (2009) [24]	United States	To examine the impact of semi-truck driver age, gender, and the presence of passengers on the likelihood of a truck driver being at fault in a collision with another vehicle.	CD	Multiple logistic regression	Driver age, gender, presence of passengers, roadway conditions, speed limits, road type, and time of day.	Solo semi-truck drivers aged 65 and older were at higher risk of being at fault in collisions compared to younger drivers. The presence of passengers in the vehicle provided a protective effect for drivers aged 65 and older. Additionally, male drivers were less likely to be at fault compared to female drivers, and collisions on curvy roads, graded roads, and those with lower speed limits were associated with higher odds of being at fault.
C. Chen & Xie (2014) [69]	United States	To analyze the effects of rest breaks, including duration, number of breaks, and timing during a trip, on the crash risk of commercial truck drivers.	CD	Cox proportional hazards model and Andersen–Gill model	Rest break duration, number of rest breaks, driving time before breaks, crash occurrence (yes/no), and driver's off-duty time.	Increasing the total rest break duration significantly reduces crash risk, with the most substantial benefits observed when the rest duration is between 0.5 and 1 h. Having two rest breaks during a 10-h trip was optimal for reducing crash risk, while three or more breaks did not significantly improve safety. The timing of breaks also mattered: taking breaks too early in the trip was less effective than taking them after a longer driving period.
C. Chen & Zhang (2016) [26]	China	To examine the background risk factors contributing to fatigue-related crashes involving truck drivers on regional roadway networks in Jiangxi and Shaanxi, China.	CD	Pearson chi square test and stepwise logistic regression	Driver demographics (age, gender, experience), vehicle factors (overloading, brake performance), roadway factors (road type, geometry), environmental conditions (weather, time of day), and traffic violations (speeding, overloading).	Young, male truck drivers with less experience are at higher risk for fatigue-related crashes. Crashes were more likely on sharp curves, long steep grades, and expressways. Adverse weather, slippery roads, and driving during nighttime (0:00–6:00) significantly increased crash risk. Traffic violations such as speeding and overloading were strongly linked to fatigue crashes.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
C. Chen et al. (2015) [89]	United States	To examine the cross-level interaction effects between crash-level and vehicle/driver-level variables on truck driver injury severity in rural crashes.	CD	Hierarchical Bayesian random intercept model	Road grade, vehicle damage, number of vehicles involved, vehicle action, driver age, seatbelt use, driving under the influence.	The study identified several key factors influencing injury severity, including road grade, vehicle damage, and driver seatbelt use. The model showed that vehicle damage (disabled vehicle) and road grade had significant impacts on driver injury severity, with a higher likelihood of incapacitating injuries and fatalities in these conditions. Interaction effects were also significant, particularly between road grade and seatbelt use, as well as between driver age and crash type.
Casey et al. (2024) [66]	Australia	To examine truck driver work and rest behaviors at Australian rest-stops and how these behaviors contribute to driver fatigue compliance and safety.	Direct observation	Qualitative data analysis	Load type, freight exchange, driver changeovers, designated parking availability, work-related behaviors at rest-stops, rest compliance.	Truck drivers generally comply with rest requirements, but factors like load type, driver changeovers, parking availability, and work-related activities reduce rest time. Drivers carrying livestock and refrigerated loads were more likely to have less than 15 min of rest. Freight exchange and driver changeovers, though routine, often led to reduced rest time. Inadequate parking availability also influenced rest stop behaviors, with some drivers opting to park illegally to comply with rest requirements.
Catarino et al. (2014) [90]	Portugal	To assess the prevalence of excessive daytime sleepiness (EDS) and other sleep disorders among truck drivers and identify individual traits and work habits associated with increased sleepiness and accident risk.	Interview and QS	Bivariate analysis and multivariate logistic regression	Daytime sleepiness, obstructive sleep apnea syndrome, body mass index, neck circumference, snoring, fatigue, antidepressant use, alcohol consumption, and accident history.	20% of truck drivers had EDS, and 29% were at high risk for obstructive sleep apnea (OSA). Drivers with EDS were more likely to report near-miss and actual accidents, especially those linked to sleepiness. Drivers using antidepressants had a significantly higher accident risk. A high Mallampati score (III–IV) was associated with an increased risk of near-miss accidents. Sleep loss, obesity, smoking, and alcohol intake also contributed to higher accident risk.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Choudhary et al. (2022) [91]	India	To examine the prevalence of mobile phone use during driving among long-haul truck drivers in India and to assess the associated crash risk using binary logistic regression.	QS	Binary logistic regression model	Demographic characteristics, phone use habits (both talking and texting), crash history, driving experience, vehicle type, road type, penalty history.	55% of truck drivers reported using a phone while driving, primarily for talking. Drivers who used their phone frequently were 29 times more likely to be involved in a crash compared to those who used it infrequently. Factors such as education, vehicle ownership, and everyday phone use habits were significantly associated with phone use during driving.
Claveria et al. (2019) [82]	United States	To identify the factors influencing truck drivers' decisions to report using a cell phone while driving a commercial vehicle, and to examine how these factors contribute to distracted driving behavior.	QS	Binary logit model	Driver characteristics (e.g., age, marital status, income, crash history), work characteristics (e.g., truck parking decisions, work start time), and management characteristics (e.g., fatigue management policies, driving hours management).	Younger truck drivers (18–25 years old), drivers with a history of crashes, and those starting work during midday hours were more likely to report using a cell phone while driving. In contrast, drivers who had received safety training, worked for companies with effective fatigue management policies, or had the autonomy to make parking decisions were less likely to report cell phone use. Additionally, the study identified a positive correlation among driving while tired, taking frequent breaks, and the likelihood of using a cell phone while driving.
Cori et al. (2021) [40]	Australia	To assess whether extending the major rest break between shifts from 7 h (standard) to 11 h improves truck drivers' sleep, alertness, and driving performance.	ND	Mixed linear model	Sleep duration, subjective sleepiness, ocular metrics (eye aperture, blink rate), vehicle metrics (steering wheel angle, speed), lane departures, and adverse driving events.	The 11-h rest break condition led to greater sleep duration (6.59 h vs. 5.07 h) and improved subjective sleepiness and driving performance (ocular alertness and steering metrics). However, contrary to expectations, the rate of lane departures was higher during the 11-h condition.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Cui et al. (2024) [67]	China	To examine how different fatigue levels influence the visual attention of heavy-duty truck drivers using eye-tracking technology, with fatigue levels measured using the Percentage of Eye Closure (PERCLOS).	ND	ANOVA and correlation analysis	Fatigue level (PERCLOS), eye movements (glance frequency to windshield, left-wing mirror, right-wing mirror, speedometer), driver characteristics (age, driving experience).	Fatigue significantly reduced the frequency of glances towards the left-wing mirror and windshield, particularly when fatigue levels (PERCLOS) were high. As drivers became more fatigued, their visual attention narrowed, focusing more on the windshield and reducing their scanning of peripheral mirrors and areas. The study also confirmed that PERCLOS could be a reliable indicator of driver fatigue and attention distribution.
de Oliveira et al. (2015) [73]	Brazil	To investigate whether occupational conditions are associated with amphetamine use among truck drivers in São Paulo, controlling for demographic factors and mental health characteristics.	QS	Descriptive statistics, Fisher's exact test, chi square, and logistic regression	Age, education, type of employment (freelance vs. employed), work shift, daily working hours, restless driving hours, alcohol consumption, sleep quality, and emotional stress.	Factors such as being younger than 38 years, having less than nine years of education, working freelance, working night shifts or irregular schedules, and working over 12 h daily were significantly associated with higher odds of amphetamine use. Additionally, alcohol consumption was also associated with higher amphetamine use.
de Oliveira, Barroso, et al. (2020) [92]	Brazil	To assess the prevalence of psychostimulant drug use (amphetamines and cocaine) among truck drivers and its impact on cognitive performance, specifically attention levels and executive functioning.	QS, oral fluid and urine samples	Descriptive statistical analysis	Psychostimulant drug use (cocaine, amphetamines), cognitive performance (attention, executive functioning), sleep quality, psychological distress, work hours.	9.7% of truck drivers had recently used psychostimulants. Although users performed faster in cognitive tests (e.g., sustained attention and executive tasks), they committed more errors and had worse precision in some measures, especially in tasks requiring divided or sustained attention. This suggests that while psychostimulants may temporarily enhance alertness, they negatively affect performance accuracy.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
de Oliveira, Eckschmidt, et al. (2020) [72]	Brazil	To estimate the prevalence of alcohol mixed with energy drinks (AmED) use and its association with driving violations among truck drivers in São Paulo, Brazil.	Interview and QS	Polynomial logistic regression, Poisson regression, and descriptive statistics	Alcohol use (AmED, alcohol-only, abstainers), driving violations (e.g., driving unbelted, speeding, fights while driving), age, experience, illicit drug use, sleep quality.	16.8% of truck drivers reported using AmED. Users of AmED were more likely to be younger, less experienced, and engage in more risky behaviors such as driving unbelted and speeding. They also had poorer sleep quality and a higher prevalence of illicit drug use compared to alcohol-only users. AmED use was associated with a significantly higher prevalence of driving violations, particularly driving unbelted, speeding, and having arguments or fights while driving.
Delhomme & Gheorghiu (2021) [53]	France	To examine the relationship among perceived stress, organizational factors, mental health, and self-reported risky driving behaviors among French and non-French truck drivers operating in France.	QS	Structural equation modeling	Perceived stress, organizational support, supervisor pressure, mental health (well-being, burnout, mind-wandering, insomnia), driving skills, self-reported risky behaviors (e.g., speeding, fatigue-related driving, seatbelt use).	Perceived stress among truck drivers was significantly influenced by both organizational factors (e.g., supervisor pressure, job satisfaction) and individual factors (e.g., mental health, driving skills). Higher stress levels were associated with increased self-reported risky driving behaviors, including speeding and not using seatbelts. Perceived stress was also correlated with lower levels of well-being, higher burnout, and increased risk perception.
Douglas et al. (2019) [44]	United States	To investigate how truck drivers' perceptions of carrier safety climate influence their safety-related attitudes, risk avoidance, and intentions to commit unsafe acts.	QS	Ordinary least squares regression and confirmatory factor analysis	Safety climate, safety attitudes, safety norms, perceived control, risk avoidance, safety-related intentions, and demographic factors (e.g., age, career stage).	A positive safety climate within a carrier significantly influenced drivers' safety attitudes, norms, and risk avoidance behaviors, which, in turn, reduced their intentions to commit unsafe acts. It was also discovered that safety norms, alongside attitudes and control, were significant predictors of unsafe driving intentions. Additionally, risk avoidance was identified as an important factor mediating the relationship between safety climate and drivers' safety-related intentions.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Ebrahimi et al. (2024) [93]	Iran	To investigate the impact of a co-driver or team driving on health and safety conditions in truck transportation.	QS	Independent *t*-test, chi square, and Fisher's exact test	Driver fatigue, alertness, safety task performance, musculoskeletal health, fatigue, job satisfaction, and depression levels.	The study showed that the presence of a driver assistant significantly improved alertness and reduced fatigue during the driving process. Tasks like parking, tire repairs, and opening/closing the trailer were safer and more efficiently performed with a driver assistant. Additionally, mental health benefits were noted, including reduced feelings of depression and isolation among drivers with an assistant.
Filomeno et al. (2019) [21]	Japan	To examine the relationship between alcohol consumption and excessive daytime sleepiness (EDS) among commercial truck drivers in Japan and the implications of this on public health.	QS	Descriptive statistics, chi square test, ANCOVA, and logistic regression	Alcohol consumption (light, moderate, heavy drinkers), excessive daytime sleepiness (measured by the Epworth Sleepiness Scale), body mass index (BMI), smoking status, oxygen desaturation index (ODI).	Among older drivers (≥43 years), there was a significant association between alcohol consumption and higher levels of excessive daytime sleepiness, with heavy drinkers showing the strongest association. Younger drivers (<43 years) did not show the same correlation between alcohol intake and daytime sleepiness. The study highlights the importance of considering alcohol consumption when identifying drivers at risk for sleep disorders and accidents.
Filtness et al. (2020) [94]	United States	To investigate the relationship between high caffeine consumption and its effects on driving safety, sleep quality, and health behaviors in truck drivers.	QS, CD, and medical examination	Descriptive statistics, chi square, *t*-test, Mann-Whitney U test, and binary logistic regression	Caffeine consumption, sleep quality (Epworth Sleepiness Scale), health behaviors (smoking, diet, exercise), driving safety indicators (crashes, Dula Dangerous Driving Index).	High caffeine consumers (≥5 drinks/day) were found to have poorer sleep quality, shorter average sleep durations, and higher daytime sleepiness (7.5% vs. 5.7%). They also exhibited more negative health behaviors such as higher smoking rates, poorer diet, and less exercise. Furthermore, high caffeine consumers reported more crashes (27.8% vs. 21.6%) and worse driving safety indicators, particularly in terms of aggressive driving, negative emotions, and risky driving behaviors.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Fitch et al. (2015) [83]	United States	To investigate the risk of a safety-critical event (SCE) associated with mobile device use during specific driving contexts, exploring how task demands alter the risk.	ND	Chi square test and odds ratio	Mobile device use (cell phone, PDA, CB radio), driving contexts (level of service, relation to junctions), safety-critical events (SCEs), visual–manual subtasks, and hands-free cell phone use.	Visual–manual subtasks, such as texting and dialing, significantly increased the risk of SCEs in low-demand contexts (non-junction road segments). However, conversing on a mobile device, either hands-free or handheld, was generally associated with a decreased risk in specific contexts like intersections or ramps. SCE risk was highest for visual–manual tasks in low task-demand environments and decreased for conversations in high task-demand settings.
G.X. Chen et al. (2015) [95]	United States	To describe the injury rates, safety behaviors, and working conditions of long-haul truck drivers (LHTDs) based on the 2010 National Institute for Occupational Safety and Health (NIOSH) survey.	QS	Descriptive statistical analysis	Truck crashes, near misses, moving violations, non-crash injuries, work environment (e.g., tight delivery schedules, road conditions), safety climate, training adequacy, driving behaviors (e.g., speeding, seatbelt use).	35% of LHTDs reported at least one truck crash in their career, and 24% reported at least one near-miss in the past week. A significant number of drivers also reported non-compliance with Hours of Service rules and unsafe driving behaviors such as speeding and not wearing seatbelts. Furthermore, many drivers felt their training was inadequate and their work conditions (e.g., unrealistic schedules) contributed to unsafe behaviors.
G.X. Chen et al. (2016) [28]	United States	To examine the impact of truck drivers' sleep patterns during non-work periods on their driving performance and risk during subsequent work periods.	ND	Negative binomial regression	Sleep duration, sleep start and end points, sleep percentage during non-work periods, body mass index (BMI), years of commercial vehicle driving experience, and driving performance (measured by safety-critical events).	Shorter sleep duration, especially when it occurred early in the non-work period, was associated with higher rates of safety-critical events (SCEs). Shifts with more sleep between 1 a.m. and 5 a.m. showed better driving performance. Additionally, male drivers and those with higher BMI had higher SCE rates.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Garbarino et al. (2017) [33]	Italy	To measure the prevalence of insomnia among truck drivers and investigate its association with motor vehicle accidents (MVAs) and near-miss accidents (NMAs).	QS	Logistic regression	Insomnia (difficulty initiating or maintaining sleep), obstructive sleep apnea (OSA), excessive daytime sleepiness (EDS), sleep duration, comorbidities.	Insomniac truck drivers had a significantly higher risk of MVAs (OR: 1.82) and NMAs (OR: 3.35) compared to non-insomniac drivers. The association between insomnia and accidents remained significant even after adjusting for factors like OSA, EDS, and sleep duration. Insomnia was identified as an independent risk factor for driving accidents.
Gates et al. (2013) [75]	Canada	To investigate the influence of stimulant use on unsafe driving actions (UDAs) in fatal crashes, using data from the Fatality Analysis Reporting System (FARS), while considering the impact of confounding variables.	CD	Logistic regression	Stimulant use (presence or absence), driving history (e.g., prior crashes, convictions), unsafe driving actions (e.g., lane departures, speeding, erratic driving).	Stimulant-positive drivers had a 78% greater likelihood of committing unsafe driving actions (UDAs) compared to stimulant-negative drivers. Additionally, stimulant-positive drivers had a greater proportion of driving record infractions and narcotic drug use compared to those who tested negative for stimulants.
Girotto et al. (2016) [32]	Brazil	To investigate the relationship between the length of professional experience as a truck driver and involvement in traffic accidents or near-miss accidents.	QS	Multinomial regression analysis	Time working as a driver, age, substance use (alcohol and psychoactive substances), working conditions, drowsiness, driving behaviors (speeding, overtaking in prohibited locations), and truck type.	Longer professional experience was inversely associated with involvement in both accidents and near-miss accidents. Drivers in the third tertile of professional experience (more than 22 years) were less likely to report accidents and near-misses. In contrast, drivers in the second tertile (11–22 years) had a moderate reduction in risk. The study also identified that excessive alcohol consumption, and the frequent practice of speeding were associated with higher accident and near-miss involvement.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Hamido et al. (2021) [17]	Japan	To examine the key factors influencing the safety of truck drivers in an ageing society by analyzing accident data, driver attributes, and work-related factors.	QS	Binary logistic regression, chi square, and Mann–Whitney test	Age, driving experience, penalty points, work-related attributes (vehicle type, driving distance, waiting time), accident involvement.	No significant difference in accident involvement between younger and older drivers. However, older drivers with penalty points had a higher likelihood of accidents. Older drivers were less affected by arduous working conditions compared to younger drivers. Factors like driving distance, waiting time, vehicle type, and gross vehicle weight were significant predictors of accident involvement. Older drivers showed more stable work performance, and safety was better linked to their physical fitness (e.g., lower obesity levels).
Han et al. (2021) [62]	China	To develop a driving behavior scale for professional drivers of heavy semi-trailer trucks in China and investigate the causes and impacts of such behaviors on traffic safety.	QS	Principal component analysis and binary logistic regression	Risky violations, negligence/lapses, errors, ordinary violations, positive driving behaviors, demographic data, traffic accidents.	Drivers who exhibited higher levels of negligence/lapses had a 2.293 times higher likelihood of being involved in accidents. The time between 1 and 5 a.m. was identified as the most dangerous period for truck drivers, with a much higher risk of accidents during that time. Additionally, violations such as using a mobile phone while driving and failure to observe traffic signs were common among drivers involved in accidents.
Heaton et al. (2021) [96]	United States	To explore and describe the factors influencing sleep-related and safety decision making among truck drivers, focusing on both personal and professional influences.	Interview	Content and thematic analysis	Sleep conditions, safety-related decision making, sentinel events, driver characteristics, relationships (family, dispatchers), company-level factors.	Four key themes were identified: sentinel events (e.g., near-misses or crashes), evolving driver characteristics (such as gaining confidence and experience), relationships (family and dispatcher influence), and company-level factors (such as work culture and pay structure). Drivers identified personal wake-up calls, like crashes and near-misses, that led them to make better sleep and safety decisions. Relationships with family members and dispatchers also played a key role in decision making.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Hickman & Hanowski (2012) [81]	United States	To assess the prevalence of driver distractions, specifically cell phone use, in commercial motor vehicle (CMV) drivers and determine the associated risks of these distractions.	ND	Descriptive statistics and odds ratio	Cell phone use, tertiary tasks (e.g., texting, dialing, reaching), safety-critical events, baseline events.	Texting, dialing, and reaching for a mobile phone significantly increased the odds of being involved in a safety-critical event. Talking on a hands-free phone did not significantly increase the likelihood of such events.
Hokmabadi et al. (2021) [97]	Iran	To investigate the association between high-risk behaviors, fatigue, and drowsiness in the occurrence of road accidents and near miss accidents among truck drivers in Tehran.	QS	Descriptive statistics, Fisher's exact test, chi square, and Pearson's correlation	High-risk behaviors (e.g., talking on the cell phone, texting, eating snacks), fatigue, drowsiness, driving hours, rest hours, number of accidents and near misses.	High-risk behaviors, such as talking on the cell phone, texting, and eating snacks, along with long driving hours, insufficient rest, and drowsiness, were significantly associated with an increased risk of both road accidents and near misses. Specifically, truck drivers who drove for extended hours without adequate rest and experienced fatigue had a higher likelihood of being involved in accidents. These factors were identified as major contributors to unsafe driving behavior and accidents.
Horberry et al. (2022) [98]	Australia	To design an effective human-machine interface (HMI) for a truck driver fatigue and distraction warning system using a human-centered design (HCD) approach.	QS	Thematic analysis, usability testing, and inspection-based evaluations	Driver fatigue, driver distraction, multi-modal warning systems (visual, auditory, tactile), HMI design.	The HCD approach developed an effective HMI for a fatigue and distraction warning system with a multi-modal (visual, auditory, tactile) escalating warning system. The design was iteratively refined through driver interviews, workshops, and evaluation studies. Drivers preferred tactile warnings, especially via the seat, and supported a two-stage system (cautionary and urgent) for both fatigue and distraction.
Hosseinzadeh et al. (2021) [76]	Iran	To identify the factors affecting the severity of large truck-involved crashes in Iran using both Support Vector Machine (SVM) and Random Parameter Binary Logit (RPBL) models.	CD	Random parameter binary logit model, support vector machine, and cross-validation	Fatigue, unsafe lane-changing, deviation to the left, failure to yield the right-of-way, vehicle defects, crash time, road type, weather, and visibility conditions.	Fatigue and deviation to the left were the most significant factors increasing crash severity, particularly when the truck driver was at fault. Tailgating increased fatal crashes when the truck driver was at fault but decreased the likelihood of fatal crashes in non-truck driver at-fault crashes. The results also highlighted that crash severity varied significantly across different conditions such as weather and road type.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Ikeda et al. (2021) [99]	Japan	To examine the relationship between sleep problems (sleep duration, sleep quality, and sleepiness at the wheel) and dangerous driving behaviors (e.g., sudden braking, overspeeding) in short-haul commercial truck drivers in Japan.	QS and ND	Logistic regression and Spearman's correlation Analysis	Sleep duration, sleep quality (Pittsburgh Sleep Quality Index), sleepiness at the wheel (self-reported frequency), dangerous driving behaviors (e.g., sudden braking, overspeeding).	Truck drivers with poor sleep quality and frequent sleepiness at the wheel had a 2.5–5.1 times greater risk of sudden braking compared to drivers without these sleep problems. Short sleep duration (less than 5 h) was also associated with a higher risk of sudden braking. However, sleep problems were not significantly associated with other dangerous driving behaviors such as overspeeding or sudden acceleration.
Iseland et al. (2018) [79]	Sweden	To investigate if long-haul truck drivers engage in secondary tasks while driving, the reasons for performing them, and the psychological factors influencing these behaviors.	Direct observation, interview and QS	Thematic analysis and descriptive statistics	Secondary tasks performed while driving, driver age, driving experience, personality traits, perceived stress, workload, health-related quality of life.	Drivers engage in secondary tasks like using mobile phones, eating, and adjusting in-cab technology. Boredom, self-imposed stress, and the need for social interaction were key reasons. Younger and less experienced drivers performed more secondary tasks. Secondary task engagement was correlated with health-related quality of life and workload.
Islam & Ozkul (2019) [23]	United States	To identify the key risk factors contributing to large-truck fatal crashes for different driver age groups using data from the Fatality Analysis Reporting System (FARS).	CD	Binary logistic regression and odds ratio	Driver age group, single-occupant status, CDL status, speed, time of day, day of the week, vehicle characteristics, environmental conditions (weather, road conditions).	The study identified different fatality risk factors for four age groups of truck drivers (<30, 30–49, 50–65, 65+). For younger drivers, risk was associated with speed and lack of CDL, while for older drivers, fatigue and road conditions played significant roles. Temporal characteristics like time of day and day of the week also contributed to the risk of fatal crashes for different age groups. Notably, older drivers were less likely to be involved in crashes during late-night hours.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Kemp et al. (2013) [54]	United States	To examine the stressors professional truck drivers, experience and how these stressors impact their safety attitudes and compliance with regulations, particularly Hours of Service (HOS) rules.	Interview and QS	Structural equation modeling, thematic analysis and descriptive statistics	Time pressure, stress, emotional exhaustion, physical fatigue, attitudes toward safety compliance, compliance with CSA regulations, and violation of Hours of Service regulations.	Severe time pressures and stress were positively related to emotional exhaustion and physical fatigue. These factors contributed to negative attitudes about safety compliance and the CSA program. Additionally, drivers with negative attitudes about safety compliance were more likely to violate HOS regulations. The study highlighted the importance of addressing driver stress to improve safety compliance.
Ketabi et al. (2011) [100]	Iran	To assess the association between aberrant driving behaviors and the incidence of road accidents among truck drivers in Yazd, Iran, in 2010.	QS	Descriptive statistics, chi square, Pearson's correlation, and multiple regression	Aberrant behaviors (e.g., misjudging speed, disregarding speed limits), driver mood, driving violations, road accident involvement.	Five types of aberrant behaviors were most associated with road accidents: misjudging the speed of oncoming vehicles, disregarding speed limits late at night, ignoring "give way" signs, risky overtaking due to frustration, and distracted driving. Drivers whose behavior was influenced by negative emotions were more likely to commit deliberate violations and errors. The findings emphasized the need for targeted interventions to reduce unsafe driving behaviors.
Kudo & Belzer (2019) [42]	United States	To examine how truck driver compensation, including both pay per mile and fringe benefits, influences safety performance, specifically the incidence of moving violations among long-haul truck drivers.	QS	Negative binomial regression, Poisson regression, Vuong and Clark tests	Pay per mile, non-driving pay, health insurance, retirement benefits, work weeks, truck type, and other demographic variables (e.g., age, gender, union status, experience).	Drivers who received higher pay per mile and those with employment-based health insurance were less likely to commit moving violations. The results support the hypothesis that higher compensation improves safety performance by attracting and motivating more skilled, risk-averse drivers. However, other forms of compensation, such as retirement benefits and non-driving pay, did not show a significant relationship with moving violations.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Kumagai et al. (2023) [101]	Japan	To explore microsleep-related behaviors in professional truck drivers involved in collisions caused by falling asleep at the wheel, using dashcam video footage to analyze driver and vehicle behavior.	VD	Descriptive statistics, segmented regression, chi square, Mann-Whitney U-test, and Clopper–Pearson confidence method	Anti-sleepiness behaviors (touching, yawning), behavioral signs of microsleep (absence of body movement, eye closure), abnormal vehicle behavior (inappropriate line crossing, speed reduction).	Anti-sleepiness behaviors decreased as signs of microsleep, and abnormal vehicle behavior increased. Collisions were preceded by increases in microsleep signs and abnormal vehicle behavior. The process leading to collisions involved five phases: anti-sleepiness behavior, behavioral signs of microsleep, abnormal vehicle behavior, and collision. Rear-end collisions were more common on urban roads, while side-impact collisions were more common on highways.
Lemke et al. (2016) [52]	United States	To investigate the relationship between sleep quality, sleep duration, and safety-relevant performance in long-haul truck drivers, with the goal of identifying predictors for safer driving behaviors and reducing accident risk.	QS and biometric measurement	Descriptive statistics and linear regression analysis	Sleep duration, sleep quality, job performance, accident risk, and driving behavior (driving while sleepy, concentration, job performance).	Sleep quality was a stronger predictor of safety-relevant performance, such as driving while sleepy, than sleep duration. Drivers who reported better sleep quality were less likely to engage in unsafe driving behaviors like driving while sleepy. Sleep duration, however, was more strongly associated with accidents and accident risk. Long work hours and violations of federal driving regulations (e.g., working beyond the daily hour limit) were also significant predictors of driving while sleepy.
Lemke et al. (2021) [51]	United States	To identify factors associated with Hours of Service (HOS) compliance and assess its significance in sleep-related safety risks among long-haul truck drivers.	QS	Descriptive statistics, bivariate correlation, ordinal logistic regression, and multinomial logistic regression.	Miles driven per week, daily work hours, pace of work, supervisor support, sleep duration, sleep quality, HOS violations, sleep-related safety risks.	Higher Hours of Service violations were associated with longer work hours, higher miles driven, and poorer sleep quality. Sleep-related safety risks were significantly predicted by factors such as daily work hours and lack of supervisor support. However, Hours of Service violations themselves did not directly predict sleep-related safety risks. Drivers with more supervisor support and those who reported telling supervisors they were too tired to drive had lower sleep-related safety risks.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Leyton et al. (2019) [74]	Brazil	To assess the prevalence of psychoactive substance use, including amphetamine, benzoylecgonine (cocaine metabolite), and THC-COOH (cannabis metabolite), among truck drivers in São Paulo over an eight-year period, and to identify trends in drug use across these years.	QS and urine sample	Descriptive statistics, Pearson's chi square test, Student's *t*-test, and multivariable logistic regression	Psychoactive substances (amphetamine, benzoylecgonine, THC-COOH), age, work experience, travel distance, and number of hours driven.	The overall prevalence of illicit drug use among truck drivers was 7.8%, with the most common substance being benzoylecgonine (3.6%), followed by amphetamine (3.4%) and THC-COOH (1.6%). The highest prevalence occurred in 2010 (11.3%), while the lowest was in 2011 (6.1%). A notable trend was the significant decrease in amphetamine use after the 2011 ban on appetite suppressants containing compounds metabolized into amphetamine. Despite this decline, drug use remained high, suggesting that truck drivers continued to rely on stimulants, likely to combat fatigue during long journeys.
M. Chen et al. (2020) [102]	United States	To examine the factors influencing injury severity in truck-involved collisions in Los Angeles from 2010 to 2018 using a cumulative link mixed model (CLMM).	CD	Cumulative link mixed model	Driver and occupant demographic factors, driving behavior (alcohol use, speeding), environmental conditions (lighting, road surface), and collision characteristics (type of crash, location).	Key factors influencing injury severity included alcohol use, improper driving, unsafe speeds, and the use of safety equipment. Collisions at night and in dark/no streetlight conditions were associated with higher injury severity, while intersections had lower severity outcomes. The study also highlighted the role of vehicle characteristics, with older trucks being more likely to be involved in severe crashes.
Mahajan, Velaga, Kumar, & Choudhary (2019) [58]	India	To study the impact of driver sleepiness, fatigue, and work-rest patterns on the prevalence of traffic violations among long-haul truck drivers in India.	QS	Principal component analysis and negative binomial regression	Sleepiness, fatigue, work-rest patterns, violations (speeding, overtaking, etc.), demographic factors (age, education, experience).	Sleep-deprived drivers (less than 4 h of sleep) were more likely to commit traffic violations, such as speeding and overtaking. Fatigue and sleepiness significantly increased the likelihood of unsafe driving behavior, especially during late-night driving shifts. Young drivers and those working long hours with insufficient rest were at higher risk of violating traffic rules.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Mahajan, Velaga, Kumar, Choudhary, et al. (2019) [39]	India	To investigate the role of payment incentives, work-rest patterns, and lifestyle habits on driver sleepiness and fatigue among long-haul truck drivers in India.	QS	Principal component analysis, Kruskal–Wallis test, and logistic regression	Work-rest patterns, lifestyle habits (caffeine, alcohol, tobacco consumption), payment incentives, sleepiness, fatigue.	Financial incentives, particularly those related to overtime and timely deliveries, increased the odds of drowsy driving among truck drivers. Long driving hours, insufficient rest, and the consumption of caffeine and tobacco were also strongly linked to higher sleepiness levels. The odds of drowsy driving were significantly higher for drivers working more than 10 h a day without adequate rest, especially for those with financial incentives tied to their work hours.
Makuto et al. (2023) [55]	Canada	To identify the factors associated with depressive symptoms in long-haul truck drivers in Canada and the U.S. by analyzing work-related stress, health, and social factors.	QS	Descriptive statistics, univariate logistic regression, and multivariate logistic regression	Health status, work stress, social isolation, back pain, stimulant use, financial strain.	High levels of stress due to social isolation and tight delivery deadlines were strongly associated with depressive symptoms. Poor health and low back pain also contributed to higher depressive scores. Truckers who experienced high stress from tight schedules, poor road conditions, and being away from social relationships had significantly higher depression scores.
McKnight & Bahouth (2009) [47]	United States	To identify causes of large truck rollover crashes and propose preventive measures.	CD	Descriptive statistics, categorical data classification, and cause attribution analysis	Speed, inattention, misjudgment, control errors (e.g., oversteering, understeering), road conditions, and driver distractions.	Almost half of the rollover crashes were due to failing to adjust speed to curves, loads, brake conditions, and road surfaces. Inattention, including distractions, dozing, and general lack of focus, was another major contributor. Control errors like oversteering and understeering also played significant roles. The analysis indicated that improving driver awareness, speed control, and attention management could substantially reduce rollover incidents.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Meng et al. (2016) [103]	China	To explore the demand for Fatigue Warning Systems (FWSs) among professional drivers and gather their opinions on the design of such systems to reduce fatigue-related accidents.	QS and focus group	Thematic analysis, descriptive statistics, and frequency analysis	Driver fatigue, Fatigue Warning System features, warning signals (auditory, visual, vibrotactile), driver preferences.	Drivers expressed a strong preference for receiving fatigue warnings, especially via auditory signals such as alarms or verbal messages, with some also supporting vibrotactile feedback. Fatigue monitoring and relief features were highly valued. Drivers indicated a preference for systems that could provide timely warnings and help relieve fatigue before they could stop. They also expressed concerns over the cost, reliability, and complexity of FWSs.
Meuleners et al. (2017) [31]	Australia	To examine the association between a heavy vehicle driver's work environment, including fatigue-related factors, and the risk of a crash in Western Australia.	QS and biometric measurement	Descriptive statistics, univariate logistic regression, and conditional multiple logistic regression	Work environment factors (load type, truck configuration, breaks), sleep-related factors (sleep quality, Epworth Sleepiness Scale, MAP Index), and driver characteristics (experience, fatigue).	Driving an empty load, driving a rigid truck, and driving more than 50% of the trip at night significantly increased crash risk. The risk of crashing was nearly five times higher for drivers who drove between midnight and 5:59 AM. Drivers with less than 10 years of experience were more likely to crash. Time since last break and type of load (empty load) were significant risk factors.
Minusa et al. (2021) [34]	Japan	To analyze the relationship between truck drivers' autonomic nerve function (ANF), stress-induced fatigue, and the risk of rear-end collisions during on-road driving.	ND	Gradient boosting decision tree, logistic quantile regression, and bootstrapping	Sympathetic nerve activity (LF/HF ratio), parasympathetic nerve activity (NN50), heart rate variability (AVGHR), driving speed, acceleration, and collision risk index.	Acute stress-induced fatigue, marked by increased sympathetic nerve activity and reduced parasympathetic activity, was found to elevate the risk of rear-end collisions. The study identified that drivers exhibiting more sympathetic dominance (higher LF/HF ratio) had higher rear-end collision risk indices, while parasympathetic activity (higher NN50) mitigated collision risk.
Mizuno et al. (2020) [65]	Japan	To identify the relationship between truck driver fatigue, measured by autonomic nerve function, and rear-end collision risk, using a developed collision risk index.	ND	Correlation analysis, decision tree analysis, and Welch's *T*-Test	Autonomic nerve function (LF deviation score, sympathetic/parasympathetic nerve activity), rear-end collision risk index (R1hr), fatigue symptoms (VAS scores), vehicle behavior during warnings.	The study found a positive correlation between the rear-end collision risk index on a shift-day and the sympathetic nerve activity index measured post-shift, suggesting that higher sympathetic nerve activation due to fatigue increases collision risk on the following day. The developed collision risk index showed higher accuracy in predicting risk situations compared to automotive sensor warnings.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Murphy et al. (2019) [46]	United States	To investigate the moderating effect of occupational tenure on the relationship between safety climate perceptions and driving safety behavior among long-haul truck drivers.	QS	Hierarchical multiple regression, path analysis, and descriptive statistics	Safety climate, occupational tenure, driving safety behavior, near misses (measured by hard braking), and organizational tenure.	Safety climate had a positive effect on driving safety behavior, and this behavior mediated the relationship between safety climate and near misses (measured by hard braking incidents). However, the moderating effect of occupational tenure was observed, as drivers with longer occupational tenure were less influenced by safety climate in terms of their safety behavior. Despite this moderation, the effect of safety climate remained significant, and the occupational tenure interaction explained only a small portion of the variance in safety behavior.
Naderi et al. (2018) [104]	Iran	To assess the relationship between sleep problems and aberrant driving behaviors among Iranian truck drivers.	QS	Structural equation modeling, confirmatory factor analysis, and path analysis	Driver sleep problems, daily fatigue, driver exposure, truck price, aberrant driving behaviors (errors, slips, violations, inattention).	Daily fatigue significantly correlates with increased aberrant driving behaviors and inattention; sleep dissatisfaction and exposure also contribute to higher fatigue. Higher-priced trucks were associated with less fatigue and fewer driving errors.
Naderi et al. (2021) [105]	Iran	To predict at-fault collisions among heavy vehicle drivers in Iran by analyzing the influence of human factors using structural equation modeling (SEM) and Bayesian Network (BN).	QS	Structural equation modeling and Bayesian network	Driving behavior (slips, errors, violations), fatigue, sleep quality, mobile phone usage, education level, exposure (driving hours), and at-fault collision occurrence.	Only the “driving error” factor had a direct impact on at-fault collisions among heavy vehicle drivers. Other factors like mobile usage, fatigue, and sleep dissatisfaction indirectly contributed to collisions through their effect on driving errors. The Bayesian Network model indicated a 17% probability of a driver having an at-fault collision in the next three years if no additional information about the driver was available.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Newnam et al. (2018) [18]	United States	To explore differences in crash characteristics and injury outcomes between older (60 years and older) and middle-aged (27–59 years) truck drivers using data from two U.S. crash databases.	CD	Chi square, descriptive statistics, and weighted analysis	Driver age, crash severity, crash type, injury severity, crash location, lighting conditions, road alignment, and surface conditions.	No significant differences were found between older and middle-aged drivers in terms of crash severity and injury outcomes. Older drivers displayed safer behaviors, such as higher seat belt use and lower alcohol consumption compared to middle-aged drivers. Older drivers were involved in a higher percentage of crashes involving veering off the road, hitting objects, and turning across the path of another vehicle. There was no significant difference in environmental conditions or road surface conditions between the two age groups.
Okafor et al. (2022) [106]	United States	To examine the factors contributing to the severity of crashes involving in-state and out-of-state large truck drivers in Alabama, focusing on differences in crash outcomes based on driver residency.	CD	Random parameter multinomial logit model and marginal effects analysis	Fatigue, speeding, overcorrection, collision with vehicle, road conditions, lighting conditions, crash location, driver age, and driver's state of residence (in-state vs. out-of-state).	Fatigue was a significant factor in both in-state and out-of-state truck crashes, with higher contributions to severe crashes among out-of-state drivers. Speeding was more common in in-state crashes, but it only significantly affected the severity of crashes involving out-of-state drivers. Other contributing factors such as running red lights, overcorrection, and collisions with fixed objects were significant across both groups. The results suggest that while the contributing factors were generally similar, they had varying impacts on crash severity depending on the driver's state of residence.
Peng & Boyle (2012) [107]	United States	To analyze the impact of commercial driver factors on the severity of single-vehicle, run-off-road (ROR) crashes involving large trucks using data from Washington State.	CD	Descriptive statistics, chi square, and binary logistic regression	Driver distraction, inattention, speeding, seatbelt use, drowsiness, fatigue, environmental conditions (e.g., road type, lighting, weather).	Speeding, fatigue, distraction, and inattention strongly affected the severity of run-off-road crashes. Fatigued drivers had a 5.8 times higher likelihood of being involved in a fatal or injury crash. Distraction and speeding also significantly increased the severity of ROR crashes. The use of seat belts was shown to significantly reduce the likelihood of a crash being fatal or resulting in injury.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Pourabdian et al. (2020) [108]	Iran	To investigate how fatigue impacts the coping behaviors of international truck drivers and its potential effect on driving safety and accident risk.	QS	Descriptive statistics, chi square, paired *t*-test, and structural equation modeling	Fatigue, coping behavior (problem-oriented, emotion-oriented, avoidance styles).	Fatigue levels significantly increased after long-distance travel, with a shift in coping styles from problem-oriented to emotion-oriented and avoidance. This change in coping behavior could potentially increase accident risk as fatigue impairs decision making and increases the likelihood of dangerous driving behaviors. The shift toward emotion-oriented coping was correlated with higher fatigue levels, which could contribute to unsafe driving practices.
Pylkkönen et al. (2015) [41]	Finland	To explore the impact of working hours on sleepiness, sleep quality, and the use of countermeasures for sleepiness among shift-working long-haul truck drivers.	ND	Generalized estimating equations, descriptive statistics, odds ratio, and chi square test	Sleepiness, sleep quantity, use of sleepiness countermeasures (e.g., caffeine, naps, in-vehicle activities), shift types, and sleep loss.	Severe sleepiness was most common during the first night shift (37.8%) and least on morning shifts (10.0%). Drivers slept well before duty on most shifts, but total sleep time was shortest before morning shifts (5:43) and longest before the first night shifts (7:21). Efficient sleepiness countermeasures like napping and caffeine were used more frequently during night shifts (41.4%) than non-night shifts (19.0%). The study found significant associations between shift type and sleepiness, with the first night shift having the highest odds of severe sleepiness.
Rashmi & Marisamy-nathan (2024a) [38]	India	To investigate the direct and indirect effects of socio-demographic, work-related, and health-related lifestyle factors on crash risk among long-haul truck drivers, mediated through aberrant driving behaviors.	QS	Descriptive statistics, exploratory factor analysis, confirmatory factor analysis, and structural equation modeling	Socio-demographic characteristics (e.g., age, marital status, income), work and vehicle characteristics, health-related lifestyle (e.g., smoking, BMI), aberrant driving behaviors (errors, lapses, ordinary violations, aggressive violations), crash involvement.	Aberrant driving behaviors, including errors, lapses, and violations, significantly influenced crash involvement among long-haul truck drivers. Younger drivers and those with less education or lower income were more likely to engage in risky driving behaviors. Drivers carrying perishable goods exhibited higher crash risk.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Rashmi & Marisamy-nathan (2024b) [59]	India	To develop a prediction model for speeding behavior and identify the contributory factors influencing speeding behavior among long-haul truck drivers (LHTDs) in India using both binary logit and machine learning (ML) techniques.	QS	Binary logistic regression and machine learning models	Socio-demographics (age, income, education), work-related factors (truck age, driving hours, delivery pressure), health-related lifestyle factors (sleep duration, smoking), and speeding behavior (speeding frequency, road conditions).	The study identified key factors influencing speeding behavior among LHTDs, including pressured delivery schedules, inadequate sleep, truck age, and driving duration. Random Forest (RF) outperformed other ML algorithms in predicting speeding behavior, with high predictive accuracy (80%). Key contributors to speeding included pressured delivery and inadequate sleep, with truck age and driving duration also playing significant roles. The study also revealed a non-linear relationship between these factors and speeding behavior.
Ren et al. (2023) [109]	Australia	To examine the role of demographic, occupational, lifestyle, and other health risk factors associated with fatigue among Australian truck drivers.	QS	Descriptive statistics, logistic regression analysis, and Cronbach's alpha	Working hours, sleep quality, loneliness, lifestyle factors (diet, smoking), financial stress, and health status.	Prolonged working hours, poor sleep, and feelings of loneliness were significantly associated with high-risk fatigued driving. Drivers working 40–60 h had nearly three times higher odds of fatigued driving. Poor sleep increased the odds by seven times, and loneliness doubled the risk.
Rezapour et al. (2018) [27]	United States	To identify the contributory factors of truck-at-fault crashes using both crash data and traffic violations, particularly focusing on Interstate 80 in Wyoming, a region with a high truck crash rate.	CD	Binary logistic regression, odds ratio, stepwise model selection, and goodness-of-fit test	Driver demographics, crash characteristics (e.g., single/multiple vehicle crash, vehicle speed, crash type), violation record (e.g., speeding, DUI, HOS violations), weather conditions, road conditions.	The study identified key factors contributing to truck-related injury and fatal crashes, including driver distraction, fatigue, and a history of traffic violations. Drivers with multiple violations were more likely to be involved in severe crashes. Female drivers were found to have higher odds of injury or fatality in crashes. Crash types such as head-on collisions, rollovers, and driver ejections were significantly associated with increased crash severity. Additionally, the analysis of violation data revealed that non-resident drivers had a higher likelihood of committing violations that could lead to severe crashes.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Ronen et al. (2014) [77]	Israel	To examine the effectiveness of combining short rest and energy drink consumption as countermeasures for fatigue in professional truck drivers during a prolonged drive.	DSE	General linear mixed models, ANOVA, and descriptive statistics	Energy drink (caffeine), placebo drink, driving performance (lane position, steering wheel deviations), subjective fatigue, physiological measures (HRV), and workload.	Energy drink consumption improved lane position and steering wheel control during the first 80–100 min of driving. The addition of a short 10-min rest after 100 min further maintained performance for the remainder of the drive. The combination of energy drink and rest was more effective than energy drink alone, especially in maintaining driving consistency.
Rosso et al. (2016) [110]	Italy	To investigate the prevalence of obesity, alcohol consumption, unhealthy alcohol use, and sudden-onset sleepiness at the wheel among Italian truck drivers and identify potential predictors for these issues.	QS	Descriptive statistics, univariate logistic regression, multivariate logistic regression, ANOVA and linear regression	Body mass index, alcohol use, sudden sleep onset at the wheel, age, length of service, driving distance, working hours, and fatigue levels.	45% of truck drivers were overweight, and 21.4% were obese. Additionally, 24.2% of drivers reported consuming alcohol during work hours, and 41.6% experienced sudden sleep onset while driving at least once per month. Factors such as longer years of service and unhealthy alcohol use were associated with a higher likelihood of obesity. Older drivers (age > 55), those driving more than 50,000 km per year, and those reporting higher fatigue levels were more likely to experience sudden sleep onset while driving.
S. Chen et al. (2020) [19]	China	To examine the factors contributing to the severity of truck-involved crashes in Shanghai's river-crossing tunnels, using data from 2014 to 2016.	CD	Ordered logit regression analysis	Driver factors (age, gender, fatigue, alcohol, safety belt use), environmental factors (time of day, weather conditions), vehicle factors (truck type, overload, number of vehicles), tunnel factors (number of lanes, tunnel length, speed limits, crash location).	Male drivers and older drivers (≥65) were more likely to be involved in severe crashes. Fatigue driving and alcohol consumption significantly increased crash severity. Crashes occurring during late night (00:00–06:59) and afternoon rush hours (16:30–18:59) were more severe. Snowy, icy, or rainy road conditions were linked to higher injury severity. Single-unit trucks and overloaded trucks had a higher likelihood of severe injury, and crashes in interior zones of tunnels had a greater severity compared to transition zones.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Sagar et al. (2020) [37]	United States	To analyze the relationship between the socioeconomic and demographic characteristics of drivers' residence zip codes and the likelihood of being involved in crashes, identifying high-risk groups for targeted safety interventions.	CD	Logistic regression and quasi-induced exposure technique	Income, education level, poverty level, employment, age, gender, rurality of zip code, housing characteristics.	Younger and older drivers were more likely to be at fault in crashes, with age, household income, education, and rurality being key predictors. Drivers from lower-income areas with lower educational attainment were more likely to be involved in crashes. There was a significant association between rural living and higher crash involvement.
Sarker et al. (2023) [111]	United States	To examine the injury severity of single-vehicle large-truck crashes in Florida, with an emphasis on accounting for heterogeneity using a random parameter ordered logit (RPOL) model.	CD	Descriptive statistics, random parameter ordered logit, marginal effects analysis, and goodness-of-fit measures	Driving speed, defective tires, fatigued/asleep driver, driving under influence, driver distraction, lighting conditions, crash time, vehicle defects.	Driving speed (particularly between 76–100 mph) and defective tires were the most influential factors in increasing the likelihood of severe crashes. Driver fatigue, distraction, and driving under the influence were also strongly linked to higher crash severity. Crashes occurring in dark, non-lighted conditions and at Y-intersections had higher injury severity. Drivers from outside Florida were less likely to cause severe crashes compared to local drivers.
Shams et al. (2020) [3]	Iran	To explore the direct and indirect effects of sleep quality on crash involvement among Iranian truck drivers, examining how risky driving behavior mediates the relationship between sleep quality and crashes.	QS	Descriptive statistics, principal component analysis, confirmatory factor analysis, and structural equation modeling	Sleep quality (subjective sleep quality, sleep duration, habitual sleep efficiency, sleep disturbances), risky driving behaviors (errors, violations, lapses), crash involvement.	Subjective sleep quality and sleep duration not only directly affected crash involvement but also indirectly influenced crashes by increasing risky driving behaviors, such as errors and ordinary violations. Habitual sleep efficiency and daytime dysfunction had indirect effects through their relationship with risky driving behaviors. Additionally, sleep disturbances and sleep latency had direct effects on crash involvement.
Shandhana Rashmi & Marisamy-nathan (2024) [80]	India	To develop a prediction model for mobile phone use while driving (MPWD) and identify the risk factors influencing this behavior among long-haul truck drivers (LHTDs) in India.	QS	Machine learning models, Shapley additive explanations, and cross validation	Type of commodity, pressured delivery, calls received during driving, smoking habits, educational level, continuous driving duration.	MPWD is significantly influenced by factors such as the type of commodity carried, pressured delivery schedules, smoking habits, and driving duration. XGBoost was found to be the best performing model for predicting MPWD with high accuracy and interpretability.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Sinagawa et al. (2015) [71]	Brazil	To investigate the relationship between long-distance travel and the use of stimulants (amphetamines, cocaine, and cannabis) among truck drivers in Brazil.	Interview and urine sample	Descriptive statistics, chi square, binary logistic regression, and goodness-of-fit testing	Drug use (amphetamine, cocaine, cannabis), travel length, sociodemographic factors (age, gender), working conditions.	The study found a significant association between longer travel distances (>270 km) and increased use of amphetamines, both reported use and urine sample testing. Drivers traveling longer distances had a higher prevalence of amphetamine in their urine samples (9.9%) and reported current amphetamine use (10.9%). No similar association was found for cocaine or cannabis use.
Škerlič & Erčulj (2021) [43]	Slovenia	To examine how financial and non-financial incentives affect the safety behavior of heavy truck drivers and their subsequent impact on traffic accidents.	QS	Structural equation modeling, descriptive statistics, and confirmatory factor analysis	Financial incentives (e.g., salary adequacy, additional payments for weekend or holiday work), non-financial incentives (e.g., communication with superiors, company support), truck management (e.g., driver capability to manage truck performance), and safety behavior (e.g., accidents, violations of driving regulations).	Financial incentives negatively impacted the likelihood of exceeding the daily driving limit, while non-financial incentives reduced the likelihood of shortening daily rest periods. Financial incentives also positively influenced drivers' ability to manage their trucks and balance work with rest, contributing to safer driving behaviors.
Soro et al. (2020) [112]	Australia	To examine the associations between heavy vehicle driver employment type and payment methods with crash involvement, using data from long-distance drivers in New South Wales and Western Australia.	CD	Descriptive statistics, unconditional logistic regression, and chi square test	Employment type (employee drivers, owner drivers, subcontractor drivers), payment methods (time-based, trip-based, distance-based), payment for loading/unloading time, and crash involvement.	Owner drivers had significantly lower odds of crash involvement compared to employee drivers. Drivers paid time- or trip-based rates had lower crash odds compared to those paid based on distance. Payment for time spent loading/unloading was also associated with lower crash odds. Driving freight other than empty trucks (e.g., general freight, livestock) was linked to fewer crashes.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Stavrinos et al. (2016) [57]	United States	To examine the impact of distractions (cell phone, texting, emailing) and self-reported driving skill on the driving performance of commercial truck drivers using a driving simulator.	DSE	Descriptive statistics, generalized estimating equations, and video coding	Distracted driving tasks (cell phone, texting, emailing), self-reported driving skill (optimism bias), driving performance (collisions, speeding, lane deviations, eye glances).	Texting and emailing tasks significantly impaired driving performance, increasing collisions, lane deviations, and off-road eye glances. Self-rated "very skilled" drivers exhibited more risky behaviors, such as speeding and greater violations, compared to those rated as "skilled."
Sulasih Mutifasari & Hikmat Ramdhan (2019) [113]	Indonesia	To explore the correlation between sleep quantity and quality and occupational stress in truck drivers, with an emphasis on how these factors affect drivers' performance and safety.	QS and biometric measurement	Descriptive statistics, chi square, and *t*-test	Sleep quantity, sleep quality, occupational stress, blood pressure, pulse rate, oxygen levels.	The study found a significant correlation between both sleep quantity and quality with occupational stress among truck drivers. Drivers who reported insufficient sleep had higher levels of stress, as measured by both subjective questionnaires and objective physiological markers (blood pressure, pulse, oxygen levels). Additionally, drivers with poor sleep quality were more likely to experience moderate to severe stress.
Swedler et al. (2015) [45]	United States	To investigate the relationship between safety climate factors and distracted driving behaviors among commercial truck drivers, and to understand how organizational safety climate influences distracted driving outcomes such as crashes and near-crashes.	Interview and QS	Descriptive statistics, exploratory factor analysis, multivariate logistic regression, and thematic analysis	Safety climate, communication and procedures, management commitment, work pressure, driver distraction (e.g., phone use, texting, swerving, crashes), and driving experience.	A poor overall safety climate was significantly associated with a higher likelihood of truck drivers experiencing crashes or distraction-related near crashes. Specifically, lower scores in communication and procedures, work pressure, and management commitment were linked to increased distracted driving outcomes. Interview participants emphasized that inconsistent or implicit expectations regarding distractions and poor management commitment to safety were key contributors to these behaviors.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Teoh et al. (2017) [48]	United States	To identify and evaluate risk factors associated with large truck crashes resulting in injury or death in North Carolina using a matched case-control study design.	CD	Conditional logistic regression, descriptive statistics, marginal effects analysis, and goodness-of-fit testing	Vehicle defects (brakes, tires, lighting), driver age, experience, violations, carrier crash history, short-haul exemption, and vehicle safety technologies.	Out-of-service vehicle defects, particularly brake and tire violations, significantly increase crash risk, with any defect tripling the risk of crashing. Short-haul exemption trucks exhibited a 383% higher crash risk. Carriers with higher historical crash rates also showed increased crash risk. Vehicle safety technologies, especially ABS, significantly reduced crash risk.
Thiese et al. (2015) [114]	United States	To assess relationships and trends over time in individual and multiple medical conditions among a large sample of truck drivers.	Medical examination	Descriptive statistics, logistic regression, trend analysis, and prevalence odds ratio estimation	Medical conditions (e.g., hypertension, diabetes, sleep apnea, opioid use), age, sex, BMI.	The study found significant increases in the prevalence of multiple medical conditions among truck drivers from 2005 to 2012, including opioid and benzodiazepine use, sleep problems, and obesity. A notable increase was observed in the number of drivers with four or more medical conditions, which may indicate a higher crash risk.
Thiese et al. (2017) [36]	United States	To evaluate the increased crash risk among truck drivers with multiple comorbid medical conditions, with an emphasis on preventable and reportable crashes.	CD	Descriptive statistics, hazard ratio estimation, Kaplan–Meier survival analysis, and multivariate cox proportional hazards models	Number of comorbid medical conditions (e.g., diabetes, cardiovascular disease, hypertension), crash occurrence, severity (DOT-reportable, preventable), and injury outcome.	Drivers with three or more medical conditions had significantly higher risks for preventable and DOT-reportable crashes (HR = 2.53 for preventable crashes). Those with multiple conditions, particularly conditions like cardiovascular disease, hypertension, and obesity, were more likely to be involved in crashes, especially those that resulted in injuries.
Torregroza-Vargas et al. (2014) [115]	Colombia	To investigate the association between truck driver fatigue and the likelihood of road crashes in Colombia, focusing on variables such as the duration of rest before trips, number of breaks, and road conditions.	QS	Descriptive statistics, relative risk estimation, multivariate logistic regression, and interaction analysis	Resting time before the trip, number and duration of breaks, terrain type (flat, sinuous, mountainous), road conditions (potholes, signs), number of lanes.	The study found a significant association between fatigue and crash occurrence, particularly in drivers who had fewer breaks or insufficient rest before their shifts. Breaks of 10–20 min increased the odds of a crash, while longer breaks (31–50 min) were associated with a lower risk. Flat terrain and single-lane roads were also identified as higher risk factors for crashes.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Tseng et al. (2016) [60]	Taiwan	To investigate the factors that lead to speeding offenses among large-truck drivers.	QS	Descriptive statistics, logistic regression analysis, and correlation analysis	Age, education, sleep quality, driving experience, annual kilometers driven, and late-night driving.	Older drivers (over 60 years) were more likely to commit speeding offenses compared to younger drivers. Drivers with poor sleep quality were more likely to report speeding offenses. Drivers with more driving experience and those who drove late at night also had higher odds of committing speeding offenses. Additionally, less educated drivers had more speeding offenses than those with higher education.
Useche et al. (2021) [116]	Spain	To assess whether work-related fatigue mediates the relationship between job stress, health indicators, and occupational traffic crashes among long-haul truck drivers.	QS	Descriptive statistics, bivariate correlation, structural equation modeling	Job strain, health indicators (general health and psychological distress), work-related fatigue, work-traffic crashes.	Work-related fatigue fully mediates the relationship between job stress and work-related traffic crashes. Higher levels of job strain and psychological distress were associated with increased fatigue, which in turn increased the likelihood of traffic crashes among long-haul truck drivers. The study suggests that fatigue plays a central role in linking stress and crashes.
Valenzuela & Burke (2020) [117]	Colombia	To understand the safety performance of professional truck drivers in Colombia, focusing on how various safety performance dimensions predict critical safety outcomes, such as hard braking events, and to evaluate the multidimensional conceptualization of truck drivers' safety performance.	QS and CD	Exploratory factor analysis, hierarchical regression analysis, and descriptive statistics	Safety performance dimensions (e.g., communicating health and safety information, exercising employee rights and responsibilities, attending to driving), hard braking frequency, safety climate, and region of operation.	The study identified six key dimensions of safety performance: engaging in work practices to reduce risk, communicating health and safety information, preparing to drive, using personal protective equipment, exercising employee rights and responsibilities, and attending to driving. safety performance dimensions such as communicating health and safety information and exercising employee rights were strong predictors of hard braking. Interestingly, the use of personal protective equipment, a less conceptually relevant factor, was also associated with hard braking.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Wang & Prato (2019) [30]	China	To identify the factors influencing injury severity in truck crashes on mountainous expressways in China, focusing on geometric, driver, crash, truck, and environmental characteristics.	CD	Partial proportional odds model, pseudo-elasticity analysis, and descriptive statistics	Geometric characteristics (curve radius, deflection angle, longitudinal gradient), driver characteristics (age, experience, behavior), truck characteristics (overloading, brake failure), environmental conditions (weather, time of day, season).	Steep longitudinal gradients (>3%) and sharp curves are linked to higher injury and fatality probabilities. Young drivers and those with less experience were associated with higher injury severity. Overloading and brake failure significantly increased the probability of fatal crashes. Nighttime crashes and adverse weather (rain, fog) were linked to higher fatality rates.
Wang et al. (2018) [22]	China	To explore the effects of continuous driving duration on commercial truck drivers' visual behaviors and subjective fatigue awareness.	ND	ANOVA, Pearson product-moment correlation, and descriptive statistics	Pupil diameter, fixation duration, saccade number, saccade speed, blink frequency, blink duration, subjective fatigue level.	The study found significant changes in visual behaviors (e.g., pupil diameter, blink frequency, fixation duration) and subjective fatigue as driving time increased. Fatigue levels were positively correlated with visual indicators such as increased blink duration and pupil diameter and negatively correlated with visual metrics like saccade speed and number of fixations. Elderly drivers were particularly sensitive to fatigue, with stronger correlations between visual changes and self-reported fatigue levels.
Wang et al. (2019) [20]	China	To identify and analyze significant risk factors affecting the severity of truck crashes on mountainous freeways in Jiangxi and Shaanxi provinces in China.	CD	Partial proportional odds model, marginal effects analysis, and descriptive statistics	Driver age, seatbelt use, vehicle type, vehicle overloading, brake system status, speeding, following distance, weather conditions, road geometry (curves, vertical grade), and time of crash.	Older truck drivers, failure to wear seatbelts, overloading, speeding, and risky following behaviors significantly increased the likelihood of injury and fatal crashes. Crash severity was also higher in adverse weather conditions, during the nighttime, and in mountainous road curves. Overloading was identified as the most important factor contributing to crash severity.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Waskito et al. (2024) [118]	Indonesia	To analyze the role of human error in truck accidents in Indonesia using the HFACS framework and Bayesian Network (BN) modeling to understand the causal relationships and identify key failure modes influencing accident severity.	CD	Human factors analysis and classification system framework, Bayesian network, sensitivity analysis, and descriptive statistics	Human errors, organizational influences, unsafe supervision, pre-conditions of unsafe acts, and unsafe acts in truck accidents.	Driver violations, particularly related to decision-making errors and operating errors, were the most significant contributors to fatalities and multiple-vehicle accidents. Additionally, environmental factors and road conditions were found to be crucial in determining accident outcomes. The integration of HFACS and BN provided a deeper understanding of the interactions between various failure modes at different levels, emphasizing the importance of both human and mechanical factors in truck accidents.
Wei et al. (2021) [56]	Taiwan	To investigate the relationship between truck drivers' personality traits and their likelihood of engaging in aberrant driving behaviors, and to predict driving risk using artificial neural networks (ANN).	QS and ND	Artificial neural networks, Jenks natural breaks optimization and Elbow method, descriptive and sensitivity analysis	Personality traits (extraversion, agreeableness, conscientiousness, neuroticism, openness to experience), aberrant driving behaviors (speeding, abnormal stay, hard acceleration, hard deceleration, driving overtime, excessive rotation speed), driving risk.	Neuroticism was significantly associated with behaviors like speeding, abnormal stay, hard acceleration, and hard deceleration. Conscientiousness was the most significant predictor for driving overtime. The proposed models accurately predicted aberrant driving behaviors and driving risk based on personality traits, with models achieving high prediction accuracies for behaviors such as excessive rotation speed and speeding.
Yosef et al. (2021) [25]	Ethiopia	To assess the prevalence and associated factors of psychoactive substance use among truck drivers in Ethiopia, particularly focusing on the use of alcohol and khat.	QS	Binary logistic regression, Hosmer–Lemeshow goodness-of-fit test, and descriptive statistics	Age, religion, education, family size, hours of sleep at night, rest breaks between driving, job stress, and psychoactive substance use (alcohol and khat).	70% of truck drivers reported using psychoactive substances in the past month, with alcohol consumption being more prevalent (55%) than khat chewing (30%). Factors associated with higher odds of psychoactive substance use included being younger than 38 years, having lower levels of education, having fewer than three family members, and insufficient sleep (less than six hours). Drivers with rest breaks between driving were more likely to use psychoactive substances.

Table A1. *Cont.*

Author, Year	Country	Objective	Data Collection	Data Analysis	Key Variables	Main Findings
Yuan et al. (2021) [119]	China	To identify various risk factors associated with fatal crash severity and analyze their impact on different groups of truck drivers by incorporating a comprehensive list of demographics, driving behavior, and conviction-related variables.	CD	Latent class clustering, partial proportional odds, likelihood ratio, and descriptive statistics	Driver-related variables (age, gender, driving history, violations, seatbelt use), vehicle-related variables (truck type, weight, age), environmental factors (weather, road conditions), and crash-related factors (collision type, number of vehicles involved).	The study identified that adverse weather, rural areas, curved roadways, and tractor-trailer units were associated with higher crash severities across all driver groups. Additionally, high-risk behaviors like driving under the influence of alcohol, drugs, fatigue, and carelessness were significantly linked to severe crashes, particularly in drivers with a high risk of violations and crash history.
Zhang et al. (2024) [35]	China	To explore the interactive effects of sleep patterns, driving tasks, and time-on-task on driving behavior and eye-motion metrics among short-haul truck drivers.	ND	ANOVA, Friedman test, Wilcoxon signed rank test, and descriptive statistics	Sleep patterns, driving tasks (outbound and inbound), time-on-task, driving behavior (speed, acceleration), eye-motion metrics (fixation duration, pupil diameter, saccadic velocity).	Sleep deprivation and excessive time-on-task lead to impaired driving performance and increased fatigue, as evidenced by increased speed volatility and eye-motion metrics such as pupil constriction and lower saccadic velocity. Driving performance was significantly impaired under sleep-deprived conditions, particularly during inbound tasks with low workload and monotony. The combined effects of poor sleep and prolonged time-on-task contributed more to fatigue than either factor alone.
Zhu & Srinivasan (2011) [61]	United States	To analyze empirical factors affecting the injury severity of large-truck crashes using a nationally representative sample.	CD	Ordered probit model, weighted maximum likelihood estimation, and descriptive statistics	Crash type, vehicle characteristics, driver demographics (age, fatigue, distractions, alcohol use), and road conditions.	Crash type (e.g., truck-rollover, truck-car head-on) significantly influences injury severity. Higher speeds, emotional driver behaviors (e.g., distractions, alcohol use), and crash location (e.g., interchanges and intersections) were associated with higher severity outcomes. Driver fatigue and seatbelt use were not statistically significant, possibly due to interaction with other behavioral variables.

Note: QS represents questionnaire survey; CD represents crash data; DSE represents driving simulator experiment; ND represents naturalistic data; VD represents videographic data.

Table A2. Quality assessment of included studies.

Author, Year	Selection Bias	Measurement Bias	Confounding	Reporting Bias	Overall Quality
Afghari et al. (2022) [68]	Some concerns	Some concerns	Low	Some concerns	Moderate
Ahlström & Anund (2024) [63]	Some concerns	Some concerns	Some concerns	Low	Moderate
Anam et al. (2022) [29]	Low	Low	Some concerns	Low	High
Anderson et al. (2017) [50]	Some concerns	Some concerns	High	Some concerns	Low
Baikejuli et al. (2023) [78]	Some concerns	High	Some concerns	Some concerns	Low
Balthrop et al. (2024) [84]	Low	Low	Low	Some concerns	High
Behnood & Al-Bdairi (2020) [85]	Low	Low	Some concerns	Some concerns	Moderate
Behnood & Mannering (2019) [49]	Low	Low	Some concerns	Some concerns	Moderate
Bekelcho et al. (2024) [86]	Some concerns	High	Some concerns	Some concerns	Low
Belzer (2018) [87]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Belzer & Sedo (2018) [64]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Benallou et al. (2023) [88]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Bombana et al. (2017) [70]	Some concerns	Low	Some concerns	Some concerns	Moderate
Bunn et al. (2009) [24]	Low	Low	Some concerns	Some concerns	Moderate
C. Chen & Xie (2014) [69]	Low	Low	Some concerns	Some concerns	Moderate
C. Chen & Zhang (2016) [26]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
C. Chen et al. (2015) [89]	Low	Low	Some concerns	Some concerns	Moderate
Casey et al. (2024) [66]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Catarino et al. (2014) [90]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Choudhary et al. (2022) [91]	Some concerns	High	Some concerns	Some concerns	Low
Claveria et al. (2019) [82]	Some concerns	High	Some concerns	Some concerns	Low
Cori et al. (2021) [40]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Cui et al. (2024) [67]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
de Oliveira et al. (2015) [73]	Some concerns	High	Some concerns	Some concerns	Low
de Oliveira, Barroso, et al. (2020) [92]	Some concerns	Low	Low	Some concerns	Moderate
de Oliveira, Eckschmidt, et al. (2020) [72]	Some concerns	High	Some concerns	Some concerns	Low
Delhomme & Gheorghiu (2021) [53]	Some concerns	High	Some concerns	Some concerns	Low
Douglas et al. (2019) [44]	Some concerns	High	Some concerns	Some concerns	Low
Ebrahimi et al. (2024) [93]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Filomeno et al. (2019) [21]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Filtness et al. (2020) [94]	Some concerns	High	Some concerns	Some concerns	Low
Fitch et al. (2015) [83]	Some concerns	Low	Some concerns	Some concerns	Moderate

Table A2. *Cont.*

Author, Year	Selection Bias	Measurement Bias	Confounding	Reporting Bias	Overall Quality
G.X. Chen et al. (2015) [95]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
G.X. Chen et al. (2016) [28]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Garbarino et al. (2017) [33]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Gates et al. (2013) [75]	Low	Low	Some concerns	Some concerns	Moderate
Girotto et al. (2016) [32]	Some concerns	High	Some concerns	Some concerns	Low
Hamido et al. (2021) [17]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Han et al. (2021) [62]	Some concerns	High	Some concerns	Some concerns	Low
Heaton et al. (2021) [96]	High	High	Some concerns	Some concerns	Low
Hickman & Hanowski (2012) [81]	Low	Low	Some concerns	Some concerns	Moderate
Hokmabadi et al. (2021) [97]	Some concerns	High	Some concerns	Some concerns	Low
Horberry et al. (2022) [98]	Some concerns	Low	Some concerns	Low	Moderate
Hosseinzadeh et al. (2021) [76]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Ikeda et al. (2021) [99]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Iseland et al. (2018) [79]	High	High	Some concerns	Some concerns	Low
Islam & Ozkul (2019) [23]	Low	Low	Some concerns	Some concerns	Moderate
Kemp et al. (2013) [54]	Some concerns	High	Some concerns	Some concerns	Low
Ketabi et al. (2011) [100]	Some concerns	High	Some concerns	Some concerns	Low
Kudo & Belzer (2019) [42]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Kumagai et al. (2023) [101]	Some concerns	Low	Some concerns	Some concerns	Moderate
Lemke et al. (2016) [52]	Some concerns	High	Some concerns	Some concerns	Low
Lemke et al. (2021) [51]	Some concerns	High	Some concerns	Some concerns	Low
Leyton et al. (2019) [74]	Some concerns	Low	Some concerns	Some concerns	Moderate
M. Chen et al. (2020) [102]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Mahajan, Velaga, Kumar, & Choudhary (2019) [58]	Some concerns	High	Some concerns	Some concerns	Low
Mahajan, Velaga, Kumar, Choudhary, et al. (2019) [39]	Some concerns	High	Some concerns	Some concerns	Low
Makuto et al. (2023) [55]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
McKnight & Bahouth (2009) [47]	Low	Some concerns	Some concerns	Some concerns	Moderate
Meng et al. (2016) [103]	Some concerns	High	Some concerns	Some concerns	Low
Meuleners et al. (2017) [31]	Some concerns	Some concerns	Low	Some concerns	Moderate

Table A2. *Cont.*

Author, Year	Selection Bias	Measurement Bias	Confounding	Reporting Bias	Overall Quality
Minusa et al. (2021) [34]	Some concerns	Some concerns	Low	Some concerns	Moderate
Mizuno et al. (2020) [65]	Some concerns	Some concerns	Low	Some concerns	Moderate
Murphy et al. (2019) [46]	Some concerns	High	Some concerns	Some concerns	Low
Naderi et al. (2018) [104]	Some concerns	High	Some concerns	Some concerns	Low
Naderi et al. (2021) [105]	Some concerns	High	Some concerns	Some concerns	Low
Newnam et al. (2018) [18]	Low	Some concerns	Some concerns	Some concerns	Moderate
Okafor et al. (2022) [106]	Low	Some concerns	Some concerns	Some concerns	Moderate
Peng & Boyle (2012) [107]	Low	Low	Some concerns	Some concerns	Moderate
Pourabdian et al. (2020) [108]	Some concerns	High	Some concerns	Some concerns	Low
Pylkkönen et al. (2015) [41]	Some concerns	Some concerns	Low	Some concerns	Moderate
Rashmi & Marisamynathan (2024a) [38]	Some concerns	High	Some concerns	Some concerns	Low
Rashmi & Marisamynathan (2024b) [59]	Some concerns	High	Some concerns	Some concerns	Low
Ren et al. (2023) [109]	Some concerns	High	Some concerns	Some concerns	Low
Rezapour et al. (2018) [27]	Low	Low	Some concerns	Some concerns	Moderate
Ronen et al. (2014) [77]	Some concerns	Some concerns	Some concerns	High	Low
Rosso et al. (2016) [110]	Some concerns	High	Some concerns	Some concerns	Low
S. Chen et al. (2020) [19]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate
Sagar et al. (2020) [37]	Low	Some concerns	Some concerns	Some concerns	Moderate
Sarker et al. (2023) [111]	Low	Some concerns	Some concerns	Some concerns	Moderate
Shams et al. (2020) [3]	Some concerns	High	Some concerns	Some concerns	Low
Shandhana Rashmi & Marisamynathan (2024) [80]	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
Sinagawa et al. (2015) [71]	Some concerns	Low	Some concerns	Some concerns	Moderate
Škerlič & Erčulj (2021) [43]	Some concerns	High	Some concerns	Some concerns	Low
Soro et al. (2020) [112]	Some concerns	Some concerns	Low	Some concerns	Moderate
Stavrinos et al. (2016) [57]	Some concerns	High	Some concerns	Some concerns	Low
Sulasih Mutifasari & Hikmat Ramdhan (2019) [113]	Some concerns	High	Some concerns	Some concerns	Low
Swedler et al. (2015) [45]	Some concerns	High	Some concerns	Some concerns	Low
Teoh et al. (2017) [48]	Low	Low	Some concerns	Some concerns	Moderate
Thiese et al. (2015) [114]	Some concerns	Some concerns	Some concerns	Some concerns	Moderate

Table A2. *Cont.*

Author, Year	Selection Bias	Measurement Bias	Confounding	Reporting Bias	Overall Quality
Thiese et al. (2017) [36]	○ Some concerns	◍ Low	○ Some concerns	○ Some concerns	○ Moderate
Torregroza-Vargas et al. (2014) [115]	○ Some concerns	● High	○ Some concerns	○ Some concerns	● Low
Tseng et al. (2016) [60]	○ Some concerns	● High	○ Some concerns	○ Some concerns	● Low
Useche et al. (2021) [116]	○ Some concerns	● High	○ Some concerns	○ Some concerns	● Low
Valenzuela & Burke (2020) [117]	○ Some concerns	● High	○ Some concerns	○ Some concerns	● Low
Wang & Prato (2019) [30]	◍ Low	◍ Low	○ Some concerns	○ Some concerns	○ Moderate
Wang et al. (2018) [22]	○ Some concerns	○ Some concerns	○ Some concerns	○ Some concerns	○ Moderate
Wang et al. (2019) [20]	◍ Low	○ Some concerns	○ Some concerns	○ Some concerns	○ Moderate
Waskito et al. (2024) [118]	○ Some concerns	○ Some concerns	◍ Low	○ Some concerns	○ Moderate
Wei et al. (2021) [56]	○ Some concerns	● High	○ Some concerns	○ Some concerns	● Low
Yosef et al. (2021) [25]	○ Some concerns	● High	○ Some concerns	○ Some concerns	● Low
Yuan et al. (2021) [119]	◍ Low	○ Some concerns	○ Some concerns	○ Some concerns	○ Moderate
Zhang et al. (2024) [35]	○ Some concerns	○ Some concerns	○ Some concerns	○ Some concerns	○ Moderate
Zhu & Srinivasan (2011) [61]	● Low	● Low	○ Some concerns	○ Some concerns	○ Moderate

Note: Symbols indicate risk of bias: ● = low, ○ = moderate/unclear, ◍ = high.

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