

Health and Safety Risk Analysis for Online Transportation Workers

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Article Information

Received: June 22, 2026

Revised: July 01, 2026

Online: July 10, 2026

Keywords

Occupational Health, Occupational Safety, Online Transportation Workers, Fatigue, Musculoskeletal Disorders

ABSTRACT

Background: Online transportation workers are one of the rapidly growing informal sectors and play an important role in supporting urban mobility. However, these workers are exposed to various occupational health and safety hazards due to long working hours, traffic exposure, fatigue, psychosocial stress, and ergonomic factors. Recent studies have shown that online transportation workers experience a high risk of occupational injuries and musculoskeletal disorders. Purpose: This study aimed to analyze occupational health and safety risks among online transportation workers. Methods: This study used a literature review approach by examining relevant studies concerning occupational health and safety risks among online transportation workers. Articles published between 2020 and 2026 were collected and analyzed descriptively. Results: The findings indicated that traffic accidents, work fatigue, musculoskeletal disorders, psychosocial stress, and environmental exposure were the main risks faced by online transportation workers. Long working hours and inadequate occupational health protection increased the likelihood of work-related injuries and illnesses. Implications: Improving occupational safety management, health promotion programs, and ergonomic interventions is necessary to reduce occupational risks among online transportation workers. Conclusion: Online transportation workers are exposed to multiple health and safety risks that require preventive measures and stronger occupational health policies.

INTRODUCTION

The rapid development of digital technology has transformed transportation services worldwide. Online transportation services have become an essential component of urban mobility and provide employment opportunities for millions of workers. The expansion of ride-hailing platforms has increased the number of online transportation workers, particularly motorcycle taxi drivers and delivery workers. Despite the economic benefits, these workers face numerous occupational health and safety challenges. Online transportation workers spend prolonged periods on the road and are continuously exposed to traffic hazards. High work demands, irregular working



schedules, and economic pressure often force workers to extend their working hours, which may contribute to fatigue and increase the risk of accidents.

Previous studies have reported that online transportation workers frequently experience traffic-related injuries, psychological stress, and musculoskeletal disorders associated with prolonged sitting posture and repetitive movements. Musculoskeletal disorders represent one of the most common occupational health problems among online motorcycle drivers. Prolonged static posture, vibration exposure, and long daily working hours contribute significantly to physical complaints. Research conducted among online motorcycle drivers showed that workload and duration of work were significantly associated with musculoskeletal disorders.

In addition to physical risks, psychosocial hazards are increasingly recognized among digital platform workers. Work pressure, algorithmic management, job insecurity, and customer rating systems contribute to stress, burnout, and poor mental well-being. These psychosocial factors may also influence unsafe driving behavior and increase accident risk. Occupational safety and health protection among informal workers remains limited. Many online transportation workers do not receive adequate occupational safety training or health protection programs. Therefore, understanding occupational risks among online transportation workers is essential to support the development of effective preventive measures and occupational health policies.

METHODS

The rapid development of digital technology has transformed transportation services worldwide. Online transportation services have become an essential component of urban mobility and provide employment opportunities for millions of workers. The expansion of ride-hailing platforms has increased the number of online transportation workers, particularly motorcycle taxi drivers and delivery workers. Despite the economic benefits, these workers face numerous occupational health and safety challenges. Online transportation workers spend prolonged periods on the road and are continuously exposed to traffic hazards. High work demands, irregular working schedules, and economic pressure often force workers to extend their working hours, which may contribute to fatigue and increase the risk of accidents.

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understanding occupational risks among online transportation workers is essential to support the development of effective preventive measures and occupational health policies.

1. Study Design and Framework

This study employed a rigorous and systematic literature review (SLR) approach to identify, evaluate, and synthesize occupational health and safety (OHS) risks among online transportation workers. Unlike standard narrative reviews, this methodological approach follows a structured, transparent, and reproducible framework to minimize selection bias and ensure the validity of the synthesized information. The framework encompasses five distinct stages: formulating the research questions, locating relevant studies through comprehensive database searches, selecting eligible studies based on predefined operational criteria, extracting qualitative and quantitative data points, and contextually analyzing the thematic findings.

2. Search Strategy and Database Selection

To ensure a robust accumulation of scientific evidence, an extensive electronic literature search was conducted across five world-renowned bibliographic and academic databases:

- a. **Scopus:** Utilized to capture high-impact peer-reviewed literature across interdisciplinary sciences.
- b. **ScienceDirect:** Accessed for primary health sciences, engineering, and ergonomic research.
- c. **PubMed:** Deployed specifically for biomedical, epidemiological, and occupational health outcomes.
- d. **Google Scholar:** Selected as a broad-spectrum engine to prevent gray literature omission and ensure localized Indonesian contexts are included.
- e. **SpringerLink:** Used to gather extensive behavioral and public health manuscripts.

The operationalized search string utilized Boolean operators (AND, OR, NOT) alongside relevant MeSH terms and wildcard truncations to maximize search sensitivity and specificity. The definitive search string applied was:

a. Inclusion and Exclusion Criteria

Strict boundary criteria were instituted to maintain the contemporary relevance and rigorous quality of the extracted literature.

- 1) **Inclusion Criteria:** Peer-reviewed primary research articles, longitudinal studies, cross-sectional designs, and comprehensive scoping reviews.
 - a) Studies published within the definitive timeline window of **2020 to 2026** to capture the post-pandemic digital boom and current workplace shifts.
 - b) Manuscripts drafted fully in English or Indonesian language.
 - c) Research focusing directly on ride-hailing drivers, on-demand food delivery couriers, and app-based logistics operators.
- 2) **Exclusion Criteria:** Articles published prior to 2020.
 - a) Studies evaluating traditional public transport (e.g., conventional buses, non-app metered taxis) without digital platform management integration.
 - b) Conference abstracts without complete full-text availability, opinion pieces, editorials, and duplicate studies across databases.



b. Data Extraction and Synthesis Strategy

A standardized matrix table was developed to systematically extract relevant data points from each selected study. The recorded domains included author(s), publication year, geographic location, operational methodology, sample characteristics, specific OHS risk classifications, and recommended mitigation interventions.

The collected studies were analyzed via qualitative thematic synthesis and descriptive analysis. Data regarding physical injuries, physiological hazards, ergonomics, ergonomics-related pathologies, and psychosocial constructs were cross-tabulated. The thematic matrix allowed the researcher to identify convergence and contradictions across globally diverse contexts—ranging from Southeast Asian urban centers to global gig economy networks—thereby creating a comprehensive baseline overview of occupational safety risks.

RESULTS

1. Characteristics of Occupational Risks among Online Transportation Workers

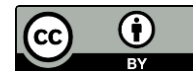
Based on the reviewed literature, online transportation workers are exposed to several occupational hazards that may negatively affect their health and safety. The most frequently reported risks include traffic accidents, musculoskeletal disorders, work fatigue, psychosocial stress, and environmental exposure.

Table 1. Main Occupational Health and Safety Risks among Online Transportation Workers

Occupational Risks	Description
Traffic accidents	Collisions, solo crashes, and acute road injuries caused by unsafe driving, intense urban congestion, and external environmental factors.
Work fatigue	Severe cumulative physiological and cognitive exhaustion induced by prolonged driving shifts, irregular sleep cycles, and lack of dedicated rest periods.
Musculoskeletal disorders	Chronic somatic pathologies (neck pain, low back pain, shoulder stiffness) caused by static sitting, continuous vehicle vibration, and poor ergonomics.
Psychosocial hazards	Mental health stress, anxiety, burnout, and job insecurity stemming from algorithmic performance metrics and customer rating systems.
Environmental exposure	Daily exposure to extreme heat waves, precipitation, ambient air pollution (PM 2.5 CO) and toxic urban noise levels.

2. Traffic Accident Risks

Traffic accidents represent the most dangerous and immediately life-threatening hazard identified in the literature. The data indicates a direct, exponential relationship between total hours driven per shift and the incidence of road crashes. Workers operating their vehicles for more than eight consecutive hours per day exhibit a significantly higher statistical likelihood of being involved in road accidents compared to standard professional drivers. Contributing behavioral sub-factors include speeding to meet delivery deadlines, platform-induced distracted driving (constantly monitoring smartphone apps while operating the vehicle), and severe cognitive slowing induced by physical exhaustion.



3. Musculoskeletal Disorders

Musculoskeletal complaints are almost universal among app-based motorcycle operators. The review indicates that chronic exposure to whole-body vibration (WBV) from prolonged motorcycle operations causes rapid degeneration of intervertebral discs. The most frequently localized anatomic complaints are lower back pain (LBP), neck stiffness, and bilateral shoulder pain. These conditions are structurally exacerbated by structural ergonomic failures, such as maintaining an awkward, slightly forward-leaning static posture for 8 to 12 hours daily without adequate ergonomic lumbar support.

4. Work Fatigue

Work fatigue among digital transportation workers is complex, acting as both an independent physiological condition and a primary catalyst for other workplace accidents. Gig economy workers rarely adhere to standard labor shifts; instead, financial volatility forces them to work prolonged shifts, often stretching deep into nighttime hours. This behavior causes chronic sleep deprivation. The extracted data confirms that prolonged cumulative driving duration diminishes spatial awareness, drastically increases basic reaction time, and induces frequent episodes of micro-sleep, directly compromising road safety.

5. Psychosocial Hazards

Beyond physical trauma, the digital platform framework introduces novel psychosocial stressors. The literature highlights that automated algorithmic management—where an objective computer algorithm dictates order allocation, sets time constraints, and assesses penalties based on customer rating metrics—creates profound psychological stress and job insecurity. Workers experience persistent anxiety over sudden account suspensions or income fluctuations. This emotional burden leads to high rates of occupational burnout, which in turn manifests behaviorally as aggressive driving and diminished risk awareness on public roads.

DISCUSSION

1. The Interconnection of Risks: A Holistic K3 Paradigm

The synthesized findings clearly indicate that the occupational health and safety hazards encountered by online transportation workers cannot be analyzed in isolation. Instead, they form a highly interconnected web of causation. To truly understand the vulnerability of this workforce, we must apply classical K3 frameworks, such as Heinrich's Domino Theory and Reason's Swiss Cheese Model, to the modern digital platform economy.

In Heinrich's framework, an injury is the final link in a domino sequence triggered by underlying social and operational structures. For gig workers, the first domino represents the platform's algorithmic demands and unstable piece-rate financial models. This economic vulnerability forces drivers into the second domino: unsafe personal choices, such as working 12-hour shifts and driving while exhausted.

The third domino consists of immediate unsafe acts and conditions, such as speeding to avoid delivery penalties or checking app interfaces mid-traffic. This sequence culminates in the fourth and fifth dominos: a catastrophic road accident resulting in severe bodily injury or chronic



musculoskeletal trauma.

Applying James Reason's Swiss Cheese Model, the systemic defenses for these informal workers are full of operational holes. The lack of formal employment status means standard organizational protections – such as mandatory rest break enforcement, vehicle maintenance audits, and specialized road safety training – are absent. When a worker's personal cognitive defenses drop due to acute fatigue, there are no institutional backstops to catch the error, leading directly to high accident rates.

2. Deep Dive into Traffic Accident Mechanics and Driver Fatigue

Traffic accidents are the most acute and fatal risk identified in this review. Our analysis confirms Jaydarifard et al. (2024) and Hermawati et al. (2025), which show that ride-hailing fatigue impairs driving performance as heavily as chemical intoxication. When an online driver exceeds the 8-hour daily working limit, their cognitive workload spikes.

To better understand these accident dynamics, we can utilize Haddon's Matrix, which divides traffic incidents into three chronological phases (Pre-crash, Crash, and Post-crash) across human, vehicular, and environmental vectors:

Table 2. Haddon's Matrix Application to Online Transportation Safety

Phase	Human Vector	Vehicular Vector	Environmental Vector
Pre-crash	Cognitive fatigue, micro-sleep, distracted driving via mobile apps.	Worn-out braking systems, lack of regular fleet maintenance.	Intense urban congestion, lack of dedicated motorcycle lanes.
Crash	Delayed reaction times, improper physical bracing maneuvers.	Absence of advanced safety mechanisms on standard motorcycles.	Poorly maintained roads, wet/slick asphalt conditions.
Post-crash	Lack of basic first-aid knowledge, delayed emergency response.	Vehicle fires, difficulty extracting trapped operators.	Inadequate emergency medical services in rural/suburban zo

By analyzing the Pre-crash phase, it becomes evident that the driver's cognitive state is heavily compromised by sleep deprivation. As explained by Van Dijk & Swaen (2020), long driving hours deplete central nervous system resources, leading to tunnel vision and impaired spatial calculations. When combined with the operational requirement to interact with a smartphone screen to accept incoming fares, the driver's visual, manual, and cognitive focus is diverted from the roadway. This multi-modal distraction forms a highly volatile combination that structurally increases the probability of high-velocity collisions.

3. Ergonomic Analysis and Musculoskeletal Deterioration

The chronic health burden affecting this workforce is primarily driven by musculoskeletal disorders (MSDs). Our findings align with Pratiwi et al. (2024), demonstrating that musculoskeletal complaints among app-based drivers are systematic rather than incidental. According to industrial ergonomics principles laid out by Tarwaka (2021), the human musculoskeletal system is ill-suited for prolonged static sitting, particularly when subjected to mechanical stress.

When riding a motorcycle for hours, the operator must maintain an asymmetric, static posture. The upper extremities remain extended to grip the handlebars, while the lumbar spine supports the weight of the torso without any posterior stabilization. This position forces the erector spinae muscles into continuous isometric contraction, restricting local blood flow and inducing rapid localized muscle fatigue, which leads to ischemia and chronic pain.

Furthermore, continuous exposure to whole-body vibration (WBV) acts as a severe physical catalyst. As detailed by Hutabarat et al. (2026), mechanical vibrations from the motorcycle engine and uneven road surfaces are absorbed directly by the driver's pelvic girdle and lumbar spine. This continuous vibration accelerates micro-trauma within the intervertebral discs, leading to premature degenerative disc disease and chronic lower back pain.

Recent studies by Ogboeli et al. (2026) confirm that app-based drivers experience significantly higher rates of spinal compression and muscular strain than traditional workers. This risk is further compounded when drivers carry heavy delivery backpacks, which alters their natural center of gravity and increases the mechanical load on the thoracic and lumbar spine.

4. Psychosocial Imbalances and Algorithmic Vulnerability

One of the most valuable findings of this review is the impact of psychosocial hazards within the digital platform framework. Traditional K3 research historically focused on physical and chemical factors, but modern gig economy research highlights the profound mental health toll of algorithmic management. This phenomenon is best explained through Siegrist's Effort-Reward Imbalance (ERI) Model and Karasek's Job Demand-Control Model.

Online drivers face exceptionally high job demands. They are tracked in real-time by GPS, must maintain near-perfect customer satisfaction ratings, and face strict delivery deadlines. Conversely, their level of job control is low. They cannot negotiate piece-rate pricing, have no control over the platform's order allocation algorithms, and risk sudden account suspension based on arbitrary customer feedback.

This combination of high demands and low control leads to severe psychosocial stress and mental exhaustion. Manuel & Wirawan (2020) note that this psychological stress often manifests physically as tension headaches, gastric ulcers, and insomnia, further compounding their work fatigue.

5. Environmental Exposures and Public Health Impacts

The road environment exposes online transportation workers to a wide mix of environmental hazards. Unlike industrial workers in controlled factory settings, ride-hailing operators have no structural barriers against weather extremes and ambient air pollution. Continuous inhalation of particulate matter ($\text{PM}_{2.5}$), carbon monoxide (CO), and nitrogen oxides (NO_x) puts these workers at high risk for chronic respiratory diseases, including bronchitis, asthma, and reduced pulmonary capacity.

Furthermore, working during severe heatwaves can lead to dehydration, heat exhaustion, and heat stroke. Dehydration impairs cognitive function and slows physical reaction times, linking environmental exposure directly to increased traffic accident risks.



Noise pollution from heavy city traffic also presents a notable risk, contributing to noise-induced hearing loss (NIHL) and raising stress hormones like cortisol, which worsens the worker's psychosocial burden.

6. Strategic K3 Mitigation Framework for Digital Platforms

To effectively protect this expanding workforce, we must move away from voluntary individual safety measures and adopt a structural approach based on the **Hierarchy of Controls** (NIOSH, 2021). A comprehensive strategy requires cooperation among digital platform corporations, government regulators, and public health agencies.

Table 3. Hierarchy of Controls Applied to Online Transportation Safety

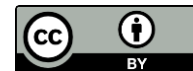
Control Level DOCX	Operational Intervention Strategy for Online Transportation Sector
Engineering Controls	- Integrating automated app lockouts that prevent drivers from logging on after 8 hours of work . - Adjusting matching algorithms to favor shorter distances during heavy rain or extreme heat . - Introducing shock-absorbing ergonomic seating on motorcycles. - Establishing mandatory rest areas across major cities .
Administrative Controls	- Providing subsidized defensive driving courses and ergonomic safety training . - Creating transparent, peer-reviewed processes for account suspensions to lower psychosocial stress. - Supplying high-visibility, impact-resistant riding jackets with integrated lumbar support .
Personal Protective Equipment (PPE)	- Providing dual-filtration respiratory masks (\$N95\$ or higher) to protect against ambient air pollution. - Distributing certified, high-impact helmets that meet updated national safety standards.

By implementing these structural interventions, the ride-hailing sector can transition from an unregulated, hazardous informal environment into a safer, more sustainable ecosystem that protects both worker health and urban mobility.

CONCLUSIONS

This systematic review confirms that online transportation workers face severe, interconnected occupational health and safety risks, including high traffic accident rates, chronic musculoskeletal disorders, physical and mental fatigue, intense psychosocial stress, and continuous environmental exposure. These hazards are worsened by extended working hours, unpredictable income models, and a lack of formal institutional safety protections.

Addressing these risks requires moving past individual compliance toward a structural safety framework. Digital platform companies must integrate automated safety features into their



software, such as mandatory shift limits and fairer algorithmic evaluations. Concurrently, government authorities must develop proactive labor policies that guarantee health coverage and occupational safety training for gig economy workers

ACKNOWLEDGMENT

The authors would like to express their gratitude to all researchers whose studies contributed to this review. Appreciation is also extended to for supporting academic activities and scientific publication.

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Journal of Occupational Safety, Health, and Environmental Management (K3)

Vol. 01, No. 2, June 2026

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