


ORIGINAL ARTICLE

Transport industry workforce risk and exposure to COVID-19 and other related respiratory pandemic diseases: A scoping review

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Abstract

The need to maintain transport during a pandemic places transport workers at higher risk of infection and can have other effects on health and well-being. The aim of this study was to understand the current state of research on the impact of respiratory diseases on transport workers and to identify any existing evidence-based recommendations that can help mitigate the risks associated with these diseases in the transport industry. A scoping review was undertaken as per PRISMA guidelines. A search was conducted in English-language databases for peer-reviewed research articles. We reviewed research articles published over 20 years (2002–2022). We found 12540 articles, of which 39 deemed relevant, were analysed. The review highlighted the high risk of transport workers' exposure to respiratory diseases during pandemics, exacerbated by structural inequalities including the significant number holding precarious/non-standard jobs. Increased financial strains led to poorer mental health outcomes and risks of detrimental behaviours for health. Economic measures implemented by governments were found to be insufficient in addressing these issues. The review found that transport is a significant transmission point for pandemics of respiratory diseases, and it suggests some remedies to best meet these challenges.

Keywords: COVID-19; Occupational health; Pandemics; Respiratory tract diseases; Transport workers

Introduction

Amongst its many profound effects, the COVID-19 pandemic demonstrated the vital role of particular industries and essential workers such as healthcare personnel in maintaining public health, before the development and roll-out of vaccines (Scholz et al 2022) and especially during the lockdown stage when other activities were curtailed (sometimes severely). In addition to the healthcare system, activities such as transport of goods, food-processing, maintaining utilities (power, water, and sewage treatment), warehousing/logistics, aged and community-care, and retailing, all needed to continue even during lockdowns. Workers in these sectors, particularly before the development of effective

vaccines and adequate supplies of effective personal protective equipment (PPE), were exposed to higher risks of infection and experienced significant mental anguish (Cherry et al 2023; Menezes et al 2023; Takala et al 2023; Syamlal et al 2024).

Unlike healthcare, the vast majority of these workers had no training in dealing with infectious diseases or only very restricted training (such as in food hygiene) unsuited to pandemic situations (Persaud et al 2022). Moreover, in most instances, their workplaces were not designed or managed with infection/pandemic risk in mind (Vecherin et al 2022). Even after the development of vaccines, United Kingdom (UK) evidence indicated vaccination rates were lower amongst workers dealing with the public or vulnerable people (Nafilyan et al 2022) although this may have been less evident in countries that took a more forceful approach to mandating vaccination, such as Australia.

The challenges of COVID for workers, especially precarious/non-standard workers, across a spectrum of industries, have been made clear in the literature that has relevance for our transport sector focussed study. Precarious workers are less likely to belong to unions or have access to worker representative mechanisms. A large Spanish survey (Ollé-Espluga et al 2024) found that the presence of worker representation was associated with greater workplace protection measures. It is worth adding that precarious workers and female workers (women are over-represented in precarious jobs) not deemed essential, were adversely impacted by the pandemic in ways that affected their health and well-being, including loss of work and income, food security, inadequate government benefits, and violations of labour and OHS standards (Bohorquez et al 2023; Bosmans et al 2023; O'Campo et al 2024; Hansson et al 2024). Employment type and duration also affected access to PPE and other COVID-19 protections, further disadvantaging precarious/non-standard workers (Gunn et al 2022). Finally, the pandemic exposed serious gaps in occupational health and safety (OHS) and industrial relations legislation, and their intersection with public health, limitations that – with notable exceptions – have not been addressed since the pandemic (Quinlan 2021; Spieler 2023).

In addition to infection risk itself, changes to work organisation/practices had occupational health and safety (OHS) effects (see for example (Hurd et al 2022)) as well as the mental anguish associated with awareness of infection risks. A Canadian study (Smith et al 2021) found that the mental health of non-healthcare 'essential' workers was significantly affected by the adequacy of infection control programs in the workplace. Furthermore, additional quarantining and port controls, along with reduced crew changeovers, increased social isolation, and fatigue, adversely affected the mental health of seafarers. (Kirkby 2020; Arulanthu 2021; Pauksztat et al 2022).

During COVID-19, the connections between precarious work and health (both public and occupational) were rediscovered to some degree. In Australia for example, special payments were introduced to cover all temporary workers and contractors who were not entitled to sick leave to cover the period of isolation mandated following infection or close contact with infected persons (Services Australia 2024). This was designed to eliminate a financial pressure to not report disease or isolate – again problems well understood in the 19th century. The then premier of the Australian state of Victoria labelled precarious employment as toxic and promised to do something about it (Quinlan 2021). Germany introduced new regulations on meatworks that restricted the use of agency-workers/contracting and in Australia a Senate Inquiry into insecure work focused, amongst other things, on lessons to be drawn from the pandemic (Purkayastha et al 2021; Security 2022). However, overall, there was surprisingly little learning from the pandemic regarding the greater risks posed by extensive flexible work arrangements.

These increased risks of infection, mental anguish, social isolation, and fatigue were exacerbated by staff shortages and cutbacks in health infrastructure that had occurred in many countries under neoliberal policies over preceding decades, but also by the growth of precarious and informal work arrangements in health/aged care and other industries

deemed essential, such as road transport, food processing and retailing (Purkayastha et al 2021; Quinlan 2021). Temporary part time work meant that some aged care workers employed in more than one facility also increased the risks of disease transmission (Henriques et al 2023). Multiple jobholding was also to be found in other industries such as food delivery but in addition to this, these workers were commonly employed on a temporary or even as self-employed contractors which meant any interruption of work (for the disease or quarantine) effectively stopped their income. Low incomes, and concentration of minorities and immigrants in some of these jobs (such as food processing and delivery), meant they were more likely to live in crowded households/communities further exacerbating risks of disease transmission and presenting additional challenges in terms of communicating messages (Côté et al 2024). The connections between precarious work and increased risks of transmission of infectious disease were not new having been pointed out by *The Lancet* as early as 1876 (Quinlan 2021).

Within these essential sectors, the transport industry played a critical role in maintaining societal function during the pandemic. However, transport workers faced unique challenges, including frequent public interaction, confined working environments, and high mobility, all of which increased their risk of exposure to respiratory diseases (Browne et al 2016). Moreover, the users of transport services, whether directly or indirectly involved, are an integral part of the transport system, and their interactions with transport workers and environments significantly influence the transmission dynamics of respiratory diseases. Understanding the impact of COVID-19 or other related respiratory diseases on transport users is crucial for a comprehensive assessment of pandemic transmission within the transport system (Guo et al 2023).

This study focusses attention on a particular sector. The transport sector is vast, encompassing subsectors such as long-haul and short-haul trucking, as well as industry-specific transport such as refrigerated and livestock transport (Belzer and Sedo 2018). Non-standard employment, including self-employed contractors and casual/temporary employees, is prevalent in this industry, further complicating the health and safety landscape. Ground transport workers, particularly those involved in road transport, represent a critical yet vulnerable segment within the transport industry. In Australia, for example, the road transport sector alone employs around 270,000 workers (Stanford and Grudnoff 2020). These workers often operate in precarious conditions, with limited access to health protections such as PPE, and inconsistent adherence to public health guidelines (Gunn et al 2022). Despite the crucial role they play, there is a significant gap in research focused on understanding the specific risks faced by transport workers during respiratory pandemics. The aim of this study was to understand the current state of research on the impact of respiratory diseases on transport workers and to identify any remedies that could mitigate the risks associated with these diseases in the transport industry.

Methods

This study examines the literature to consolidate research findings and identify the impact of respiratory pandemic diseases (including but not limited to COVID-19) on transport workers. In this study, we employed Levac et al's five-stage scoping review process (Levac et al 2010). Ethical approval was not required. The scoping review has been registered with the Open Science Framework (<https://osf.io/nsey8>).

Stage 1: Identifying the research questions

Our intention was to provide a nuanced investigation of the breadth of scholarship on transport and infectious diseases. To achieve that aim, the research team developed the

following questions: What is known from the global literature about the reasons for and factors surrounding transport workers getting infected with pandemic respiratory diseases like COVID-19? Given that equity is a key principle of public health, it ought to underpin research, policy, and practice, so, what are the equity implications of respiratory diseases like COVID-19 for diverse groups of transport workers, including the dynamics around the spread of diseases? What is the impact of COVID-19 or related respiratory diseases on those who use transport services directly or indirectly, considering the globally and locally documented measures employed by governments and transport industries?

Stage 2: Identifying relevant studies

Between December 2022 and February 2023, we searched PubMed, Embase, and EBSCO research databases using relevant keywords. The search was guided by a set of descriptive key search terms. Key search terms used were semantically related and grouped into six categories as follows:

- (a) Infection, exposure, detect, transmission.
- (b) COVID-19, respiratory, pandemic, H1N1, SARS-CoV-2, severe acute respiratory syndrome, Middle East respiratory syndrome corona virus, coronavirus.
- (c) Transport, freight, automobile, driver, truck, lorry, bus, train, taxi, rideshare, delivery.
- (d) Work, staff, employee.
- (e) Equity, demographic, social, economic, equality, disadvantage, vulnerable, deprive, gig.
- (f) Plan, strategy, measure, guideline, policy, prevention, governance, legislation, closure, restriction.

Boolean operators were used to combine key terms i.e., AND/OR/*.

Boolean operators were used as follows:

The key terms within each category were combined using the OR operator. For example, “Infection OR exposure OR detect OR transmission”.

The categories themselves were combined using the AND operator. For example, “(Infection OR exposure OR detect OR transmission) AND (COVID-19 OR respiratory OR pandemic OR H1N1 OR SARS-CoV-2 OR severe acute respiratory syndrome OR Middle East respiratory syndrome corona virus OR coronavirus).

Stage 3: Identifying the study selection criteria

Only articles published in English between 2002 through 2022 were included to ensure that the review covered recent literature. To be included, articles had to meet the following inclusion criteria, which were identified based on the research questions in Stage 1:

- (a) Focused on exposure to respiratory infectious disease pandemics, including COVID-19, among transport workers.
- (b) Reported symptomatic respiratory infections amongst and/or exposure to transport workers.
- (c) Included research papers focussed on symptomatic infections and/or exposure to transport workers that are linked to work-related factors and/or from sources other than work-related like household contact.
- (d) Covered equity implications of respiratory disease pandemics for diverse groups of transport workers.

Articles on air pollution and transportation patterns, articles related exclusively to maritime and air transport modes, and articles that primarily focused on theoretical models or strategic frameworks were excluded. Although both maritime and air transport sub-industries are present in the results, we excluded articles that focused exclusively on these modes. That decision was made because our review aimed to concentrate on the broader context of ground-based transport modes, such as freight, automobile, truck, lorry, bus, train, taxi, rideshare, and delivery services. Maritime and air transport modes operate in significantly different environments compared to ground-based transport modes.

The primary focus of this scoping review was to capture a breadth of literature related to the subject matter, rather than evaluate the quality of the studies included (Munn *et al* 2018). As such, the inclusion criteria were designed to prioritise the potential information contained within the selected papers, rather than conducting a detailed quality assessment of each paper.

To ensure the relevance of the selected publications, the screening process was conducted in three steps. In the first step, [Qureshi] independently screened the titles of the publications according to the inclusion criteria. To ensure validity, publications that met the criteria were then reviewed by [Harris and Jegasothy]. Although Levac *et al* recommend that both title and abstract screenings be conducted by at least two reviewers independently, our approach was tailored to manage the extensive volume of initial search results efficiently. The title screening was performed separately from the abstract screening to manage the large volume of initial search results more efficiently. Given the extensive number of articles retrieved, an initial title screening allowed us to quickly exclude obviously irrelevant studies, thereby streamlining the subsequent abstract screening process. This two-step approach helped ensure that only potentially relevant articles were subjected to more detailed abstract and full-text reviews, improving the efficiency and feasibility of the screening process given our resource constraints. At this stage, only the most apparent aspects of the inclusion criteria, such as focus on transport workers and respiratory diseases, were applied. Any discrepancies were resolved through discussion. In the second step, the abstracts of the shortlisted publications were screened as required by the inclusion criteria by two authors for each of the three scoping review questions. Each question was handled by two reviewers who independently screened the abstracts to ensure thorough and unbiased evaluation. Discrepancies were resolved through discussion. In the third step, the entire article was screened for relevance. The screening process is depicted in Figure 1.

Stage 4: Charting the data

Three data extraction tools were developed for each of the three research questions to extract key elements. These tools were reviewed and validated by other authors. The key elements included in the data extraction tools were used as a baseline to extract relevant information. That detail included exposure details, outcomes, factors and reason for infection, equity implications, infection control measures, strategy details, implementation, effectiveness, and evaluation of the strategies. For the purposes of this study, the term “strategy” is defined as any guideline, policy, or plan that is implemented by the government or the transportation industry to prevent and/or control the transmission of infections.

As lead author Qureshi then inductively assigned codes to the themes, which were then reviewed and validated by the co-authors (Harris, Jegasothy, Seale, Chughtai, and Quinlan). In addition to the key elements, the team also extracted baseline data related to the title and summaries of the selected studies. This information is presented in Table 1.

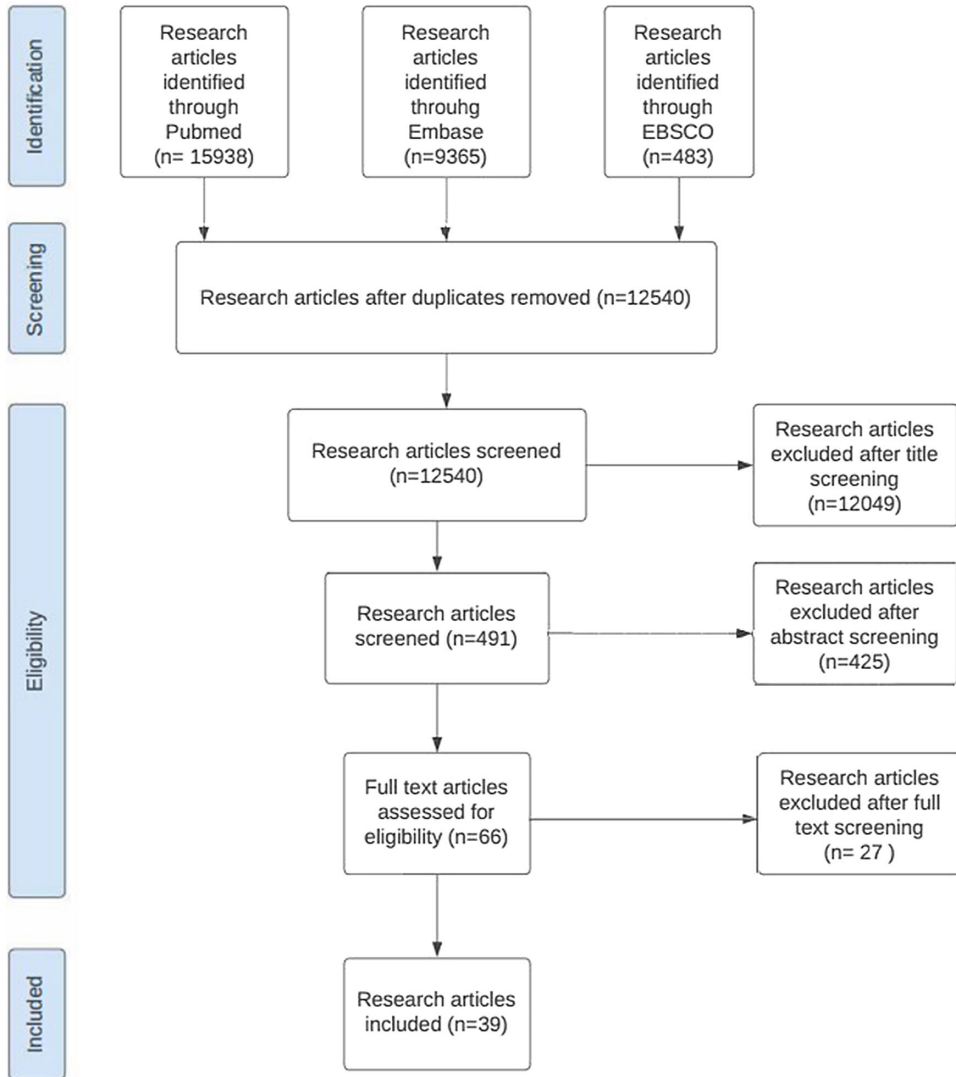


Figure 1. Selection flowchart diagram following PRISMA guidelines.

Stage 5: Summarising results

The results were summarised under four themes (see Figure 2). Themes one, two, and three correspond to questions one, two, and three of the scoping review, respectively.

Results

All the 39 research articles included in the scoping review were focused on COVID-19. Two papers emerged as common sources of information for addressing questions one, two and three (Crizzle et al 2021; Ingram et al 2022). One paper was a common source of information for addressing questions one and two (Shan 2022). All the texts included in our review met the same overall inclusion criteria outlined in the methods section. However, within this set of included studies, we further shortlisted papers based on their relevance

Table 1. Baseline details of all selected articles

Serial No.	Title of the article	Author/s	Year of publication	Journal name
1	Community Outbreak Investigation of SARS-CoV-2 Transmission Among Bus Riders in Eastern China (Shen et al 2020)	Shen et al	2020	JAMA Intern Med
2	COVID-19 Experiences, PPE, and Health Concerns in Toronto, Canada Bicycle Delivery Workers: Cross-sectional Pilot Survey (Harris and Kirkham 2021)	Harris, Kirkham	2021	Annals of Work Exposures and Health
3	COVID-19 incidence in a cohort of public transport workers (De Matteis et al 2022)	De Matteis et al	2022	Med Lav
4	COVID-19 infection rates among transportation and metal workers(Öngel et al 2022)	Ongel et al	2022	Rev. Assoc. Med. Bras
5	COVID-19 mortality among Amalgamated Transit Union (ATU) and Transport Workers Union (TWU) workers – March–July 2020, New York City metro area (Tomasi et al 2021)	Tomasi et al	2021	Am J of Indust Med
6	COVID-19 Outbreaks and Mortality Among Public Transportation Workers – California, January 2020–May 2022 (Heinzerling 2022)	Heinzerling	2022	MMWR
7	COVID-19 related risk perception among taxi operators in Kingston and St. Andrew, Jamaica (James et al 2021)	James et al	2021	Journal of Transport & Health
8	Occupational infection control measures and frontline workers' perceived COVID-19 risk during the fourth wave of the pandemic in Canada: A cross-sectional survey (Ingram et al 2022)	Ingram et al	2022	Canadian Journal of Infection Control
9	Risk analysis of different transport vehicles in India during COVID-19 pandemic (Das and Ramachandran 2021)	Das and Ramachandran	2021	Environmental Research
10	Taxi drivers and COVID-19 in Jamaica: Occupationally related income decline and health behaviour (James et al 2022)	James et al	2022	Health Soc Care Community
11	The Impact of COVID-19 on the Work Environment in Long-Haul Truck Drivers (Crizzle et al 2021)	Crizzle et al	2021	American College of Occupational and Environmental Medicine
12	The relationship between race and ethnicity, type of work, and Covid-19 infection rates (Faberman and Hartley 2022)	Hartley and Faberman	2022	Federal Reserve Bank of Chicago
13	Public Tourist Bus, Tourist Bus Driver, and COVID–19 Infection: A Note (Yasri and Wiwanitkit 2020)	Yasri and Wiwanitkit	2020	International Journal of Preventive Medicine

(Continued)

Table I. (Continued)

Serial No.	Title of the article	Author/s	Year of publication	Journal name
14	Journey of a Thai Taxi Driver and Novel Coronavirus (Pongpirul et al 2020)	Pongpirul et al	2020	The New England Journal of Medicine
15	A scoping review of the impact of long-distance truck drivers on the spread of COVID-19 infection (Malinga et al 2021)	Malinga et al	2021	Pan Am. Med J
16	Occupational safety and health challenges for maritime key workers in the global COVID-19 pandemic (Shan 2022)	Shan et al	2022	International Labour Review
17	Disparities in COVID-19 fatalities among working Californians (Cummings et al 2022)	Cummings et al	2022	Plos One
18	Health and safety risks faced by delivery riders during the COVID-19 pandemic (Tran et al 2022)	Nguyen Anh Thuy Tran et al	2022	Journal of Transport & Health
19	Prevalence and associated factors of psychosocial distress among seafarers during COVID-19 pandemic (Baygi et al 2021)	Fereshteh Baygi et al	2021	BMC Psychiatry
20	Socio-Demographic, Health, and Transport-Related Factors Affecting the COVID-19 Outbreak in Myanmar: A Cross-Sectional Study (Aung et al 2022)	Khine et al	2022	Cureus
21	The Impact of COVID-19 on Transit Workers: Perceptions of Employer Responses and Associations with Health Factors (Rice et al 2022)	Sean PM Rice et al	2022	Ann Work Expo Health
22	The impacts of the COVID-19 pandemic on transportation employment: A comparative analysis (Mack et al 2021)	Elizabeth et al	2021	Transportation Research Interdisciplinary Perspectives
23	Unequal effects of the COVID-19 epidemic on employment: Differences by immigrant status and race/ethnicity (Liao and Villarreal 2022)	Kristin Tianqi Liao and Andrés Villarreal	2022	PLOS ONE
24	Pandelivery!: Reflections on black delivery app workers experiences during COVID-19 in Brazil (da Lage and Rodrigues 2021)	Mariana Luisa et al	2020	Gender, Work and Organization
25	Gig Workers during the COVID-19 Crisis in France: Financial Precarity and Mental Well-Being (Apouey et al 2020)	Apouey et al	2020	Journal of Urban Health
26	Essential . . . but also vulnerable? Work intensification, effort/reward imbalance, fatigue, and psychological health of Spanish cargo drivers during the COVID-19 pandemic (Montoro et al 2022)	Montoro et al	2022	PeerJ

(Continued)

Table 1. (Continued)

Serial No.	Title of the article	Author/s	Year of publication	Journal name
27	Understanding risk and protective factors to UK railway workers' mental wellbeing during the COVID-19 pandemic: a cross-sectional survey (Cogan et al 2021)	Megan et al	2021	The Lancet
28	A Descriptive Analysis on the Impact of COVID-19 Lockdowns on Road Traffic Incidents in Sydney, Australia (Chand et al 2021)	Chand et al	2021	Int. J. Environ. Res. Public Health
29	A systematic review of COVID-19 transport policies and mitigation strategies around the globe (Calderón Peralvo et al 2022)	Francisco et al	2022	Transp Res Interdiscip Perspect
30	Adherence to social distancing and wearing of masks within public transportation during the COVID 19 pandemic (Dzisi and Dei 2020)	Emmanuel et al	2020	Transp Res Interdiscip Perspect
31	Challenges for urban transport policy after the Covid-19 pandemic: Main findings from a survey in 20 European cities (Christidis et al 2022)	Christidis et al	2022	Transport Policy
32	COVID-19 and transport: Findings from a world-wide expert survey (Zhang et al 2021)	Junyi et al	2021	Transport Policy
33	Covid-19 need not spell the death of public transport: Learning from Hanoi's safety measures. (Nguyen and Pojani 2021)	Pojani, D.	2021	J Transp Health
34	A Review of COVID-19-Related Literature on Freight Transport: Impacts, Mitigation Strategies, Recovery Measures, and Future Research Directions (Karam et al 2022)	Karam et al	2022	Int J Environ Res Public Health
35	Pandemic waves and the time after COVID-19 – Consequences for the transport sector (Rothengatter et al 2021)	Rothengatter et al	2021	Transp Policy
36	Physical distancing on public transport in Mumbai, India: Policy and planning implications for unlock and post-pandemic period (Thomas et al 2022)	Thomas, N., Jana, A.	2022	Transp Policy
37	How Does Railway Respond to the Spread of COVID-19? Countermeasure Analysis and Evaluation Around the World (Yin et al 2021)	Yonghao Yin et al	2021	Urban Rail Transit
38	Insights into the long-term effects of COVID-19 responses on transportation facilities (Kutela et al 2022)	Kutela et al	2022	Transp Res D Transp Environ
39	Transportation in the Mediterranean during the COVID-19 pandemic era (Tarasi et al 2021)	Tarasi et al	2021	Glob Transit

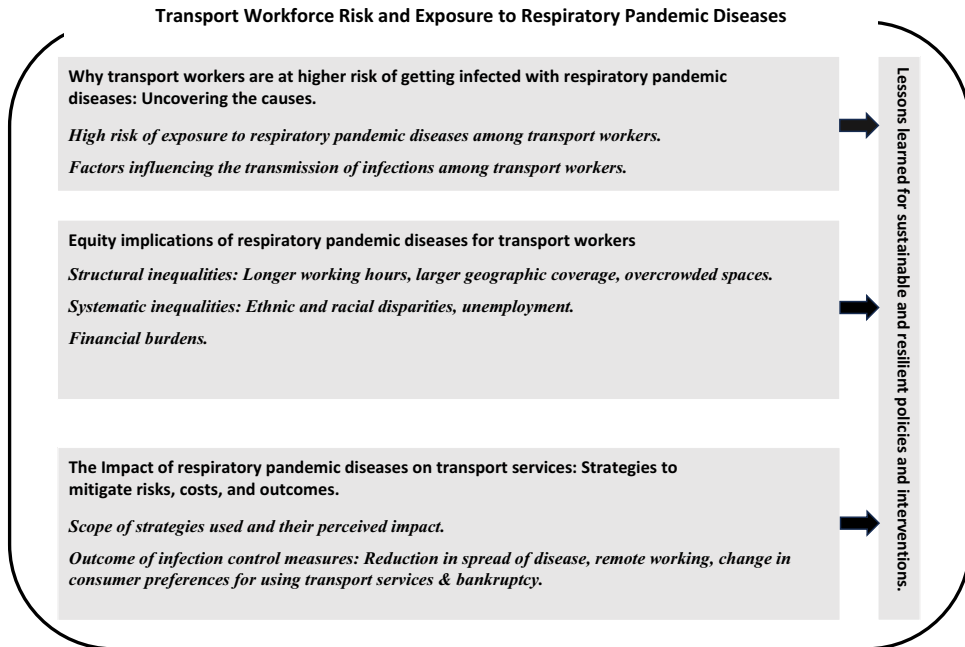


Figure 2. Graphic Representation of the Key Transport Workforce Risk and Exposure to Respiratory Pandemic Diseases. Themes Identified from the Selected 39 Research Articles.

to each specific research question. The main themes and subcategories are depicted in Figure 2. General characteristics of the 39 research articles have been presented in Tables 2–4.

Theme one: Why transport workers are at higher risk of infection from respiratory pandemic diseases: Uncovering the causes

The literature on transport workers and risk of infection is multifaceted. The following sub-sections examine the high risk of exposure and the factors that influence the transmission of respiratory pandemic infections among transport workers and addresses question one of the scoping review.

High risk of exposure to respiratory pandemic diseases among transport workers

Transport workers faced heightened risk of exposure to respiratory pandemic diseases potentially resulting in an increase in mortality rate (Tomasi et al 2021). For example, an observational study (Yasri and Wiwanitkit 2020) about COVID-19 outbreaks and mortality among public transportation workers in California reported the cumulative outbreak incidence for all public transportation industries was 1.4 times as high as that for all industries, and the cumulative crude mortality rate for all public transportation industries was 174 per 100,000 workers, which was 1.5 times as high as the rate across all industries. Among individual public transportation industries, the cumulative outbreak incidence was 5.2 times as high in bus and urban transit (129.1) and 3.6 times as high in air transportation (87.7) as in all industries. Annual outbreak incidence in public transportation industries increased by 68.4%, from 11.7 outbreaks per 1,000 establishments in 2020 to 19.7 in 2021, whereas outbreak incidence across all industries increased by 22.9% (from 8.3 to 10.2)

Table 2. Characteristics of Studies Included in the Scoping Review for Question number 1: Study Design, Methodology, Industry Focus, and Demographic Characteristics

Theme One	Study design	Methodology	Study time period/s	Focus Industry/ Sector name	Spatial distribution	Occupation focused on	Age range	Gender
Community Outbreak Investigation of SARS-CoV-2 Transmission Among Bus Riders in Eastern China (Shen <i>et al</i> 2020)	Cohort study	Quantitative	January 27-February 23, 2020	Public transport	China	Bus driver and passengers	Mean age: 58.6 year	Men: 15 (11.7%) Women: 113 (88.3%)
COVID-19 Experiences, PPE, and Health Concerns in Toronto, Canada Bicycle Delivery Workers: Cross-sectional Pilot Survey (Harris and Kirkham 2021)	Cross-sectional survey	Quantitative	29 July 2020–26 August 2020	Transport	Canada	Bicycle Delivery Workers	Mean age: 32.5	Men: 74%
COVID-19 incidence in a cohort of public transport workers (De Matteis <i>et al</i> 2022)	Cohort study	Quantitative	September 2020	Transport	Italy	Bus drivers and the rest of the personnel.	20–29 years: 10 30–39 years: 199 40–49 years: 563 50–59 years: 906 60–69 years: 374	Men: 1,893 (1,161 bus drivers) Women: 159 (24 bus drivers)
COVID-19 infection rates among transportation and metal workers (Öngel <i>et al</i> 2022)	Survey	Quantitative	June 2-June 17, 2020	Manufacturing/ transport	Turkey	Automotive supply industry and cargo workers	Mean age: 36 years	The proportion of women was 14.6% in the transportation sector and 6.5% in the metal sector ($p < 0.001$).
COVID-19 mortality among Amalgamated Transit Union (ATU) and Transport Workers Union (TWU) workers—March–July	Non-traditional epidemiological surveillance methods	Quantitative	March 1–July 7, 2020	Transport	United States	Transit workers	Median age: 58 years (range: 39–71)	Most decedents were male (83%)

(Continued)

Table 2. (Continued)

Theme One	Study design	Methodology	Study time period/s	Focus Industry/ Sector name	Spatial distribution	Occupation focused on	Age range	Gender
2020, New York City metro area (Tomasi et al 2021)								
COVID-19 Outbreaks and Mortality Among Public Transportation Workers – California, January 2020–May 2022 (Heinzerling 2022)	Observational study	Quantitative	January 2020–May 2022	Transport	United States	Air transportation, rail transportation, bus service and urban transit, taxi and limousine service and transportation support services.	Not available	Not available
COVID-19 related risk perception among taxi operators in Kingston and St. Andrew, Jamaica (James et al 2021)	Cross-sectional survey	Quantitative	May-2020	Transport	Jamaica	Taxi drivers	Most (56.1%) participants were in the age category 36–55 years	Male: 97.5%
Occupational infection control measures and frontline workers’ perceived COVID-19 risk during the fourth wave of the pandemic in Canada: A cross-sectional survey (Ingram et al 2022)	Cross-sectional survey	Quantitative	July 1-November 30, 2021	Transportation, Manufacturing; Transportation or warehousing; manufacturing and food processing.	Canada	Not specified	There were many study groups. Further breakdown was not provided.	There were many study groups. Further breakdown was not provided.
Risk analysis of different transport vehicles in India during COVID-19 pandemic (Das and Ramachandran 2021)	Environmental sampling	Quantitative		Various transport	India	Transport worker and passengers	Not specified	Not specified
Taxi drivers and COVID-19 in Jamaica: Occupationally related income decline and health behaviour (James et al 2022)	Cross-sectional survey	Quantitative	May-2020	Transport	Jamaica	Taxi driver	≤35 year - 62 (22.1) 36–55 years –	Male: 274 (97.5) Female: 7 (2.5)

(Continued)

Table 2. (Continued)

Theme One	Study design	Methodology	Study time period/s	Focus Industry/ Sector name	Spatial distribution	Occupation focused on	Age range	Gender
							157 (56.1) ≥ 56 years - 61 (21.8)	
The relationship between race and ethnicity, type of work, and COVID-19 infection rates (Faberman and Hartley 2022)	Literature Review	Qualitative	March 2020-April 2021	All workers, including transport	United States	Not specified	Not specified	Not specified
Public Tourist Bus, Tourist Bus Driver, and COVID-19 Infection: A Note (Yasri and Wiwanitkit 2020)	Case report	Qualitative	Mar-2020	Transport	Thailand	Bus drivers	Not specified	3 Male
Journey of a Thai Taxi Driver and Novel Coronavirus (Pongpirul et al 2020)	Case report	Qualitative	2020	Transport	Thailand	Taxi driver	51 year old	Male
A scoping review of the impact of long-distance truck drivers on the spread of COVID-19 infection (Malinga et al 2021)	Scoping review	Qualitative	2014-2020	Transport	African region.	Truck drivers	Not applicable	Not applicable
Occupational safety and health challenges for maritime key workers in the global COVID-19 pandemic (Shan 2022)	Legal doctrinal analysis, media coverage analysis and qualitative interview data	Mixed Methods	June-December 2020	Maritime workers	Canada, China and India	Seafarers who had worked at sea and seafarers waiting ashore. Ship managers, maritime welfare professionals, and a representative of a maritime authority	Not specified	Not specified
The Impact of COVID-19 on the Work Environment in Long-Haul Truck Drivers (Crizzle et al 2021)	Online survey	Mixed Methods	August 2020-March 2021	Transport	Canada	Long-haul truck drivers (LHTD)	mean age: 48.1 (SD +- 11.8)	Men: 82.2%

Table 3. Characteristics of Studies Included in the Scoping Review for Question number 2: Study Design, Methodology, Industry Focus, and Demographic Characteristics

Theme Two	Study design	Methodology	Study time period	Focus Industry/ Sector name	Spatial distribution	Occupation focused on	Age range	Gender
Disparities in COVID-19 fatalities among working Californians (Cummings et al 2022)	Descriptive analysis	Quantitative	Till April 15, 2021	Various	United States	Various	18–64 years	Male: 76.3%
Health and safety risks faced by delivery riders during the COVID-19 pandemic (Tran et al 2022)	Cross-sectional study	Quantitative	August–September 2021	Food delivery	Vietnam	Delivery riders	Mean 30.81	Male: 94.8%
Occupational infection control measures and frontline workers' perceived COVID-19 risk during the fourth wave of the pandemic in Canada: A cross-sectional survey (Ingram et al 2022)	Cross-sectional survey	Quantitative	July 1–November 30, 2021	Transportation, Manufacturing; Transportation or warehousing; manufacturing and food processing.	Canada	Not specified	There were many study groups. Further breakdown was not provided.	There were many study groups. Further breakdown was not provided.
Prevalence and associated factors of psychosocial distress among seafarers during COVID-19 pandemic (Baygi et al 2021)	Cross-sectional study	Quantitative	Jul-20	Transport-Maritime	Global	Not specified	mean age 34.5	Not specified
Socio-Demographic, Health, and Transport-Related Factors Affecting the COVID-19 Outbreak in Myanmar: A cross-sectional study (Aung et al 2022)	Cross-sectional study	Quantitative	August 20, 2020 to January 31, 2021	Not mentioned	Myanmar	Not mentioned	Not applicable	Not applicable
The Impact of COVID-19 on Transit Workers: Perceptions of Employer Responses and Associations with Health Factors (Rice et al 2022)	Cross-sectional study	Quantitative	July and August 2020 and followed up 3 months later	Transport	United States	Transit workers, including public-facing vehicle operators.	Mean age: 50.7	Male: 71.2%
The impacts of the COVID-19 pandemic on transportation employment: A comparative analysis (Mack et al 2021)	Cross-sectional design and logistic regression models	Quantitative	May 2020 and December 2020	Transport	United States	No information	16 years and older	Male: 52.19% Female 47.81
Unequal effects of the COVID-19 epidemic on employment: Differences by immigrant status and race/ethnicity (Liao and Villarreal 2022)	Longitudinal study	Quantitative	January 2020 to December 2021	Various, including, Transportation.	United States	Various	Not applicable	Not applicable

(Continued)

Table 3. (Continued)

Theme Two	Study design	Methodology	Study time period	Focus Industry/ Sector name	Spatial distribution	Occupation focused on	Age range	Gender
Pandelivery I: Reflections on black delivery app workers experiences during COVID-19 in Brazil (da Lage and Rodrigues 2021)	Literature review	Qualitative	Not applicable	Transport	Brazil	Delivery app workers	Not applicable	Not applicable
Gig Workers during the COVID-19 Crisis in France: Financial Precarity and Mental Well-Being (Apouey et al 2020)	Survey – qualitative and quantitative	Mixed Method	March–April 2020 over 4 phases	Gig economy workers – drivers and food delivery	France	Drivers and food delivery	18–50+	Majority male
Essential... but also vulnerable? Work intensification, effort/reward imbalance, fatigue and psychological health of Spanish cargo drivers during the COVID-19 pandemic (Montoro et al 2022)	Cross-sectional questionnaire – quantitative indices	Mixed Method	2020	Cargo transportation	Spain	Cargo drivers	Mean 48.5 SD 7.9	Male: 97%
The Impact of COVID-19 on the Work Environment in Long-Haul Truck Drivers (Crizzle et al 2021)	Online survey	Mixed Method	August 2020–March 2021	Transport	Canada	Long-haul truck drivers	22–79 years mean age: 48.1 (SD +- 11.8)	Men: 82.2%
Understanding risk and protective factors to UK railway workers' mental wellbeing during the COVID-19 pandemic: a cross-sectional survey (Cogan et al 2021)	Cross-sectional survey	Mixed Method	Dec 1, 2020, and March 24, 2021	Railway transport	United Kingdom	Railway workers	Not available	Not available
Occupational safety and health challenges for maritime key workers in the global COVID-19 pandemic (Shan 2022)	Legal doctrinal analysis, media coverage analysis and qualitative interview data	Mixed Methods	June–December 2020	Maritime workers	Canada, China and India	Seafarers who had worked at sea and seafarers waiting ashore. Ship managers, maritime welfare professionals, and a representative of a maritime authority	Not specified	Not specified

Table 4. Characteristics of Studies Included in the Scoping Review for Question number 3: Study Design, Methodology, Study time period, Industry Focus, and Spatial distribution

Study	Study design	Methodology	Study time period	Focus industry/ Sector	Spatial distribution
A Descriptive Analysis on the Impact of COVID-19 Lockdowns on Road Traffic Incidents in Sydney, Australia (Chand et al 2021)	Descriptive analysis	Quantitative	Early September 2021. The data on traffic incidents were obtained from the Transport for New South Wales live traffic website from 1 January 2018 to 31 August 2021	Transport	Australia
A systematic review of COVID-19 transport policies and mitigation strategies around the globe (Calderón Peralvo et al 2022)	Systematic literature review	Quantitative	2020 to the present (April 2022)	Transport	Global
Adherence to social distancing and wearing of masks within public transportation during the COVID 19 pandemic (Dzisi and Dei 2020)	Cross-sectional study	Quantitative	May-2020	Transport	Kumasi, Ghana
Challenges for urban transport policy after the Covid-19 pandemic: Main findings from a survey in 20 European cities (Christidis et al 2022)	Cross-sectional study	Quantitative	Second quarter of 2021	Transport	20 European cities
COVID-19 and transport: Findings from a world-wide expert survey (Zhang et al 2021)	Cross-sectional study	Quantitative	End of April and late May 2020	Transport	Global
COVID-19 need not spell the death of public transport: Learning from Hanoi's safety measures (Nguyen and Pojani 2021)	Cross-sectional study	Quantitative	7 September and 3 October 2020	Transport	Hanoi
Occupational infection control measures and frontline workers' perceived COVID-19 risk during the fourth wave of the pandemic in Canada: A cross-sectional survey (Ingram et al 2022)	Cross-sectional study	Quantitative	July 1 to November 30, 2021	Healthcare, education, transportation, manufacturing, and warehousing.	Canada
A Review of COVID-19-Related Literature on Freight Transport: Impacts, Mitigation Strategies, Recovery Measures, and Future Research Directions (Karam et al 2022)	Literature review	Qualitative	Till December 2021	Freight Transport	Global

(Continued)

Table 4. (Continued)

Study	Study design	Methodology	Study time period	Focus industry/ Sector	Spatial distribution
Pandemic waves and the time after COVID-19 - Consequences for the transport sector (Rothengatter et al 2021)	Literature review	Qualitative	Not specified	Transport	Global
Physical distancing on public transport in Mumbai, India: Policy and planning implications for unlock and post-pandemic period (Thomas et al 2022)	Literature review	Qualitative	Pre COVID-19 pandemic and during COVID-19 pandemic	Public Transport	India
How Does Railway Respond to the Spread of COVID-19? Countermeasure Analysis and Evaluation Around the World (Yin et al 2021)	Mixed-methods approach	Mixed Method	Not specified	Transport	Global
Insights into the long-term effects of COVID-19 responses on transportation facilities (Kutela et al 2022)	Mixed-methods approach	Mixed Method	The study was conducted between March and September 2020, and the data used in the paper was downloaded from the September 2021 version of the dataset.	Transport	Global
The Impact of COVID-19 on the Work Environment in Long-Haul Truck Drivers (Crizzle et al 2021)	Cross-sectional study	Mixed Method	August 2020 and March 2021	Not applicable	Canada
Transportation in the Mediterranean during the COVID-19 pandemic era (Tarasi et al 2021)	Cross-sectional study	Mixed Method	Two phases (four periods) before, during, and after the quarantine.	Transport	Cretan

during the same period. Furthermore, the study concludes that these observations underscore the vulnerability of public transport workers, whether exposure occurs from interactions with the public, coworkers, or other sources. Notably, in a case report from Thailand, transport workers who contracted the infection were found to have a higher likelihood of requiring hospitalisation, indicating the severe impact of the disease on this vulnerable group (Yasri and Wiwanitkit 2020).

These findings highlight that transport workers are a vulnerable group who should be prioritised in future pandemic preparedness and response strategies. Such strategies can include targeted vaccination efforts, access to antiviral treatments, public health messaging, and enhanced workplace protection measures. These measures might involve improving ventilation systems and ensuring the use of well-fitted masks or respirators (e.g., N95s) by both workers and the public (Heinzerling 2022).

Factors influencing the transmission of infections among transport workers

The implementation of preventive measures, such as the provision of PPE and passenger restrictions, was a crucial step towards mitigating the risk of respiratory pandemic diseases among transport workers (De Matteis et al 2022; Harris and Kirkham 2021). However, these measures were generally found to be inadequate. Several key factors contributed to the continued high risk of infection among transport workers:

Public Contact and Material Handling: A high percentage of transport workers were involved in positions that required frequent contact with the public and the handling of materials, which increased the risk of infection (De Matteis et al 2022; Harris and Kirkham 2021; Öngel et al 2022; Pongpirul et al 2020; Ingram et al 2022).

Air-Conditioned Vehicles: A study on aerosol transmission of COVID-19 in different commuter microenvironments found that air-conditioned vehicles increased risk of transmission (Das and Ramachandran 2021). Relatedly, the highest number of outbreak-associated cases occurred in the air transportation sector (Heinzerling 2022).

Inconsistent Use of PPE: In response to the elevated risk of respiratory pandemic diseases among transport workers, several preventive measures were introduced, including the provision and compulsory use of PPE (Harris and Kirkham 2021; De Matteis et al 2022; Pongpirul et al 2020; James et al 2022). Although these measures aimed to minimise the risk of infection, the adherence to PPE usage among transport workers was inconsistent (James et al 2022; Harris and Kirkham 2021) with a significant association between the relative change in income and reduced mask-wearing practice (James et al 2022).

Ethnicity: Ethnicity was identified as a significant risk factor across the literature, with black or Hispanic populations disproportionately affected by the COVID-19 pandemic reporting higher infection rates in the transport industry (Faberman and Hartley 2022).

Underlying Health Conditions: The literature also indicated a higher risk of infection among transport workers due to underlying health conditions, including hypertension, type 2 diabetes, sleep apnoea, high cholesterol, and depression (Crizzle et al 2021).

Theme two: Equity implications of respiratory pandemic diseases for transport workers

This section explores the equity implications identified in the literature concerning transport workers and the transmission and control of respiratory diseases, including COVID-19. The primary equity issues highlighted relate to the distribution of impacts, notably in terms of employment precarity and the lack of agency and control among transport workers.

The main pathways to impact were physical and psychosocial, increased exposure to infection, increased susceptibility to disease, financial precarity, and uncertainty regarding policies and responsibilities for protection from the virus. The following subsections examine the equity implications of respiratory diseases like COVID-19 for diverse groups of transport workers across structural conditions and systematic disparities.

Structural inequalities: Longer working hours, larger geographic coverage, overcrowded spaces

Structural inequalities concerned the institutional barriers faced by transport workers that caused them to be at higher risk of poor outcomes. Workers who faced inadequate infection control measures, longer working hours, and larger geographic coverage for deliveries were affected in their ability to take health and safety measures; they also limited time and resources to prioritise their own well-being (Ingram *et al* 2022; Tran *et al* 2022). Poor socio-economic situations, longer working hours, broader geographic coverage, and operating in closed environments significantly increase the risk of exposure and transmission of respiratory diseases among transport workers (Ingram *et al* 2022). Additionally, the inability to avoid crowded spaces increased the risk of virus exposure (Baygi *et al* 2021). Cyclist delivery workers faced increased risks due to the absence of road safety infrastructure, such as bike paths and parking, as well as limited options to avoid crowded spaces, leading to higher chances of virus exposure (da Lage and Rodrigues 2021). Accessing medical care posed a significant challenge for transport workers due to the unprecedented nature of the pandemic and the nature of their work (Shan 2022).

Systematic inequalities: Ethnic and racial disparities, unemployment

Systematic inequalities concerned the increased risk of disadvantage for particularly vulnerable workers. The impact of the pandemic was not equally distributed among all workers. The pandemic significantly influenced employment in the transportation sector, with higher rates of unemployment observed compared to non-transportation industries groups (Mack *et al* 2021). Racial disparities were apparent among some transport workers during the pandemic. Workers from minority groups, including non-White, Hispanic, and non-citizens, were disproportionately affected compared to their counterparts. Additionally, intersectional factors played a significant role; for example, a study conducted in the US demonstrated that non-White and Hispanic females faced an even greater impact. Transport workers as a whole faced a 20.6% increased likelihood of unemployment due to the pandemic, with non-White and Hispanic females encountering an alarming 29.5% higher probability of unemployment during this challenging period (Mack *et al* 2021; Baygi *et al* 2021). In Brazil, companies were also shown to have profited from hiring marginalised groups, such as black delivery workers, due to their low wages and working conditions. Thus, black men were at a high risk of contracting respiratory diseases, including COVID-19, due to their history of social vulnerability (da Lage and Rodrigues 2021). This lack of protections for minority groups and marginalised workers further emphasised systematic inequality.

Additionally, education was shown to matter. University-educated riders displayed greater awareness of the risks associated with COVID-19 infections and traffic infractions. In contrast, transport workers with lower educational levels, particularly older riders, displayed reduced propensity to sanitise their hands or use a shield (Tran *et al* 2022).

Moreover, profound impacts on gig workers – those without formal worker status – also emerged from the literature. One study (Apouey *et al* 2020) revealed how gig workers were impacted in terms of financial precarity, anxiety about the future, and perceptions of risk of infection. There was variation in requirements for personal/workplace infection control

for gig workers. Equity impacts varied in terms of the level of reliance on gig work and the ability to continue gig work through the lockdown.

Higher-income gig workers were more likely to transition to remote work, while those with lower incomes faced greater obstacles making that transition (Apouey et al 2020). Other behavioural challenges were also documented for gig workers, including the relationship between stress and coping mechanisms such as increased smoking (Crizzle et al 2021).

Financial burdens

The financial situation of transport workers played a significant role in shaping their health and safety behaviours. Those who suffered substantial income loss during the lockdown were particularly burdened with rent payments and demonstrated increased risky behaviours, such as less adherence to safety measures, compared to homeowners who had more financial stability. In contrast, transport workers who were the sole source of household income or those living with older adults at higher risk of COVID-19 complications, showed a greater tendency to use additional protective measures, such as face shields (Tran et al 2022).

Theme three: The impact of respiratory pandemic disease measures on transport services: Strategies to mitigate risks, costs, and outcomes

The following sub-sections of theme three examines the impact of infection control measures employed by governments and transport industries (see Table 5). This includes analysis of risky behaviours exhibited by transport workers and users of transport workers.

Scope of strategies used and their perceived impact

Various infection control measures were implemented by governments and transport industries to prevent the spread of respiratory pandemic diseases; however, these measures could not fully protect transport workers. Infection control measures, such as lockdowns, use of PPE, social distancing, and increased hygiene practices, were the main non-pharmaceutical measures employed to control the transmission of respiratory pandemic diseases (Chand et al 2021; Dzisi and Dei 2020; Karam et al 2022). Several other interventions were implemented to improve the travel experience for passengers and working conditions for transport workers. These measures included controlling loading rates, temperature screening, decentralised staff distribution, suspending ticket checking, encouraging remote communication, and enhancing work flexibility (Yin et al 2021). Measures, such as investigating qualifications, reporting suspected cases, and recording and tracing close contacts, were also employed (Yin et al 2021).

Numerous challenges arose when it came to ensuring full compliance with infection control measures for the transport industry. This was particularly significant in the context of public transport, where strict adherence is essential to minimise the risk of transmission. Although the literature indicated a positive compliance rate with social distancing guidelines in buses, partial adherence to the policy on wearing face masks in most types of vehicles was highlighted (Dzisi and Dei 2020). Also, another study reported that the low percentage of guidelines and contingency plans in the transport sector was problematic (Zhang et al 2021).

The effectiveness of measures implemented by governments and transport industries was significantly influenced by how well these measures were communicated to the public. Effective dissemination of information about these measures, often through the internet

Table 5. Strategies Implemented During COVID-19 Pandemic to Control Spread of Infections in the Transport Industry

Theme three	Encouraging the use of PPE	Implementing social distancing measures	Improved ventilation systems in transportation vehicles	Vaccination	Lockdown	Reducing public transport capacity and frequency	Other relevant strategies listed by the literature
A Descriptive Analysis on the Impact of COVID-19 Lockdowns on Road Traffic Incidents in Sydney, Australia (Chand et al 2021)	No information	Yes	No information	No information	No information	Yes	Imposing travel restrictions and stay-at-home orders for non-essential workers and activities. Encouraging active transport modes such as walking and cycling for essential trips. Implementing pop-up cycleways and pedestrian paths to facilitate active transport.
A systematic review of COVID-19 transport policies and mitigation strategies around the globe (Calderón Peralvo et al 2022)	Yes	Yes	Yes	Yes	No information	Yes	1. Focusing on crowding at stations and households 2. Generating spatially differentiated travel restriction policies 3. Promoting hyper pedestrian-oriented development 4. Proposing the use of open spaces for holding events that require the

(Continued)

Table 5. (Continued)

Theme three	Encouraging the use of PPE	Implementing social distancing measures	Improved ventilation systems in transportation vehicles	Vaccination	Lockdown	Reducing public transport capacity and frequency	Other relevant strategies listed by the literature
							<p>attendance of many people</p> <p>5. Proposing alternatives for the boarding and disembarking of passengers</p> <p>6. Addressing the use of cell phones to determine the movement of people and relate this information to levels of contagion</p> <p>7. Promoting change in activity/mobility patterns within the community like</p> <ul style="list-style-type: none"> • Work from home (telework) • Flexible work arrangements • Staggered working, school, services, and organizations hours • Use of online/door-to-door services <p>8. Adjusting ticketing pricing and</p>

(Continued)

Table 5. (Continued)

Theme three	Encouraging the use of PPE	Implementing social distancing measures	Improved ventilation systems in transportation vehicles	Vaccination	Lockdown	Reducing public transport capacity and frequency	Other relevant strategies listed by the literature
							<p>policies to meet new travel patterns</p> <p>9. Encouraging self-sustainable neighbourhoods</p> <p>10. Making cities more pedestrian-friendly</p> <p>11. Managing seating in public-use vehicles to comply with social distancing</p> <p>12. Vehicle disinfection</p> <p>13. Smartcard-based contact tracing</p> <p>14. Operator-controlled contact tracing</p> <p>15. Fare-free policies to lure passengers back to public transport</p> <p>16. Reducing public transport fares</p> <p>17. Creating safe routes for bicyclists and pedestrians</p> <p>18. Promoting cycling and walking as</p>

(Continued)

Table 5. (Continued)

Theme three	Encouraging the use of PPE	Implementing social distancing measures	Improved ventilation systems in transportation vehicles	Vaccination	Lockdown	Reducing public transport capacity and frequency	Other relevant strategies listed by the literature
							<p>alternatives to public transport</p> <p>19. Providing bike parking facilities and bike-sharing services.</p> <p>20. Imposing travel restrictions and stay-at-home orders for non-essential workers and activities.</p>
Adherence to social distancing and wearing of masks within public transportation during the COVID 19 pandemic (Dzisi and Dei 2020)	Yes	Yes	No information	No information	No information	No information	Encouraging active transport modes such as walking and cycling for essential trips.
Challenges for urban transport policy after the COVID-19 pandemic: Main findings from a survey in 20 European cities (Christidis et al 2022)	No information	No information	No information	No information	Yes	Yes	
COVID-19 and transport: Findings from a world-wide expert survey (Zhang et al 2021)	No information	Yes	No information	No information	Yes	No information	<p>1. Implementing pop-up cycleways and pedestrian paths to facilitate active transport.</p> <p>2. Restrictions of out-of-home activities and other physical distancing requirements.</p>

(Continued)

Table 5. (Continued)

Theme three	Encouraging the use of PPE	Implementing social distancing measures	Improved ventilation systems in transportation vehicles	Vaccination	Lockdown	Reducing public transport capacity and frequency	Other relevant strategies listed by the literature
Covid-19 need not spell the death of public transport: Learning from Hanoi's safety measures (Nguyen and Pojani 2021)	Yes	No information	No information	No information	No information	No information	Encouraging use of hand sanitizer. It is noted that face masks were mandated, while hand sanitizer was recommended but not required.
Occupational infection control measures and frontline workers' perceived COVID-19 risk during the fourth wave of the pandemic in Canada: A cross-sectional survey (Ingram et al 2022)	Yes	Yes	Yes	Yes	No information	No information	1. Contact tracing programs. 2. Testing and isolation.
A Review of COVID-19-Related Literature on Freight Transport: Impacts, Mitigation Strategies, Recovery Measures, and Future Research Directions (Karam et al 2022)	No information	No information	No information	No information	Yes	No information	Travel restrictions
Pandemic waves and the time after COVID-19 – Consequences for the transport sector (Rothengatter et al 2021)	No information	No information	No information	No information	Yes	No information	
Physical distancing on public transport in Mumbai, India: Policy and planning implications for unlock and post-pandemic period (Thomas et al 2022)	No information	Yes	No information	No information	Yes	Yes	1. Long-term interventions such as flexible work arrangements 2. Allowing private transport (like cars and bikes) for essential and emergency services with passenger limits in Mumbai

(Continued)

Table 5. (Continued)

Theme three	Encouraging the use of PPE	Implementing social distancing measures	Improved ventilation systems in transportation vehicles	Vaccination	Lockdown	Reducing public transport capacity and frequency	Other relevant strategies listed by the literature
							<ol style="list-style-type: none"> 3. No restrictions on private transport in Delhi 4. Not allowing pillion riders on private transport in Bangalore 5. Not allowing paratransit (like auto-rickshaws) in Mumbai 6. Allowing paratransit with no restrictions in Delhi 7. Not allowing public transport (like buses and trains) in Mumbai 8. Allowing buses with passenger limits in Delhi 9. Allowing local trains for selected populations in Delhi 10. Allowing local trains for the general public during non-peak hours in Kolkata 11. Not allowing metro in Delhi

(Continued)

Table 5. (Continued)

Theme three	Encouraging the use of PPE	Implementing social distancing measures	Improved ventilation systems in transportation vehicles	Vaccination	Lockdown	Reducing public transport capacity and frequency	Other relevant strategies listed by the literature
							12. Allowing metro in Kolkata and Chennai. 13. Flexible work arrangements
How Does Railway Respond to the Spread of COVID-19? Countermeasure Analysis and Evaluation Around the World (Yin et al 2021)	Yes	Yes	Yes	No information	No information	No information	1. Temperature screening 2. Adjusting catering service 3. Close public places such as restaurants, shops and passenger waiting rooms of the stations. 4. Decentralizing staff distribution. 5. Encouraging remote communication. 6. Releasing information by TV and the Internet. 7. Controlling the loading rate. 8. Suspending ticket checking. 9. Enhancing work flexibility. 10. Investigating qualifications. 11. Reporting suspected cases. Recording and tracing close contacts.
Insights into the long-term effects of COVID-19 responses on transportation facilities (Kutela et al 2022)	No information	Yes	No information	No information	Yes	No information	

(Continued)

Table 5. (Continued)

Theme three	Encouraging the use of PPE	Implementing social distancing measures	Improved ventilation systems in transportation vehicles	Vaccination	Lockdown	Reducing public transport capacity and frequency	Other relevant strategies listed by the literature
The Impact of COVID-19 on the Work Environment in Long-Haul Truck Drivers (Crizzle et al 2021)	No information	No information	No information	No information	No information	No information	<ol style="list-style-type: none"> 1. Truck driving schools were closed during the height of the pandemic. 2. Many rest areas were closed during the pandemic, resulting in fewer places for truck drivers to stop and use restroom facilities
Transportation in the Mediterranean during the COVID-19 pandemic era (Tarasi et al 2021)	No information	Yes	No information	No information	Yes	No information	<ol style="list-style-type: none"> 1. Temporary suspension of schools/educational institutions 2. Closure of shopping malls, restaurants, cafes, entertainment centers, libraries, cinemas, theaters, sports facilities, hairdressers, and beauty salons 3. Restrictions on citizens' movement 4. Remote working policies 5. Self-isolation suggestion 6. Reopening of smaller retailers and some services 7. Implementation of social distancing measures

and television, was crucial in promoting compliance. While dissemination is indeed a part of the implementation process, it plays a distinct role in ensuring that the intended audience understands and adheres to the control measures. (Yin et al 2021).

While the implementation of infection control measures by governments and transport industries demonstrated positive significance in curbing transmission, the literature nevertheless highlights how these efforts came with additional costs and challenges especially in global south countries (Yin et al 2021). Economic measures to alleviate those negative impacts were reported to be less sufficient in these settings (Zhang et al 2021).

Outcome of infection control measures: Reduction in spread of disease, remote working, change in consumer preferences for using transport services and bankruptcy

Most studies included in this review suggested that measures generally helped to reduce the spread of pandemic infectious diseases while also resulting in reduced vehicle capacity and increased waiting times for passengers (Karam et al 2022; Yin et al 2021). Inequity also resulted, as reduced public transport services disproportionately impacted low-income communities and essential workers who relied on those services (Thomas et al 2022).

On the other hand, infection control measures increased the significance of remote working while reducing demand for travel, particularly in urban areas (Thomas et al 2022). This shift in work dynamics decreases in demand for certain transport services amongst those who can afford to work from home, such as public transport and ride-hailing services, while simultaneously leading to an increase in demand for delivery services (Rothengatter et al 2021). Limiting demand for transport had broader economic impacts on the industry, particularly airlines, with many companies facing bankruptcy and staff layoffs. In turn, those changes reduced transport options and increased ticket prices (Karam et al 2022; Calderón Peralvo et al 2022). Increased car dependence resulted, as well as changes in walking and cycling patterns (Zhang et al 2021; Christidis et al 2022; Nguyen and Pojani 2021).

During the COVID-19 pandemic, truck drivers faced increasing challenges finding adequate parking at truck stops and rest areas. This scarcity of parking spaces not only disrupted their regular rest schedules but also contributed to heightened levels of fatigue among these essential workers. Almost a fifth (18.5%) reported being more fatigued, and more than 50% of 146 reported feeling drowsy while driving with 12% nodding off or falling asleep at the wheel while driving (Crizzle et al 2021).

Theme four: Lessons learned for sustainable and resilient policies and interventions

The studies included in this scoping review provided recommendations for reassessing and analysing current transport systems and policy governance, considering pandemic situations. Some studies emphasised the significance of education, collaboration, and screening in mitigating transmission (Malinga et al 2021; Ingram et al 2022). Others emphasised the need for accessible data to enable workers to evaluate their risk of exposure (Harris and Kirkham 2021; Shan 2022). New transport policies and decision-making frameworks were proposed with the aim of building a less-risky and environmentally sustainable public transport system during the pandemic and into the post-pandemic era (Karam et al 2022; Calderón Peralvo et al 2022; Rothengatter et al 2021; Thomas et al 2022). Recommendations from one study included implementing stringent sustainability policies, investing in zero-carbon transportation technologies, and monitoring individuals' and companies' behaviours to understand the long-term impacts of the pandemic on transportation (Rothengatter et al 2021). Other studies suggested long-term interventions such as remote work and staggered work hours was suggested to reduce peak hour demand, over-crowding, and traffic congestion in the post-pandemic

period (Calderón Peralvo et al 2022; Thomas et al 2022). Foreseen changes to public transport use in the post-pandemic era led to recommendations to evaluate long-term effects of these shifts (Kutela et al 2022). Transportation planners and decision-makers, another study suggested, should focus on promoting the use of public transport by rebuilding riders' confidence in services and discouraging excessive car usage. (Tarasi et al 2021). Another argued for prioritising the implementation of dedicated cycling lanes and infrastructure to safeguard cyclists during and after lockdown periods.

The ongoing production and distribution of masks was highlighted as necessary to address the continuing challenges of COVID-19 transmission on public transportation, especially targeting low-income communities, given their vulnerability to the virus and cost of masks at market rates (Dzisi and Dei 2020).

Different modes across the industry were highlighted for recommendations. Another study reinforced the crucial role in society and the economy played by long haul truck drivers (LHTDs) and the unique challenges they faced during the pandemic, with recommendations ranging from improving rest area and washroom access to transport workers (Crizzle et al 2021).

Expanding the focus of research was recommended. One study (Thomas et al 2022) pressed for researching the impacts of the pandemic on the transport sector specifically in developing countries. Others highlighted the importance of ongoing research for innovation to effectively tackle the challenges faced by the transportation industry in the face of the pandemic profit reduction (Karam et al 2022; Calderón Peralvo et al 2022; Rothengatter et al 2021; Thomas et al 2022).

Discussion

Pandemics are a fact of human existence, and preparation based on evidence and experience is fundamental if future pandemics are to be managed better, and so less damaging (Maccaro et al 2023). This comprehensive scoping review has demonstrated the vulnerability and consequences of respiratory pandemics for the transport industry workforce globally. Transport workers were placed at the front line of infections and bore the consequences of non-pharmaceutical interventions. These interventions not only disrupted standard ways of working in the transport industry but also changed the role of transport in everyday life (Browne et al 2016; Fielbaum et al 2023). Other high-interaction industries, including healthcare (Qureshi Chughtai and Seale 2022), have seen proactive steps introduced to maintain the well-being of healthcare workers and the communities they serve. This review suggests a similar urgency was, and indeed will be, required to address risks and hazards faced by transport workers. (Maccaro et al 2023) The literature suggests lessons for targeted solutions and preventive measures that can both improve the safety and well-being of transport workers and contribute to a more sustainable transport sector. Certainly, the evidence from the literature reviewed indicates that transport workers face more elevated risk from respiratory pandemic diseases than people who work in other industries (Heinzerling 2022). This heightened vulnerability can be attributed to the nature of their work, which involves frequent interactions with the public as well as movement of people and goods (Öngel et al 2022). The range of challenges identified in the literature as those faced by transport workers during a pandemic supports the importance of comprehensive universal interventions across society as well as tailored targeted measures that address the specific risks and demands of the transportation industry (Fisher et al 2023). These risks are related to different pathways that impact the holistic wellbeing of transport workers, particularly those who are more vulnerable than others due to the nature of their work (Apouey et al 2020; Tran et al 2022; da Lage and Rodrigues 2021; Mack et al 2021). (Fisher et al 2023; Agarwal et al 2020; Ming et al 2020) One

reason that societal measures were not effective for transport workers was because a high percentage of workers were involved in close contact with customers and materials, making them more likely to become infected during their work (De Matteis *et al* 2022; Harris and Kirkham 2021; Öngel *et al* 2022; Pongpirul *et al* 2020; Ingram *et al* 2022). For example, specific transport modes, like air-conditioned vehicles, were found to increase the chance of transmission of pandemic respiratory diseases (Das and Ramachandran 2021). This demonstrates the importance of considering all modes of transport and their associated risks when implementing preventive strategies (Cahill *et al* 2022; Qureshi *et al* 2022). As has been highlighted by studies from other sectors (Meng *et al* 2017; van Heijster *et al* 2022; Babaei *et al* 2022), the transportation industry should prioritise targeted interventions, especially for vulnerable groups of workers who have underlying health issues, as these individuals are susceptible to infectious diseases. Effective communication strategies can be used to deliver information regarding these solutions, ensuring the safety of these transport workers during respiratory pandemics (Ingram *et al* 2022; Silva *et al* 2021). In addition, the reviewed literature found inconsistencies in adherence to PPE usage emphasising the need for improved training programs to ensure proper utilisation (Cahill *et al* 2022; Qureshi *et al* 2022). Effective risk communication is necessary, and guidelines and contingency plans in the transport sector should be mandatory. (Zhang *et al* 2021; Das and Ramachandran 2021; Yasri and Wiwanitkit 2020; Aung *et al* 2022; Tran *et al* 2022; Thomas *et al* 2022) The equity implications identified in the literature related primarily to the distribution of impacts in terms of precarity of employment, and lack of agency and control amongst the workforce. Equity was revealed as having structural and systematic dimensions. The review revealed structural inequities among transport workers including lower-income gig workers during respiratory pandemics, in line with other literature (Crizzle *et al* 2021; Shen *et al* 2020; Apouey *et al* 2020). Additionally, limited access to medical care further exacerbates the challenges faced by transport workers, hindering their ability to seek timely healthcare interventions (Aguilar-Palacio *et al* 2021).

Addressing these structural dynamics requires government agencies, employers, unions, and industry groups collaborate to create a fair and inclusive environment within the transportation industry (Ingram *et al* 2022; Aung *et al* 2022; Rice *et al* 2022). One of the challenges reviewed, for instance, was that on line platform work – such as online deliveries – operated on a business model which, categorise workers as ‘self-employed’ rather than employees. That categorisation effectively side-stepped regulatory protections on wages, hours, other working conditions, and access to such transport workers’ compensation after suffering a work-related injury or illness (Wething 2022).

Improved/universal work protection and targeted educational initiatives are all required (Mack *et al* 2021). By resolving systematic inequalities, the industry can nurture a more resilient workforce and be better prepared for future pandemics. In a number of countries/jurisdictions, efforts have recently been made to address these gaps, most notably by deeming gig-workers to be employees, and so, covered by labour protections relating to minimum wages and the like (for a review see (Munton and Rawling 2023)). A potentially more far-reaching setting of reforms was recently enacted in Australia in the ‘closing the loopholes’ industrial relations legislation. This empowered the Fair Work Commission – Australia’s federal industrial relations tribunal – to set minimum wages/payment and conditions for platform/gig-workers (such as those doing food delivery) and contract truck drivers (Underhill and Quinlan 2024). For industry practice, improving compliance with infection control measures is crucial for ensuring the safety and well-being of both transport workers and the general population during a respiratory pandemic. However, the literature reviewed here demonstrated some of the challenges in ensuring full compliance (Zhang *et al* 2021).

The measures implemented by governments routinely failed to consider the complexities of the transport industry, impacting negatively on the workforce, which in turn risked the effectiveness of the pandemic response (Dzisi and Dei 2020; Yin et al 2021). The transport industry also fell short in fulfilling its responsibility to curb the transmission of infections during the COVID-19 pandemic due to a lack of preparedness. It needs to be acknowledged that some countries were more active than others. Early in the pandemic Australia, like several other countries, closed not only its international borders to people movement for a prolonged period – a centuries old response to pandemics – but most of its state borders as well (Spennemann 2021). To minimise the infection risks associated with trucks moving both interstate and over short distances special protocols were implemented to deal with interstate and intrastate/urban road transport including mandatory-testing and screening (and evidence of this), isolation controls, PPE requirements, and infection control training. While some companies maintained training in infection controls after the mandatory protocols were lifted, there was no effort by government to ensure these measures were maintained (Stobart and Duckett 2022).

To enhance compliance, our review highlighted various strategies that could be employed to protect transport workers in future pandemics. First, transport workers should be provided with thorough infection control education and training. Second, effective communication and engagement channels should be established to regularly disseminate information regarding infection control measures. Transport workers should be involved in making decisions. This would give them a sense of ownership and responsibility. Third, providing adequate resources. This will involve providing adequate PPE, hygiene supplies, and training. Additionally access to regular testing and healthcare services should be facilitated to promptly manage any potential infections. Fourth, effective monitoring is crucial. Regular audits and feedback loops can identify areas of improvement and address non-compliance effectively. Lastly, fostering collaboration among transport industry stakeholders and public health authorities is vital. Sharing best practices, coordinating efforts, and standardising methods will help improve compliance and create a unified approach to infection control.

While comprehensive, scoping reviews such as this contain inherent limitations (Arksey and O'Malley 2005). The review was based solely on the findings and interpretations reported in the included studies; the accuracy of the results depends on the methodology of the original studies.

This review included studies from various countries with differing transportation industries and healthcare policies, limiting the generalisability of the findings across different contexts. English-only articles may have missed relevant studies in other languages, omitting valuable data. The wide range of the studies included, in terms of methodology, population, and outcomes, presents a challenge in reaching conclusive findings. Future research should examine specific regional contexts and include studies in multiple languages for a more inclusive understanding.

Conclusion

The pandemic highlighted both the importance of industries like transport to maintaining public health but also the challenges to safeguarding workers and the community particularly where the workforce is vulnerable/precarious. What we found regarding road transport is mirrored in findings from other industries like maritime transport, food processing, health, and aged care. These risks are not new and require amongst other things changes to how work is regulated. Seeking to regulate all workers in 'employee-like' arrangements provides the potential for building a more sustainable workforce and industry. There is also a need for industry-specific training in infection control and other

measures OHS legislation and relevant policy instruments (like the Fair Work Commission in Australia).

However, a one-size-fits-all strategy for combating global pandemics should be avoided. Rather, some control measures need to be shaped around the circumstances of particular industries and subsectors. The transport sector is not only fundamental to the maintenance of the global economy through the transport of goods, but it also provides critical public services, such as public transit, taxis, ridesharing, and delivery services. Accepting the distinct dangers encountered by various subsets of the labour force is imperative if effective pandemic prevention measures are to be developed while also ensuring a core sector of the global economy is maintained safely for its workers, for the public, and broader society. The risks of new pandemics are ever present and increasing. Lessons from previous pandemics must guide the institutionalising of both comprehensive and targeted preventive measures in critical economic sectors, such as transport.

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