

Scoping review protocol on shift work variables associated with the health, safety, productivity, and well-being of land, air, and maritime transport workers in cargo and passenger services

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ABSTRACT

INTRODUCTION Shift work refers to labor arrangements that fall outside the standard daytime schedule and is associated with various health, safety, and productivity concerns. Numerous studies have linked shift work to sleep disturbances, chronic diseases, reduced well-being, and impaired performance. However, there is no consensus in the literature regarding which specific shift variables should be assessed, hindering comparability across studies and the formulation of evidence-based recommendations.

OBJECTIVE To explore which shift work variables have been investigated in the scientific literature in relation to the health, productivity, safety, and well-being of workers in land, air, and maritime transport, in both freight and passenger services

METHODS A scoping review will be conducted following the PRISMA-ScR guidelines and the Joanna Briggs Institute methodology. The literature search will be performed in PubMed and Scopus, including studies published in English and Spanish between 2015 and March 2025. Two reviewers will independently screen titles, abstracts, and full texts using Rayyan, and extract relevant data using a predefined data charting form. Methodological quality will be assessed using validated tools such as the Mixed Methods Appraisal Tool (MMAT) or the JBI critical appraisal checklists. A narrative synthesis will be used to summarize and map the key findings.

EXPECTED RESULTS This review aims to enhance conceptual and methodological clarity in the study of shift work by providing a structured synthesis of the variables investigated in relation to key occupational outcomes. Findings will be relevant for researchers, occupational health professionals, and policymakers seeking to design more targeted and effective interventions.

KEYWORDS Shift work, Occupational health, Occupational safety, Productivity, Transport

INTRODUCTION

Shift work, defined as work schedules in which one worker replaces another within a continuous 24-hour period, encompasses all those modalities that fall outside standard daytime hours (Monday to Friday, 8:00 a.m. to 6:00 p.m.) [1,2]. This form of scheduling is crucial to ensure operational continuity in critical sectors, such as healthcare, transportation, manufacturing, and emergency services. Notably, 20 to 30% of the workforce in Europe and North America reports working in

non-traditional schedules, underscoring the magnitude of the phenomenon and the importance of examining its implications [3].

Numerous investigations have documented associations between shift work and various adverse outcomes, including sleep disorders, metabolic, cardiovascular, and gastrointestinal diseases, psychiatric disturbances, and an increased risk of certain types of cancer [4]. Particularly, the so-called "shift work disorder" presents a prevalence that varies between 23 and 63%, depending on the characteristics of the scheme, the population, and the instruments used [5,6]. In addition, night workers have a higher incidence of specific conditions, such as gastritis (Odds ratio: 2.24; 95% confidence interval: 1.47 to 3.43) compared to those who are not exposed to this type of shift [7]. The transportation sector is particularly sensitive to the effects of shift work, given its continuous operation and high operational demands. Drivers, pilots, merchant mariners, and other workers face complex shift schedules, long hours, and limited recovery

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MAIN MESSAGES

- Heterogeneity in how shift work variables are defined and measured limits comparison and effective intervention.
- This scoping review will enable us to systematically map studied variables and their relationships to workers' health, well-being, safety, and productivity.

time between shifts, making them particularly vulnerable to fatigue, human error, and physical and mental health consequences [8].

Although the literature has extensively described the effects of shift work on health and well-being, there is significant fragmentation in how the variables that comprise shift schedules are defined, grouped, and analyzed. Adequately assessing their influence requires systematically examining variables such as shift length, number of consecutive days worked, frequency of night shifts, direction of rotation, recovery time between shifts, shift-specific hours, advance notice of scheduling, on-call shifts, breaks, weekly hours worked, and commuting time [9–11]. Along these lines, a recent study showed that starting shift work negatively affects sleep and mental health in new employees, especially in the health sector, with a reduction in sleep duration and an increase in symptoms of depression and burnout. However, the authors highlighted that most of the studies analyzed did not clearly specify key conditions of shift systems, such as the pattern of rotation, number of consecutive night shifts, duration, and exact schedules, making it difficult to understand how these variables impact the results [12].

In response to this lack of conceptual clarity, there has been a recent increase in interest in investigating specific variables, such as extended shifts of 16 hours or more, known as extended-duration work shifts, especially in care and health-care settings. A recent example is the scoping review protocol proposed by Xu et al. [13], which seeks to systematize the effects of these extended shifts on workers' well-being and safety. Similarly, some studies have proposed participatory approaches to redesign shifts from the perspective of real work. For example, Cheyrouze and Barthe [14] demonstrated that, in hospital contexts, identifying the actual working conditions and the coordination mechanisms between actors is fundamental to determining which shift variables truly influence health, productivity, and safety. This perspective reinforces the importance of panoramically mapping the variables studied in critical sectors, such as land, air, and maritime transportation, where operational schemes are often rigid, complex, and multifaceted.

The existence of trade-offs between variables increases the complexity of these schemes. For example, Ferguson and Dawson [15] found that 12-hour shifts may favor total sleep time, but impair social and family life. In turn, 8-hour shifts may improve specific safety indicators, but not necessarily have a positive impact on mental or physical health. This diversity of

effects highlights the need to adopt a multidimensional and systemic approach to analyze shift work.

To overcome these limitations, more comprehensive evaluation frameworks have been developed. The Besiak procedure, proposed by Schönfelder and Knauth [16], incorporates 14 independent ergonomic variables to analyze shift systems. In contrast, Fischer et al. [17] proposed a risk index that considers the interaction between shift length, type of workday, frequency of breaks, and consecutive days worked. More recently, biomathematical models, such as SAFTE (Sleep, Activity, Fatigue, and Task Effectiveness) and FAID (Fatigue Audit InterDyne), have been implemented to simulate trajectories of fatigue, alertness, and performance as a function of different time configurations. These tools have demonstrated practical utility in high-demand operational contexts, such as transportation, aviation, or defense [8].

A scoping review is particularly well-suited to address this topic, as it allows us to map broad concepts, explore how they have been addressed in different study designs, and identify structural gaps in the body of evidence [18,19]. Despite the growing volume of research, a comprehensive synthesis is not yet available that identifies which shift work variables have been studied, how they have been conceptualized and operationalized, and in which work contexts they have been analyzed in relation to health, safety, productivity, and well-being.

To coherently organize the variables of interest, this protocol adopts a conceptual framework that integrates the bio-psycho-social approach to shift work with elements of the Job Demands-Resources (JD-R) model. This framework recognizes that shift system characteristics interact in three interrelated domains:

Biological/physiological: includes variables such as shift length, rotation, night work, inter-shift rest, and others that affect circadian rhythms, sleep, and fatigue [4].

Psychological: encompasses cognitive and emotional demands (e.g., mental workload, stress) and protective resources (e.g., scheduled breaks, control over schedule) [20].

Social/organizational: considers aspects such as contractual conditions, organizational culture and work-life balance [21].

This conceptual framework allows us to systematically classify variables, guide the interpretation of patterns and facilitate the identification of theoretical and empirical gaps, while maintaining the exploratory flexibility characteristic of scoping reviews.

Consequently, this scoping review aims to answer the following question: What specific shift work variables have been analyzed in the scientific literature in relation to health, safety, productivity, and well-being outcomes in working populations

exposed to shift patterns in land, air, and maritime transportation, as well as in cargo and passenger services? By systematically identifying and classifying these variables, this study will help to establish a common framework for future research, facilitate comparison of findings, and guide the design of evidence-based interventions.

METHODS

This scoping review will be developed in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) [19] and the methodology proposed by the Joanna Briggs Institute [18]. This protocol was registered in an international database for systematic reviews, to enhance research transparency and minimize the risk of bias.

Types of studies

Quantitative empirical studies (cross-sectional, cohort, case-control, experimental) analyzing associations between shift work variables and health, productivity, safety or welfare outcomes will be included, provided that they explicitly define and analyze shift variables. Studies without empirical analysis (such as reviews, editorials, commentaries or conference proceedings) will be excluded.

Types of information sources and eligibility criteria

Only original studies published in peer-reviewed scientific journals, in either English or Spanish, with no geographic restrictions, will be included. Books, chapters, institutional documents, or other non-refereed sources will not be considered.

Studies should focus on active workers in the transportation sector, whether land, air or maritime, involved in cargo or passenger services and exposed to shift work schemes. Research conducted in other economic sectors will be excluded, as well as those focused on non-working populations, such as students, volunteer personnel, trainee military service members or professional athletes.

Concept

This review will include studies that analyze associations between specific shift work variables and health, safety, productivity or personal and family life outcomes. Among these variables are those that, according to representative studies, have been identified as particularly problematic for workers, such as short notice, daily breaks of less than 11 hours, split duty and the accumulation of more than five consecutive shifts. All of these have been linked to increased fatigue, sleep disturbances, and difficulties in social and family life [22]:

1. **Association study:** methodological design (such as cross-sectional, cohort or case-control studies) that seeks to establish statistical relationships between shift variables and outcomes such as health, safety or

well-being. For example, studies that analyze the relationship between shift patterns and sleep duration [4,10].

2. **Shift pattern:** general structure of the shift system, which can be fixed (such as a constant morning shift) or rotating (e.g., weekly rotation between morning, afternoon and evening), with variations in speed and the inclusion of nights or weekends [4,10].
3. **Night shift:** refers to any shift that includes work between midnight and 6:00 a.m. Several studies have shown that this type of shift affects the performance, safety, and health of workers, particularly due to alterations in circadian rhythms and sleep deprivation [10,22]. This type of shift exposes the worker to the lower part of the circadian rhythm of alertness, partial sleep deprivation, and long periods of accumulated wakefulness. All this significantly increases sleepiness and the risk of incidents, especially during the commute home [23].
4. **Consecutive working days:** number of consecutive working days without rest. It has been reported that working more than five consecutive days can impair social well-being, increase fatigue and hinder recovery [9,22].
5. **Shift extension:** it is considered prolonged when it exceeds 9 or 10 hours. This type of shift has been associated with increased risk of errors, fatigue, sleep disturbance and decreased general well-being [9,11]. Prolonged work is also associated with an increased likelihood of sleep deprivation. According to evidence from professional drivers, working longer than legally permitted triples the likelihood of sleeping less than 6 hours in a 24-hour period, which compromises attention and increases the risk of accidents [24].
6. **Rotational direction:** direction in which shifts progress in rotating systems (e.g., morning-evening-night or evening-evening-morning). Although the findings are not conclusive, it has been suggested that forward rotations (morning-evening-night) are better tolerated than backward rotations, due to their greater compatibility with the biological clock [4,9].
7. **Number of hours per week:** total hours worked per week, regardless of the number of days or the distribution of shifts. For example, a 48-hour workday may correspond to four 12-hour shifts. This parameter has been used to define prolonged accumulated workload and is associated with increased fatigue, decreased recovery time, and an increased risk of errors [4,10]. In a study of professional drivers, 23.8% reported exceeding the legal limit of 48 hours per week, which was associated with a significant reduction in sleep time and an increased likelihood of fatigue [24].
8. **Shift start time:** specific start and end time of the shift, considering its alignment with the circadian rhythm. For

example, a shift starting at 5:00 may interfere with REM sleep [4,11]. In particular, shifts starting between 5:00 and 6:00 are associated with a significant reduction in total previous sleep time, which increases residual sleepiness during the shift and affects performance [23].

9. **Shift notice and unpredictability** refer to the level of anticipation and stability with which the worker is informed about their upcoming work shift. It includes both cases in which the notice is given at short notice (e.g., less than 24 hours) and those in which the shift schedule changes frequently or irregularly. This type of organization, characterized by low predictability, has been identified as one of the most problematic conditions by workers, primarily due to its negative impact on personal planning, social and family life, as well as rest. In a representative study, short notice (less than one month in advance) was perceived as a "major life problem" by 30.5% of exposed workers [9]. Additionally, this unpredictability can increase stress and make it challenging to establish and maintain healthy sleeping and eating routines [10].
10. **On-call shift:** modality in which the worker must be available outside his/her usual schedule to cover unforeseen needs. For example, medical personnel on weekend on-call [11].
11. **Inter-shift rest:** defined as the time interval between the end of one work shift and the start of the next. This variable has been identified as a crucial factor in regulating work fatigue. Particularly, when the interval is less than 11 hours, which is associated with greater drowsiness, sleep disturbance, accumulated fatigue, performance errors and less physiological recovery between work shifts. Several studies have shown that reduced inter-shift breaks, even in contexts of favorable rotation, represent a substantial risk to the worker's health and performance. Consequently, its analysis is relevant and complementary to other variables such as the direction of the rotation or the duration of the shift [9,22].
12. **Overtime:** time worked beyond the scheduled shift. For example, two additional hours after a 10-hour shift [11].
13. **Short workweek:** scheme that condenses the workweek into fewer days with longer shifts. For example, four 10-hour days instead of five 8-hour days [10].
14. **Shift breaks:** scheduled or actual interruption during the workday that allows the worker to rest, eat or recuperate. This type of break is especially relevant in long or physically demanding shifts. Evidence from a meta-analysis shows that the risk of occupational injuries increases progressively as working hours without rest accumulate, while breaks of at least 30 minutes have a significant protective effect, reducing the probability of accidents [17]. On the other hand, prolonged interruptions (e.g., greater than 1.5 hours) between two blocks of work on the same day have been identified as a source of discomfort, as they extend the total time away from home and reduce the effective use of the intermediate break [22].
15. **Commuting time:** travel time between home and workplace. For example, daily commutes of 90 minutes from rural to urban areas [11].
16. **Health and well-being:** physical, mental and social state of the worker, assessed by objective (e.g., diagnosed diseases, clinical symptoms) and subjective indicators (perceived levels of fatigue, sleepiness, stress, job satisfaction, health-related quality of life, work-life balance, among others). Examples of outcomes included in this category are driver fatigue, driver drowsiness, sleep disorders, hypertension, cardiovascular diseases, musculoskeletal disorders, anxiety, depression, psychological stress and burnout.
17. **Productivity:** work performance expressed in quantitative or qualitative terms, such as the number of products or tasks completed, compliance with established objectives, or efficiency in the use of time and available resources. It can be assessed by indicators such as absenteeism (time not worked due to excused or unexcused absences) and presenteeism (attendance at work with reduced performance capacity due to illness, fatigue or other causes) [25].
18. **Safety:** occurrence of occupational accidents resulting in death or disability (partial or total, temporary or permanent), evaluated through indicators such as the rate of fatal or disabling injury accidents, as well as transportation events (land, air or sea) with serious consequences [26].

Setting

Only studies conducted in formal, paid occupational settings will be included. Research conducted in non-occupational populations will be excluded, as will work that does not constitute original research (such as reviews, books, conference proceedings, or letters to the editor). No geographic restrictions will be applied, and only publications in English or Spanish will be considered.

Sources of information and search strategy

A systematic search will be conducted in the PubMed and Scopus databases, as they are selected for their relevance in the biomedical and multidisciplinary fields, respectively. The search will include studies published between January 2015 and March 2025, to capture the most recent literature on shift work and its effects on workers' health, safety, productivity, and well-being.

The search strategy was designed based on key terms identified in previous research, organized into three conceptual blocks:

Terms related to labor aspects.

Terms related to the shift system.

Terms related to the outcomes of interest.

The search strategy to be used in both databases is presented below:

(transport OR "transportation industry" OR "transport sector" OR "transportation services" OR "logistics industry" OR "logistics sector" OR "freight industry" OR "shipping industry" OR "maritime transport" OR "sea transport" OR seafarer OR "merchant marine" OR "port worker" OR "cargo ship" OR "road transport" OR "land transport" OR "truck driver" OR "delivery driver" OR "bus driver" OR "commercial driver" OR "rail transport" OR "railway transport" OR "train operator" OR "railway worker" OR aviation OR "air transport" OR airline OR pilot OR "flight attendant" OR aircrew OR "cargo pilot" OR "passenger airline" OR "cargo transport" OR freight OR "goods transport" OR "passenger transport" OR "public transport" OR "transportation worker")

AND

("shiftwork" OR "shift work" OR "shift system" OR "roster pattern" OR "shift type" OR "permanent shift" OR "work patterns" OR "shift pattern" OR "irregular hours" OR "work schedule" OR "work hours" OR "night work" OR "night shift" OR "fast rotation" OR "slow rotation" OR "shift length" OR "shift duration" OR "8-hour" OR "12-hour" OR "compressed workweek" OR "compressed working week" OR "shift rotation" OR "direction of rotation" OR "forward rotation" OR "backward rotation" OR "rotating shift" OR "rotating hours" OR "clockwise shift rotation" OR "counterclockwise shift rotation" OR "short rest period" OR "quick returns" OR "starting time" OR "early morning" OR "weekend work" OR "on call" OR "short notice" OR "period planning" OR overtime OR "extended hours" OR "split duty" OR "shift timing" OR "rest break" OR "shift intervals" OR "break frequency" OR "split shift" OR "rest between shifts" OR "quick shift rotation" OR "variable shift" OR "variable work hours" OR "call-in shift" OR "on-demand work" OR "early start time" OR "early shift" OR "fatiguing schedule" OR "fatigue-inducing schedule" OR "double shift" OR "irregular shift work" OR "split night shift" OR "unpredictable schedule" OR "schedule unpredictability" OR "short recovery period" OR "compressed rest" OR "inadequate rest period" OR "rotational work" OR "cyclic schedule")

AND

(performance OR production OR productivity OR output OR "task performance" OR "functional performance" OR "performance capabilities" OR "work outcome" OR absenteeism OR presenteeism OR accident OR risk OR injuries OR injury OR "frequency rate" OR "incidence rate" OR hazard OR "road crash" OR "traffic crash" OR "traffic accident" OR "road accident" OR "vehicular accident" OR "motor vehicle accident" OR "traffic collision" OR "vehicle crash" OR "collision risk" OR "crash involvement" OR "driving performance" OR "driving safety" OR "driver fatigue" OR "driver sleepiness" OR "sleep-related crash" OR "transport incident" OR "work-related crash" OR "transport-related injury" OR "aviation safety" OR "pilot fatigue" OR "flight performance" OR "air traffic incident" OR "airplane accident" OR "aircraft incident" OR "maritime accident" OR "marine accident"

OR "ship collision" OR "vessel incident" OR "seafarer fatigue" OR "navigation safety" OR "crew performance" OR health OR disease OR fatigue OR sleep OR sleepiness OR "sleep disorders" OR insomnia OR "sleep deprivation" OR "circadian disruption" OR "shift work disorder" OR "chronic disease" OR hypertension OR "cardiovascular disease" OR "metabolic syndrome" OR "diabetes mellitus" OR obesity OR dyslipidemia OR "immune dysfunction" OR "musculoskeletal disorders" OR "reproductive health" OR "gastrointestinal disturbances" OR stress OR anxiety OR burnout OR "depressive disorders" OR "mental health" OR "psychological distress" OR "emotional exhaustion" OR "occupational stress" OR "job strain" OR PTSD OR "post-traumatic stress disorder" OR "health-related quality of life" OR "personal life" OR "family life" OR "work-life")

Selection of evidence sources

After executing the search strategies, all identified records will be uploaded to the Rayyan platform [27], where automatic and manual removal of duplicates will be performed [28]. Subsequently, a pilot review of the eligibility criteria will be performed using three articles to refine the application of the criteria and resolve potential discrepancies between reviewers.

After the pilot stage, two investigators will independently conduct the review by title and abstract, applying the previously defined inclusion and exclusion criteria. In the event of disagreement, a third reviewer will intervene to facilitate a consensus through discussion. The selected articles will be evaluated in full text, where the reasons for exclusion will be documented when appropriate. The entire selection process will be reported using a PRISMA-ScR flow chart, in accordance with the methodological recommendations for scoping reviews.

Data extraction

Data extraction will be performed independently by two reviewers, using a structured and previously designed template (see Supplementary Material 1), according to the guidelines of the Joanna Briggs Institute [18]. The template will include the following information: author, year, country, study design, population, work sector, shift variables analyzed, outcomes, measurement instruments, findings and recommendations.

Before commencing the full extraction, a pilot test will be conducted using the first three included studies. The results will be compared between reviewers, and in the event of discrepancies, the template will be adjusted before proceeding. Subsequently, both reviewers will independently extract data from all selected studies. Any disagreement will be resolved by discussion with a third reviewer to ensure consistency and quality of the extracted data.

Risk of bias assessment

The methodological quality of the included studies will be independently examined by two investigators using the Mixed Methods Appraisal Tool (MMAT), version 2018 [29]. This tool has been widely used in scoping reviews that integrate quantitative,

qualitative, and mixed studies, and is suitable for assessing the methodological diversity expected in this review.

Discrepancies between reviewers will be resolved by consensus or, if necessary, with the intervention of a third investigator. Although methodological quality will not be used as an exclusion criterion, its analysis will enable us to contextualize the findings, identify the strengths and weaknesses of the body of evidence, and inform future research.

RESULTS

The protocol was registered in April 2025. Study selection is expected to begin in April 2025, and the extraction and synthesis stage is anticipated to be completed by August 2025. Manuscript writing is projected for September to November 2025.

DISCUSSION

To the best of our knowledge, this is the first scoping review that systematically identifies, classifies, and describes the shift work variables evaluated in the scientific literature in relation to health outcomes, productivity, safety, and well-being of workers, with an emphasis on the transportation sector. Although there are relevant precedents that partially address these issues, such as reviews focused on the effects of the night shift, the length of the workday or rotation schemes, none has adopted a comprehensive, multidimensional approach oriented to the systematic analysis of the independent variables involved, such as the one proposed in this study.

Some previous reviews, such as those by Dall'Ora et al. [10] and Silva et al. [4], have addressed the effects of shift work on health; however, they present thematic and methodological limitations that this review seeks to overcome. Dall'Ora et al. primarily focus on nursing staff, considering health and well-being outcomes (such as fatigue, burnout, and job satisfaction), without systematically integrating productivity and safety outcomes or analyzing interactions between shift variables. Silva et al. present a general narrative review, without sectoral focus or analytical distinction of shift configurations.

In a complementary manner, the work of Garde et al [9] proposes guidelines for scheduling night shifts to reduce health and safety risks, based on evidence on circadian rhythms, sleep, fatigue, and performance. This scoping review is intended as an integrative contribution that simultaneously considers shift system variables, multiple outcomes (health, safety, productivity, and well-being), and contextual differences between land, air, and maritime transportation sectors.

Although not a systematic review, this document represents a rigorous effort to translate accumulated scientific knowledge into actionable recommendations. Additionally, it emphasizes the importance of considering multiple dimensions of the shift system simultaneously, including duration, number of consecutive nights, subsequent time off, and direction of rotation. However, the article itself acknowledges the paucity

of integrated evidence relating these variables to specific outcomes in specific work populations.

The need to systematize this information is particularly urgent in the transportation sector, where continuous operation, high operational responsibility and exposure to non-circadian schedules increase vulnerability to adverse shift effects. In this context, several countries have adopted regulatory frameworks that combine prescriptive approaches (e.g., hours-of-service limits) with risk-based management models. Documents such as the American Academy of Sleep Medicine consensus guide [11] and the Working Time Society consensus [21,30] propose evidence-based scheduling principles and the implementation of Fatigue Risk Management Systems (FRMS), which integrate tools such as predictive biomathematical models (FAID, SAFTE), proactive monitoring and reactive post-incident analysis.

Taken together, these methodological, regulatory, and technological advances justify the relevance of the selected period to capture evidence aligned with current challenges and tools in shift work design and evaluation.

In addition, this protocol explicitly considers the need to integrate multiple dimensions of the shift system and its interaction with contextual factors specific to the transportation sector. Therefore, it contemplates the inclusion of studies that simultaneously analyze variables such as shift duration, number of consecutive nights, time off, sense of rotation and schedule predictability, in combination with organizational and psychosocial factors. In line with guidelines such as those proposed by Garde et al., approaches that consider both circadian physiology and the worker's subjective experience, as well as operational frameworks, are incorporated. They aim to strengthen the practical applicability of findings in contexts of high operational demand. Despite these advances, the scientific literature on shift work in transportation remains scattered. It also exhibits significant heterogeneity in the variables considered, the operational definitions used, and the outcomes evaluated. This comprehensive review will enable us to identify knowledge gaps, organize the available evidence, and generate insights to inform the design of studies, interventions, and public policies. Questions such as: Which combinations of shift variables are most frequently associated with negative health or safety outcomes? Which sectors within transport have been most studied? Which outcomes are underrepresented in the literature? These can be addressed based on the results obtained.

The review employs a robust methodology, adhering to the Joanna Briggs Institute guidelines [18,19] for scoping reviews. The protocol has been previously registered, which guarantees transparency. The search strategy includes terms grouped in three conceptual blocks (population, shift variables and outcomes), which ensures sensitivity in the identification. In addition, data coding focuses on accurately describing shift variables. Validated methodological tools (MMAT or Joanna Briggs Institute) will be used for this purpose, depending on the design of each study.

Finally, some limitations related to the methodological decisions of the protocol should be considered. The exclusive selection of PubMed and Scopus databases, although justified by their biomedical and multidisciplinary coverage, may restrict the inclusion of relevant studies indexed in specialized sources such as EMBASE, PsycINFO, or Web of Science, particularly in areas like ergonomics, mental health, or operational management. Similarly, the deliberate exclusion of gray literature, including technical reports, regulatory documents or studies produced by government agencies and professional bodies, may reduce the capture of applied evidence produced in real operational contexts and partially limit the transferability of the findings.

Regarding the defined time range (from 2015 to 2025), this was selected with the aim of capturing recent literature, corresponding to a period marked by significant transformations in the approach to shift work. From 2015 onwards, scientific evidence has shown a shift towards more integrative and multidimensional approaches, which consider multiple characteristics of the shift system and its interaction with various health, safety, and work performance outcomes, as highlighted by the review of Dall'Ora et al. [10]. Likewise, this period coincides with the growing adoption of fatigue risk management models, especially in sectors such as transportation, healthcare, and mining, which have promoted the transition from prescriptive regulations to more flexible frameworks based on risk analysis [11,30,31]. In parallel, the use of technologies applied to labor monitoring has intensified, including biomathematical shift modeling and continuous feedback tools [11,31], as well as real-time drowsiness detection systems, particularly in driving and transportation contexts [32]. These innovations have facilitated a more dynamic and contextualized management of fatigue-associated risks.

On the other hand, it is important to consider that the applicability of the findings may be influenced by the geographical, regulatory and cultural differences that characterize the contexts in which shift systems are implemented. There are significant variations between countries in relation to labor regulation, working time organization and operational practices in the transport sector. All this could affect both the outcomes observed and the feasibility of applying certain recommendations. In this sense, future research with international comparative approaches could provide valuable evidence to understand how these contextual factors modulate the effects of shift work.

Additionally, a high methodological heterogeneity is anticipated among the included studies, both in their designs (cross-sectional, cohort, case-control) and in the way shift variables and outcomes are defined and measured. This diversity can make direct comparison of results difficult and limit the identification of consistent patterns. Additionally, there is a potential risk of bias in the primary studies, such as self-selection, reporting, or publication bias, which will be carefully considered when interpreting the findings.

CONCLUSION

This review will contribute to a more accurate, structured, and contextualized understanding of shift work variables in the transportation sector and their relationship to relevant health, safety, productivity, and welfare outcomes. By mapping these relationships in different operational contexts, it will inform regulatory decisions and guide both the design of interventions and the updating of labor and occupational health regulations. Furthermore, its findings are expected to serve as a basis for integrating physiological and psychosocial evidence into existing regulatory frameworks, thus facilitating the adoption of safer and more sustainable shift schedules for land, air and maritime transport workers, including their potential integration into fatigue risk management systems and other organizational prevention strategies.

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Anexos <https://osf.io/s2guc/>

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REFERENCES

1. Castellucci HI, Altamirano I. Changing the shift system in a mining company: An intervention study. *Hum Ftrs & Erg Mfg Svc*. 2018;28: 81–89. <https://onlinelibrary.wiley.com/toc/15206564/28/2> <https://doi.org/10.1002/hfm.20725>
2. Knutsson A. Methodological aspects of shift-work research. *Chronobiol Int*. 2004;21: 1037–1047. <https://doi.org/10.1081/LCBI-200038525>
3. Kervezee L, Kosmadopoulos A, Boivin DB. Metabolic and cardiovascular consequences of shift work: The role of circadian disruption and sleep disturbances. *Eur J Neurosci*. 2020;51: 396–412. <https://doi.org/10.1111/ejn.14216>
4. Silva A, Silva A, Duarte J, Torres da Costa J. Shift-work: a review of the health consequences. *IJOES*. 2020;4: 48–79. https://ijooes.fe.up.pt/issue/view/2184-0954_004.002 https://doi.org/10.24840/2184-0954_004.002_0005
5. Vantola P, Puttonen S, Karhula K, Oksanen T, Härmä M. Prevalence of shift work disorder among hospital personnel:

- A cross-sectional study using objective working hour data. *J Sleep Res.* 2020;29: 1–8. <https://doi.org/10.1111/jsr.12906>
6. Vanttola P, Härmä M, Viitasalo K, Hublin C, Virkkala J, Sallinen M, et al. Sleep and alertness in shift work disorder: findings of a field study. *Int Arch Occup Environ Health.* 2019;92: 523–533. <https://doi.org/10.1007/s00420-018-1386-4>
7. Lee S, Chae CH, Park C, Lee HJ, Son J. Relationship of shift work with endoscopic gastritis among workers of an electronics company. *Scand J Work Environ Health.* 2020;46: 161–167. <https://doi.org/10.5271/sjweh.3862>
8. Caldwell JA, Caldwell JL, Thompson LA, Lieberman HR. Fatigue and its management in the workplace. *Neurosci Biobehav Rev.* 2019;96: 272–289. <https://doi.org/10.1016/j.neubiorev.2018.10.024>
9. Garde AH, Begtrup L, Bjorvatn B, Bonde JP, Hansen J, Hansen ÅM, et al. How to schedule night shift work in order to reduce health and safety risks. *Scand J Work Environ Health.* 2020;46: 557–569. <https://doi.org/10.5271/sjweh.3920>
10. Dall'Ora C, Ball J, Recio-Saucedo A, Griffiths P. Characteristics of shift work and their impact on employee performance and wellbeing: A literature review. *Int J Nurs Stud.* 2016;57: 12–27. <https://doi.org/10.1016/j.ijnurstu.2016.01.007>
11. Gurubhagavatula I, Barger LK, Barnes CM, Basner M, Boivin DB, Dawson D, et al. Guiding principles for determining work shift duration and addressing the effects of work shift duration on performance, safety, and health: guidance from the American Academy of Sleep Medicine and the Sleep Research Society. *J Clin Sleep Med.* 2021;17: 2283–2306. <https://doi.org/10.5664/jcsm.9512>
12. Harris R, Kavaliotis E, Drummond SPA, Wolkow AP. Sleep, mental health and physical health in new shift workers transitioning to shift work: Systematic review and meta-analysis. *Sleep Med Rev.* 2024;75: 101927. <https://doi.org/10.1016/j.smrv.2024.101927>
13. Xu M, Song Y, Lan C, Xu Y, Liu X, Dong S, et al. Extended-duration work shifts among care workers: a scoping review protocol. *BMJ Open.* 2024;14. <https://doi.org/10.1136/bmjopen-2024-087389>
14. Cheyrouze M, Barthe B. Designing shift work: Proposal for a participatory approach deployed in a hospital setting and focusing on actual work. *Appl Ergon.* 2023;106: 103901. <https://doi.org/10.1016/j.apergo.2022.103901>
15. Ferguson SA, Dawson D. 12-h or 8-h shifts? It depends. *Sleep Med Rev.* 2012;16: 519–528. <https://doi.org/10.1016/j.smrv.2011.11.001>
16. Schönfelder E, Knauth P. A procedure to assess shift systems based on ergonomic criteria. *Ergonomics.* 1993;Available: 37–41. <http://www.tandfonline.com/doi/abs/10.1080/00140139308967856>
17. Fischer D, Lombardi DA, Folkard S, Willetts J, Christiani DC. Updating the “Risk Index”: A systematic review and meta-analysis of occupational injuries and work schedule characteristics. *Chronobiol Int.* 2017;34: 1423–1438. <https://doi.org/10.1080/07420528.2017.1367305>
18. Peters MDJ, CM GodfreyMcInerneyPThe Joanna Briggs Institute Reviewers’ Manual 2015: Methodology for JBI scoping reviews. Joanne Briggs Inst. 2015; 1–24.
19. Tricco AC, Lillie E, Zarin W, O’Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169: 467–473. <https://doi.org/10.7326/M18-0850>
20. Reynolds AC, Ferguson SA, Appleton SL, Crowther ME, Melaku YA, Gill TK, et al. Prevalence of Probable Shift Work Disorder in Non-Standard Work Schedules and Associations with Sleep, Health and Safety Outcomes: A Cross-Sectional Analysis. *Nat Sci Sleep.* 2021;13: 683–693. <https://doi.org/10.2147/NSS.S301493>
21. Honn KA, VAN Dongen HPA, Dawson D. Working Time Society consensus statements: Prescriptive rule sets and risk management-based approaches for the management of fatigue-related risk in working time arrangements. *Ind Health.* 2019;57: 264–280. <https://doi.org/10.2486/indhealth.SW-8>
22. Åkerstedt T, Kecklund G. What work schedule characteristics constitute a problem to the individual? A representative study of Swedish shift workers. *Appl Ergon.* 2017;59: 320–325. <https://doi.org/10.1016/j.apergo.2016.09.007>
23. Åkerstedt T. Shift Work - Sleepiness and Sleep in Transport. *Sleep Med Clin.* 2019;14: 413–421. <https://doi.org/10.1016/j.jsmc.2019.07.003>
24. Davidović J, Pešić D, Antić B. Professional drivers’ fatigue as a problem of the modern era. *Transportation Research Part F: Traffic Psychology and Behaviour.* 2018;55: 199–209. <https://doi.org/10.1016/j.trf.2018.03.010>
25. Viviani CA, Bravo G, Lavallière M, Arezes PM, Martínez M, Dianat I, et al. Productivity in older versus younger workers: A systematic literature review. *Work.* 2021;68: 577–618. <https://doi.org/10.3233/WOR-203396>
26. Bravo G, Viviani C, Lavallière M, Arezes P, Martínez M, Dianat I, et al. Do older workers suffer more workplace injuries? A systematic review. *Int J Occup Saf Ergon.* 2022;28: 398–427. <https://doi.org/10.1080/10803548.2020.1763609>
27. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. *Syst Rev.* 2016;5. <https://doi.org/10.1186/s13643-016-0384-4>
28. McKeown S, Mir ZM. Considerations for conducting systematic reviews: evaluating the performance of different methods for de-duplicating references. *Syst Rev.* 2021;10. <https://doi.org/10.1186/s13643-021-01583-y>
29. Hong Q, Pluye P, Fàbregues S, Bartlett G, Boardman F, Cargo M, et al. Mixed Methods Appraisal Tool (MMAT): User guide. McGill. 2018; 1–11.
30. Gärtner J, Rosa RR, Roach G, Kubo T, Takahashi M. Working Time Society consensus statements: Regulatory approaches to reduce risks associated with shift work-a global comparison. *Ind Health.* 2019;57: 245–263. <https://doi.org/10.2486/indhealth.SW-7>
31. Sprajcer M, Thomas MJW, Sargent C, Crowther ME, Boivin DB, Wong IS, et al. How effective are Fatigue Risk Management

- Systems (FRMS)? A review. *Accid Anal Prev.* 2022;165: 106398. <https://doi.org/10.1016/j.aap.2021.106398>
32. Cori JM, Manousakis JE, Koppel S, Ferguson SA, Sargent C, Howard ME, et al. An evaluation and comparison of commercial driver sleepiness detection technology: a rapid review. *Physiol Meas.* 2021;42: 074007. <https://doi.org/10.1088/1361-6579/abfbb8>

Protocolo de revisión panorámica sobre variables del trabajo por turnos asociadas a salud, seguridad, productividad y bienestar de trabajadores del transporte terrestre, aéreo y marítimo de carga y pasajeros

RESUMEN

INTRODUCCIÓN El trabajo por turnos es una organización del tiempo laboral, que expone a los trabajadores a horarios fuera del esquema diurno convencional. Diversas investigaciones han demostrado su asociación con trastornos del sueño, enfermedades crónicas, afectación del bienestar y disminución del rendimiento. No obstante, no existe un consenso en la literatura sobre qué variables específicas del turno son relevantes para estudiar estos efectos. Ello dificulta la comparación entre estudios y la formulación de recomendaciones basadas en evidencia.

OBJETIVO Explorar qué variables del trabajo por turnos han sido investigadas en la literatura científica en relación con la salud, productividad, seguridad y bienestar de los trabajadores del transporte terrestre, aéreo y marítimo, en servicios de carga y pasajeros.

MÉTODOS Se llevará a cabo una revisión panorámica conforme a las directrices *Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews* (PRISMA-ScR) y a la metodología del Instituto Joanna Briggs. La búsqueda se realizará en las bases de datos PubMed y Scopus, incluyendo artículos en inglés y español publicados entre 2015 y marzo de 2025. Dos revisores seleccionarán de forma independiente los títulos, resúmenes y textos completos en la plataforma Rayyan. Luego, extraerán la información relevante mediante una plantilla estandarizada. Además, se evaluará la calidad metodológica de los estudios incluidos utilizando herramientas validadas como *Mixed Methods Appraisal Tool* (MMAT) o las herramientas de evaluación crítica del Instituto Joanna Briggs. Los resultados serán sintetizados de forma narrativa, identificando patrones conceptuales, metodológicos y contextuales. Además de la síntesis narrativa, se realizará un análisis estructurado que permita mapear de manera sistemática las relaciones entre las variables del turno y los desenlaces considerados (salud, seguridad, productividad y bienestar). Para ello, cada variable será codificada y categorizada según el marco conceptual adoptado, registrando su frecuencia de aparición y el sector laboral en el que ha sido estudiada. Esta codificación se utilizará para elaborar una matriz analítica que cruce variables y desenlaces, identificando patrones, vacíos y redundancias en la literatura. Los resultados de este análisis se presentarán en formato tabular y gráfico, lo que facilitará la comparación entre estudios y la visualización integrada de la distribución sectorial de la evidencia.

RESULTADOS ESPERADOS Se espera que esta revisión contribuya a mejorar la claridad conceptual y metodológica en el estudio del trabajo por turnos, ofreciendo una base sólida para futuros diseños de investigación, comparaciones entre estudios e intervenciones basadas en evidencia. Los hallazgos serán relevantes tanto para investigadores como para responsables de políticas laborales y salud ocupacional.



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