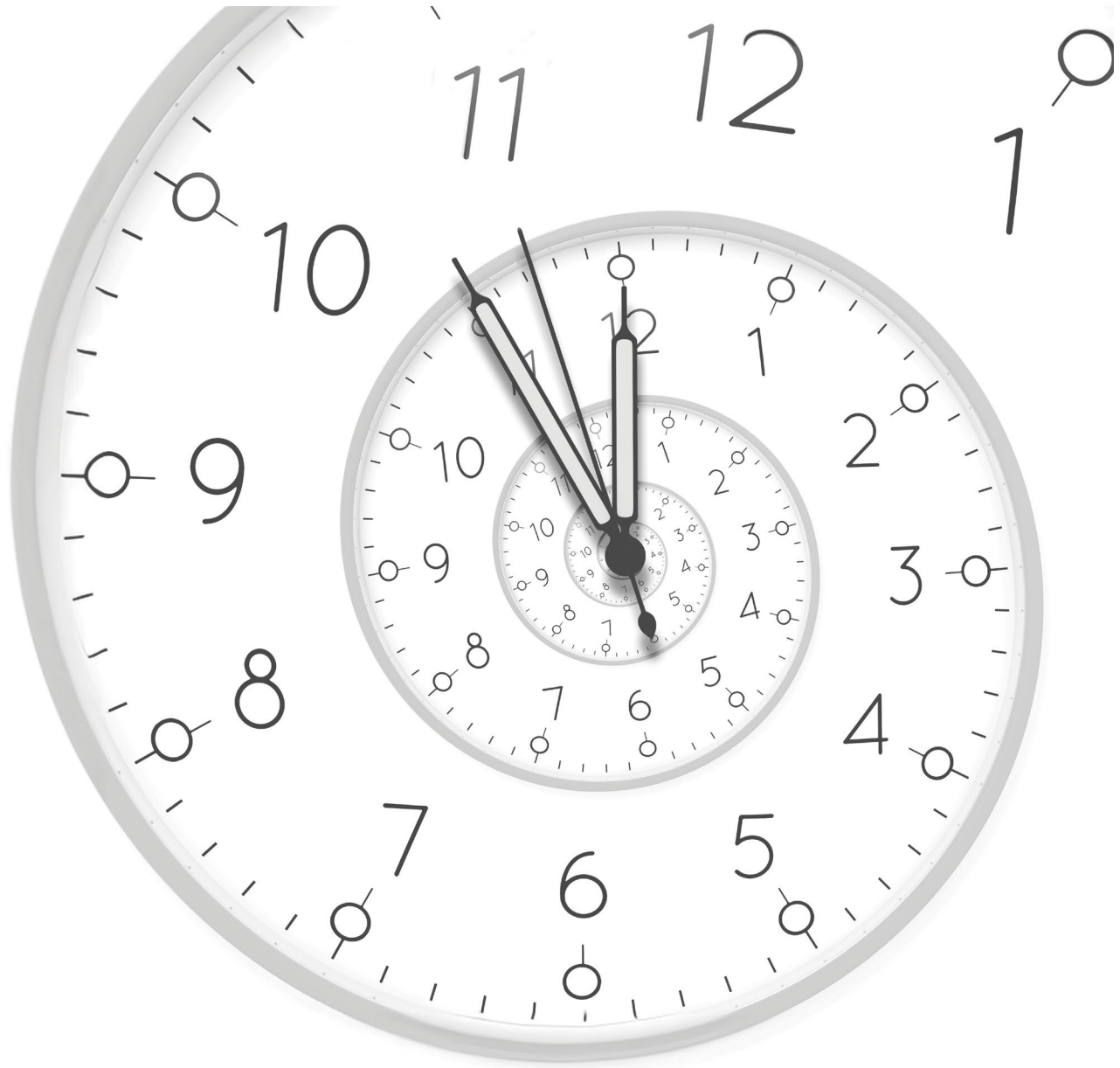




CANADIAN
FEDERATION
OF NURSES
UNIONS



FULL REPORT

December 2023

Safe Hours Save Lives!

Study on Safe Working Hours for Nurses

Dr. Heather Scott-Marshall



Canadian Federation of Nurses Unions

About the CFNU

The CFNU is Canada's largest nurses' organization, representing 250,000 frontline unionized nurses and nursing students in every sector of health care — from home care and long-term care to community and acute care — and advocating on key priorities to strengthen public health care across the country.



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ISBN
ISBN: 978-1-990840-10-4 (print)
978-1-990840-09-8 (digital)

French ISBN
978-1-990840-14-2 (print)
978-1-990840-15-9 (digital)

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MESSAGE FROM LINDA SILAS, CFNU PRESIDENT

Nurses have been grappling with endemic burnout and work overload. They are being asked to work excessive overtime more than ever before. In 2022, nurses who worked overtime worked an average of 8.2 extra hours on top of their regular shifts per week – an increase of almost two full hours since 2000.

As a result, nurses are enduring continuous shifts as long as 16 to 24 hours, with consequences that extend far beyond the workplace. Over the course of the pandemic, the CFNU has surveyed nurses and found that up to 94% of nurses said they had been experiencing symptoms of burnout, with 45% experiencing severe burnout. Many have been pushed to the brink and forced to make the painful decision to leave the workplace. Some have sought refuge in private agencies, straining our public health system further, while others have chosen to leave the profession entirely. Far too many nurses are understandably worried about the safety of their patients and their own well-being.

In response to these pressing issues, the Canadian Federation of Nurses Unions (CFNU) commissioned Dr. Heather Scott-Marshall, President and Scientific Director of Mission Research, to prepare a research report addressing the critical need for safe work hours for nurses. This report draws from existing evidence in the literature, jurisdictional approaches and invaluable insights from nurses and subject matter experts. I would like to extend my heartfelt appreciation to Dr. Scott-Marshall and the CFNU's advisory committee for this project: Dewey Funk (United Nurses of Alberta), Justin Hiltz (Nova Scotia Nurses' Union), Tarya Morel (British Columbia Nurses' Union), Bridget Whipple (formerly with the Manitoba Nurses Union) and Arun Shrichand (CFNU).

I spoke recently to an experienced frontline nurse, who told me about the long hours she's being asked to work. She said that "around hour 20" she started to get confused. How can anyone be expected to function after over 20 straight hours on the job?

The findings confirm what many of us feared: excessive hours of continuous work have a profound impact on nurse fatigue. Research shows that fatigue is similar to the effects of alcohol intoxication, and it poses long-term health risks such as high blood pressure, heart disease and diabetes. Furthermore, it has been linked to work-related injuries in nurses, contributing to absenteeism that costs our health care system nearly a billion dollars annually.

Moreover, there is a growing body of evidence linking fatigue to safety incidents in health care. Canadian data demonstrates that the rate of hospital harm has increased from pre-pandemic rates, with one in 17 hospital stays involving at least one harmful event.

The imperative is clear: we owe it to our health care system to proactively address nurse fatigue. It's a question of safety and respect!

Federal, provincial and territorial governments must establish legislation and regulatory limits on consecutive work hours for nurses, mirroring the safeguards already in place for other safety-sensitive industries. Pilots, for example, have regulations in place stating their maximum duty period is 13 hours. A plane is rightly delayed in the event this threshold is breached. The safety of passengers matters. So should the safety of patients.

Employers need to devote resources to implementing formal programs of fatigue risk management. They must cultivate a work environment where nurses feel comfortable to identify fatigue-related incidents, errors or near misses. They should have provisions in place to support nursing staff such as duty-free rest breaks that feature a designated quiet area for napping, as well as safe third-party transportation options for nurses who are too fatigued to drive home after their shifts. I would do the same for you if you were at my house and had consumed an excessive amount of alcohol! This is my civic duty. Today nurses are pushing for fatigue to have a similar level of accountability, making nurse and patient safety a fundamental obligation.

As nurses' unions, we are deeply committed to pursuing the best practices outlined in this research report. As we negotiate collective agreement provisions, our aim is to promote high-quality practice environments that prioritize the well-being of nurses and patient safety.

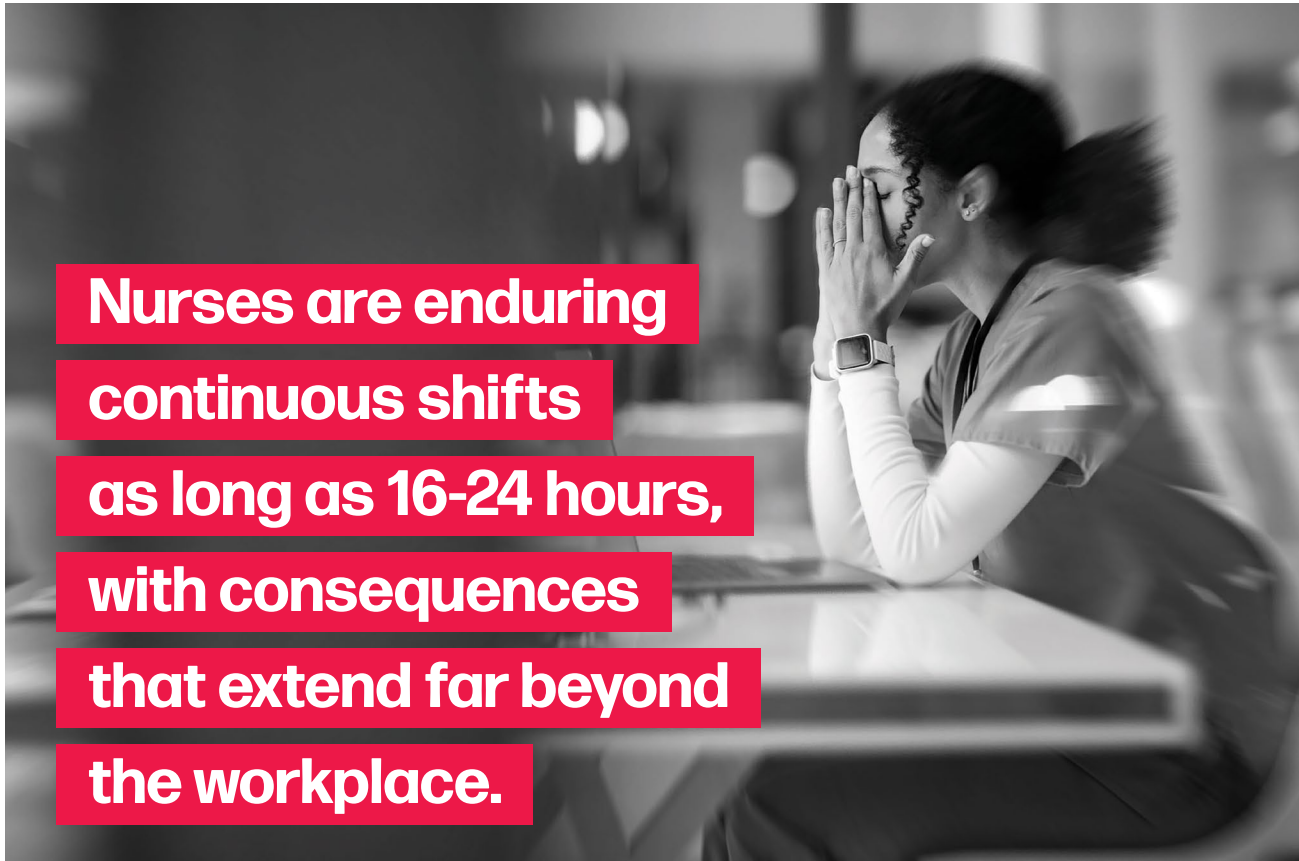
Lastly, I ask nurses to always take steps to ensure adequate rest and sleep prior to starting your shift. If there is a fatigue-related risk that poses a threat to your own safety or that of your patient, I encourage you to voice your concerns. The provincial professional responsibility form is one occupational health and safety process that allows you to report these issues.

Together, let's recognize the profound challenges and work collaboratively towards a safer, more sustainable future for nurses, patients and our beloved public health care system.

In solidarity always,



Linda Silas
CFNU President



SUMMARY OF FINDINGS

The purpose of Phase 1 of the study was to undertake a comprehensive review of the scientific literature regarding the effects of long work hours on key occupational health and safety outcomes, namely: risk of accident or injury at work, impacts to organizational culture and cohesion among work peers, and individual health-related effects. A second component involved an environmental scan of cross-jurisdictional policies and practices with respect to work hours and scheduling, with a focus on safety-sensitive industries, including health care. Phase 2 of the research comprised interviews with key informants to garner first-hand accounts and expertise with respect to work hours safety in nursing and health care.

Key findings from the Phase 1 review and synthesis of the literature

- From a human factor's standpoint, there is a neurophysiological limit to the number of hours that an individual can safely work.
- OHS risk analytics across multiple work contexts, including health care, show that, on average, the risk of safety incident increases exponentially following the 8th consecutive hour of work; by 12 hours the risk of safety incident doubles, and by 16 hours the risk can be as high as three-fold.
- Risk of safety incident increases with each successive work shift, increasing by as much 50% by the fourth 12-hour shift.
- Shift timing constitutes a significant factor in OHS risk, with night shifts generally associated with higher risk of safety incident; in particular, the window of circadian low (WOCL) occurs between roughly 2:00 am and 6:00 am and is associated with incremental safety incident risk.
- Weekly work hours burden has a significant impact on OHS outcomes, with more than 40 hours of work per week associated with increased risk of adverse effects.
- Individual factors can exacerbate fatigue risk and should be monitored; these include age, biological sex, health status, and individual circumstances that may affect the quality and duration of sleep. Organizational-level factors affecting fatigue risk are the intensity of work, including the level of mental and physical demands, and the structure of the work schedule (e.g., whether this includes extended shifts, rotating/night shifts, and adequacy of break times for rest and recovery).
- Fatigue-related risks of extended shifts (12+ hours) may transcend the workplace setting; in particular, drowsy driving has been shown to increase the risk of a motor vehicle accident during the home commute.
- Excessive work hours and fatigue within work teams can contribute to the breakdown of cohesion and civility among work peers.
- Long work hours and shift work can contribute to proximate adverse health outcomes such as mood and sleep disorders; in the longer term, excessive work hours have been shown to be associated with a range of chronic conditions, including cardiovascular disease, metabolic disorders and cancer.

Key findings from Phase 2, based on the expertise and recommendations of key informants

- In most cases, 12 hours should be considered the safe maximum for shift length; all informants, including frontline nurses, agreed that although 16-hour work shifts have become more common in practice and are stipulated within some collective agreements as the de facto “safe” maximum, for most nurses extending shifts beyond 12 hours represents a period of high risk wherein nurses are, in fact, “too tired to [do your] work.”
- There was consensus across informants that employing strategies for actively monitoring fatigue in nurses should be considered best practice; in particular, informants supported implementation of formal programs of fatigue risk management (FRM) that include “fitness for duty” assessments like those used in other safety-sensitive professions such as transportation, aviation and nuclear.
- There was broad agreement across informants that effectively mitigating fatigue in nurses requires that employers recognize their obligation to support nursing staff with key worksite provisions, namely: duty-free rest breaks that include a designated quiet space for napping; fresh nutritious food (particularly for nurses who lack access to cafeteria services during overnight shifts); and safe third-party transportation home post-shift for nurses too fatigued to drive.
- All informants expressed support for implementation of formal legislated protections to ensure safe work hours for nurses; in particular, they understood health care as a safety-sensitive industry with an obligation in the protection of public/patient safety through mitigating fatigue-related risk among staff. In turn, the general view held by informants was that health care requires “a framework and conditions” for safe work hours safety similar to those which are currently operative within the aviation, transportation and nuclear industries.



RECOMMENDATIONS

Based on the collective body of findings across each major research phase, to follow are evidence-informed recommendations with respect to work hours scheduling and mitigation of fatigue-based risk.



1. Legislation/regulations

That federal, provincial and territorial governments prioritize and address issues of long hours of work in nursing by:

- Stopping the practice of mandating nurses to work overtime.
- Introducing legislation/regulations governing work hours, that set restrictions on each of: number of consecutive work hours (recommended maximum is 12 hours); number of successive work shifts (recommended maximum is four); minimum periods for recovery between shifts (recommended minimum is 11 consecutive hours of rest).
- Instituting legislated/regulatory requirements that include mandatory use of comprehensive fatigue management programs.



2. Occupational health and safety

That employers and unions prioritize and address issues of long hours of work in nursing by:

- Adopting international standards for managing risks related to fatigue, such as those provided by the ISO 45001 occupational health and safety management system. Employers should build on these standards and adopt fatigue mitigation provisions such as designated napping spaces, fresh food for nurses on extended or overnight shifts, and providing nurses' transportation home post-shift.
- Lessening workload when a nurse's shift surpasses 12 hours and during the window of circadian low (WOCL) (between roughly 2:00 am and 6:00 am).
- Monitoring individual factors affecting fatigue such as age, health status and personal circumstances.

3. Hours of work/scheduling



That employers and unions prioritize and address issues of long hours of work in nursing by:

- Looking to establish thresholds during the collective bargaining process that include a maximum shift duration of 12 hours, ensuring nurses work no more than 40 hours per week on average, requiring no more than three to four consecutive work shifts lasting 10-12 hours, especially night shifts. Beyond these thresholds, heightened monitoring of fatigue must be considered mandatory for employers.
- Ensuring that labour management policies include protocols for fatigue management.

This report also offers the following considerations.

- Individual factors can exacerbate fatigue such as age, health status and personal circumstances that can affect sleep habits and should be monitored.
- Consider ways to restrict the number of rotating shifts. Solutions could include incentivizing a portion of staff to permanent nights; or, alternatively, implement rotations in accordance with a *fast rotation schedule* — e.g., 2 days/2 nights, including a minimum of two days off between rotations. Shift sequences should be structured in a forward rotation (i.e., day, evening, night).
- Best practice in work scheduling for nurses should include protocols for fatigue management (FAID, fatigue risk management systems) involving self-auditing of fatigue levels using objective measures (e.g., Karolinska Sleepiness Scale) and implement standards in fitness for duty as currently required in safety-critical industries such as transport, nuclear and aviation.
- Broad FRM programs should include education and training regarding the dangers of work-related fatigue, how to recognize fatigue in oneself and in one's work peers, as well as best practices for sleep hygiene (e.g., adopting a regular sleep-wake schedule, ensuring a minimum of six hours of sleep, engaging in physical exercise regularly, avoiding the over-consumption of caffeine during a shift).



**There are no
federal or provincial
regulations governing
the work hours of nurses.
Other industries have safeguards.**

BACKGROUND

For decades, nurses in Canada have been confronted with serious and mounting challenges to providing high-quality patient care. Years of health care underfunding, coupled with manifold failures in human resources planning that have lacked a complete vision of the consequences of population aging, have each converged to produce a crisis in health care settings and working conditions for nurses. A long-standing driver of the crisis has been chronic staffing shortages, which has fed into longer work hours, untenable increases in workload assignments, toxic workplaces and clinical burnout. The onset of the COVID-19 pandemic functioned to exacerbate pre-existing challenges in health care settings; in turn, since 2020 — the first year of the pandemic — we have seen a spike in the proportion of nurses who have chosen to either change jobs or leave the profession altogether. Among those who have changed jobs, many have opted to work for private agencies with severe implications for the long-term viability of the public system.

A survey undertaken by the Canadian Federation of Nurses Unions in February 2022 found that more than half (53%) of nurses were considering leaving their current position within the coming year. Reasons cited for leaving included burnout, stress and poor working conditions due to insufficient staffing levels. The shortage of nurses has become a major concern for health care systems across Canada, with many hospitals and long-term care facilities struggling to maintain adequate staffing levels. Data from Statistics Canada show that, between 2018 and 2023, job vacancies in nursing increased three-fold from 14,245 to 44,350, indicating that staffing deficiencies will be very difficult to remedy in the near term.

A major externality of the massive and growing staffing shortfalls in health care has been heightened pressure on nurses to work more hours. Whether or not explicit (e.g., in the form of mandatory overtime), there exists a pervasive expectation on the part of health care authorities and employers that nurses should “step into the breach” by working more shifts and longer hours. Scheduled shifts can be up to 16 hours long and are less likely to follow the traditional pattern of day, evening and night shifts. For example, although 12-hour shifts typically start at 7:00 am and end at 7:00 pm, nurses may be asked to work shifts starting at 3:00 pm until 3:00 am, depending on the staffing contingencies within particular unit. Nurses working within specialized units such as surgery, dialysis or intensive care are often required to be available to work extra hours in addition to working their regularly scheduled shifts. Twenty-four-hour shifts are becoming increasingly common, particularly in emergency rooms, where staffing shortages are especially acute. These scheduling practices are taking hold despite evidence that wakeful periods lasting 24 hours or more can slow cognitive and physical response time to the equivalent of a blood alcohol level that exceeds the legal standard for operating a motor vehicle (Scott, Rogers, Hwang, & Zhang, 2006). In fact, in sharp contrast to the growing body of evidence on the effects of excessive work hours on occupational fatigue-related risks, the practice of demanding more work hours from a shrinking cohort of nurses has become a mainstay within health care settings struggling with ongoing staffing shortages.



PHASE 1: REVIEW AND SYNTHESIS OF SCIENTIFIC STUDIES ON LONG WORK HOURS AND OCCUPATIONAL FATIGUE

Purpose and methods

The present review has two major objectives: 1) to identify policies and practices that may be effective in managing or forestalling the adverse consequences of occupational fatigue; and 2) to review and synthesize evidence on the health and human consequences of excessive work hours, work-related fatigue and related OHS risks. Excessive work hours are defined in relation to their potential to increase the risk of occupational fatigue and its consequences in the form of fatigue-based impairment. The review proceeds in two major sections. The first section provides an overview of policies, practices and regulations related to work hours safety in Canada and select peer countries (the US, the EU). The second section contains an overview of existing evidence on excessive work hours, work-related fatigue and fatigue-based impairment. A synthesis of findings from the scientific literature can provide the basis for evidence-informed strategies for managing occupational fatigue within health care settings.

Section 1: Policies and practices regarding long work hours and managing fatigue-based risk in safety-critical industries

The potential impact of long work hours on health and safety is a major concern that has resulted in an increased adoption of regulations across industries (Folkard & Lombardi, 2006). Governments around the developed world have increasingly set limits on work hours in an attempt to minimize the adverse effects of fatigue on occupational health and safety outcomes.

The following review examines regulations on work hours within Canada and Western peers, namely the US and the EU. A search for policies and practices on work hours in Canada is focused within two areas: 1) active regulatory limits enforced by government or other external regulatory body within safety-sensitive industries (e.g., transport, nuclear, aviation, health care); and 2) policies set forth in collective agreements of nurses working within different jurisdictions. Policies regarding safety limits on work hours within the US and the EU are focused on restrictions enforced by regulatory bodies within health care.



Work hours regulations in safety-sensitive industries in Canada

In Canada, certain classes of workers within federally regulated safety-sensitive industries are subject to specific restrictions on work hours. Motor vehicle operations/trucking, rail, nuclear and aviation are each governed by a set of restrictions on work hours to help maintain worker performance, forestall the onset of fatigue and reduce the risk of accidents. The specific policies regarding work hours for each domain are described in turn. In general, work hours regulations focus on three key aspects of the work schedule: 1) total number of consecutive work hours; 2) number of successive [night] shifts; and 3) mandatory minimum periods for recovery.

Motor vehicle operators

Under part III of the *Canada Labour Code* (CLC), motor vehicle operators are governed by the *Motor Vehicle Operators Hours of Work Regulations* (C.R.C., c. 990). Under the classification, motor vehicle operators include city and highway vehicle operators involved in interprovincial and international transport of goods or passengers and in the transport of mail, and bus operators (*Canada Labour Code*, 2023). This category includes commercial vehicles and trucking. The general limits on work hours for each class of worker set forth by the regulations are given in Table 1.

Table 1 – Motor vehicle operators hours of work regulations by class of worker

Class of worker	Standard hours after which overtime is payable DAILY	Standard hours after which overtime is payable WEEKLY	Maximum hours	Mandatory rest period
Highway motor vehicle operators	N/s*	60	13 hours daily	10 hours (8 hours must be consecutive)
City motor vehicle operators	9	45	13 hours daily	10 hours (8 hours must be consecutive)
Bus operators	8	40	13 hours daily	10 hours (8 hours must be consecutive)

*N/s = not specified

Notes: All regulations are based on safety scheduling “Driving South of Latitude 60°N”.

C.R.C. denotes: Consolidated Regulations of Canada.



Railway operating employees

Transport Canada has set limits on work hours to protect the health and safety of railway operators under the *Railway Safety Act*. These types of employees include locomotive engineers, conductors, trainmen, yardmen, pilots, operators of remote-control locomotives and operators of light rail passenger equipment.

Notably, unlike regulations covering motor vehicle operators, legislation regarding work hours limits for railway operators specifically identifies its purpose as “fatigue management” to mitigate “fatigue-related risk that may affect safe railway operations.” Fatigue management is considered a “shared responsibility” between the railway company and the employees. In turn, the term “fit for duty” with respect to work hours limits and rest breaks appears multiple times in the legislation. An objective measure of fatigue/duty-fitness is taken prior to shift periods using the Karolinska Sleepiness Scale (Transport Canada, 2023). Specific directives of the regulations follow in Table 2.

Table 2 - Transport Canada *Railway Safety Act*, work hours provisions for employees

Maximum duty period	Minimum rest period	Other provisions
<ul style="list-style-type: none"> • 12 hours daily • 60 hours weekly 	<ul style="list-style-type: none"> • 12 hours at home terminal • 10 hours away from home terminal • Within each rest period, 8 hours must be undisturbed by the company 	Mandatory fatigue management plan (FMP) to be implemented by all railway companies

Relevant excerpts from the policy as to specific strategies for fatigue management include the following.

- Where an employee’s duty period is scheduled to last more than 10 hours and to end between 00:01 and 06:00, an employee shall report to the railway company, in accordance with the company’s fatigue management plan, that they believe themselves to be fit for duty in accordance with the fatigue self-assessment training provided by the railway company and that they have:
 - Obtained at least five hours of sleep in the 24 hours prior to commencing the duty period;
 - Obtained at least 12 hours of sleep in the 48 hours prior to commencing the duty period; and
 - Assessed themselves as scoring a seven or lower on the Karolinska Sleepiness Scale
- In an effort to achieve maximal mitigation of fatigue-based risk, the policy also explicitly allows for “use of controlled napping protocols,” where appropriate (Transport Canada, 2023).



Nuclear

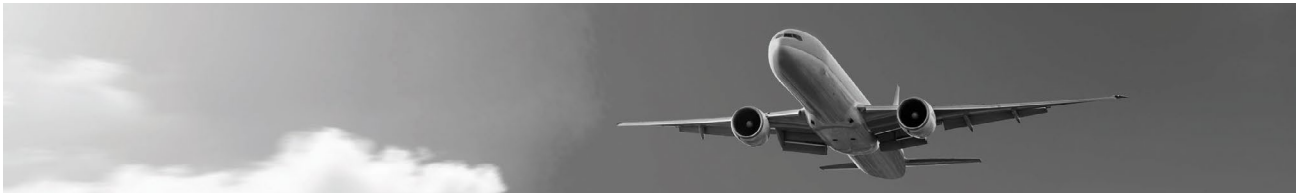
The work hours of employees in the nuclear energy industry are governed by the Canadian Nuclear Safety Commission under the *Nuclear Safety and Control Act* (NSCA). Like the railway industry, regulations for nuclear employees stipulate that the goal is to ensure “fitness for duty” by effectively “managing worker fatigue.” In particular, the regulation requires that nuclear operators shall document and implement limits on hours of work and recovery periods that:

1. Provide sufficient time for sleep daily
2. Restrict consecutive shifts to limit the build-up of sleep debt
3. Provide sufficient time off to allow for recovery from sleep debt
4. Limit average weekly hours as a safeguard against cumulative fatigue

Moreover, nuclear operators must “document the rationale that justifies their limits on hours of work and recovery periods” and “the rationale shall be based on scientific principles and knowledge.” In turn, it is required that all nuclear operators must “define and implement a range of measures to manage risks associated with fatigue, including those to manage the level of fatigue workers experience at work and to reduce the likelihood and consequences of fatigue-related errors” (Canadian Nuclear Safety Commission, 2023). The range of measures recommended for mitigating worker fatigue include: allowing rest periods or an opportunity to sleep, nurturing an environment that includes self-reporting when workers believe they are too fatigued to perform their duties competently and safely; employing additional supervisory oversight and independent verification when the risk of fatigue is highest (e.g., during the night shift, near the end of a shift, working beyond 12 hours); rotating workers between tasks of varying cognitive and physical workloads; and scheduling safety-critical tasks outside of peak times for fatigue (especially between the hours of 2:00 am and 6:00 am — referred to in the research as the “window of circadian low”). Specific limits on work hours as set forth by the NSCA are outlined in Table 3.

Table 3 - *Nuclear Safety and Control Act*, work hours provisions for employees

Maximum duty period	Minimum rest period	Other provisions
<ul style="list-style-type: none"> • 16 hours daily • 60 hours weekly 	<ul style="list-style-type: none"> • 72 hours of rest must follow a block of 4 consecutive night shifts. • 48 hours of rest must follow 2 consecutive night shifts. 	<ul style="list-style-type: none"> • Maximum of 6 shifts on consecutive days • Maximum of 4 consecutive nights for 10- and 12-hour shifts • Maximum of 54 hours per week averaged over a fixed period of 13 weeks • Work shifts are not to exceed 12 hours, especially night shifts



Aviation

Work hours limits for air crews and air traffic controllers are governed by Transport Canada's Canadian Aviation Regulations (CAR). As part of a comprehensive approach to safety management, CAR also requires that all air operators have a fatigue risk management program in place for flight crew members as part of a comprehensive approach to safety management. Table 4 provides an overview of work hours restrictions and mandatory rest periods set forth in the regulation.

Table 4 – Canadian Aviation Regulations, provisions for work hours by class of worker

Category	Maximum duty period	Minimum recovery period	Other provisions
Pilots and flight crew	<ul style="list-style-type: none"> • Flight duty not to exceed period greater than 13 hours in a 24-hour period • For long-range flights operated by unaugmented flight crews and where any part of the flight duty period infringes the window of circadian low (WOCL), no flight may follow a scheduled flight of more than 7 hours • Set maximum of 70 hours in 7 consecutive days 	Must be provided with 120 consecutive hours free from duty, including 5 consecutive local nights' rest in any 504 consecutive hours	Minimum 15-minute break every 6 hours of flight duty
Air traffic controllers	Maximum of 10.5 hours of duty-time in a 24-hour period	Minimum of 3 consecutive days of rest between shifts	34/22 shift cycle, comprised of 34 days of work and 22 days of rest (over a 56-day period); shift cycles consist of 5 days on, 3 days off

The regulations also require that air operators implement a specific protocol for managing fatigue risk in employees — i.e., Fatigue Risk Management System for the Canadian Aviation Industry. The policy stipulates that, among other requirements, employers must provide aviation workers training in each of the following areas: personal fatigue management strategies relating to sleep hygiene, lifestyle, exercise and diet; sleep requirements and the science of fatigue; how to recognize fatigue in themselves and others; awareness of human and organizational factors causing fatigue, such as sleep quality and duration, the impact of shift work and overtime, and the effects of changes in time zones.

Regulations on work hours in health care in Canada

At present, there are no federal regulations governing the work hours of health care employees. The work hours of medical residents, however, are governed through negotiated agreements between the provincial residents' associations (PRAs) and employers. The PRAs currently set limits for residents at between 24 and 26 consecutive work hours; the exception is Quebec, where the maximum is 16 hours. Weekly work hours limits vary widely across provinces at between 60 and 90 hours per week. General regulations and restrictions pertaining to resident duty hours in Canada are outlined in Table 5.

Table 5 – Canadian medical residents' work hours regulations

National regulations	Regulatory oversight	Duty hours restrictions
No	Work hours are currently regulated primarily through negotiated agreements between provincial residents' associations (PRAs) and employers. In future, work may also be regulated via residency accreditation mechanisms.	<ul style="list-style-type: none"> • Variability in maximum hours worked per week (range 60-90 hours) • Limit of 24-26 consecutive duty hours; exception is Quebec (2011), where limit is 16 consecutive work hours • Limit of in-house call once every 4 days, averaged over four weeks • Limit of out-of-house call once every 3 days

Adapted from Pattani, Wu, & Dhalla, 2014

Despite some restrictions on duty hours for medical residents in Canada, for the most part these fail to conform to the evidence regarding safe work hours limits. The exception is Quebec, where since July 1, 2012, residents' time on duty has been restricted to 16 hours due to an arbitration ruling in the province that a 24-hour duty period is a violation of the *Canadian Charter of Rights and Freedoms* and the *Quebec Charter of Human Rights and Freedoms* (Resident Doctors of Canada, 2012). As a consequence, the subsequent agreement negotiated by the *Fédération des médecins résidents du Québec* restricted all medical residents training in Quebec to a 16-hour duty schedule for in-house calls. The Quebec ruling foregrounds the possibility of the broader application to all medical residents in Canada because of its legal basis, namely *Charter of Rights and Freedoms* (Dussault, Saad, & Carrier, 2014). In view of the large body of evidence regarding occupational health and safety risks associated with excessive work hours, duty periods of 24 hours or more consecutive work hours without restorative sleep should be avoided (Pattani et al., 2014).

Like medical residents, currently there is no pan-Canadian limitation on nurses' work hours. Where regulations exist, these are primarily through collective agreements with employers. There are currently dozens of collective agreements in effect within each province, covering a range of nurse practice types — e.g., hospital, community health and long-term care. Table 6 provides an overview of select policies with respect to work hours limits contained within the master agreements for each province.

Table 6 – Work hours provisions within nurses’ collective agreements by province

Province	Maximum duty periods	Mandatory rest periods	Other provisions
British Columbia	<ul style="list-style-type: none"> • No maximum shift length • No more than 6 consecutive shifts (no more than 4 consecutive 12-hour shifts) 	<ul style="list-style-type: none"> • Two rest periods of 15 minutes during a standard shift, three rest periods for shifts of 10 or more hours • 30-minute meal period for each 5 consecutive hours of work • At least one weekend off every 3 weeks 	<ul style="list-style-type: none"> • Right to decline unreasonable overtime, except in emergency conditions
Alberta	<ul style="list-style-type: none"> • Maximum shift length of 16 hours • No more than 6 consecutive shifts • No more than 2 consecutive weekends on duty 	<ul style="list-style-type: none"> • Two 15-minute rest periods and one 30-minute meal break per 7.75-hour shift; additional rest periods for extended shift lengths • At least 15 scheduled hours off duty between 7.75-hour shifts • At least 2 consecutive days of rest • In the case of overtime and call back, 8 hours off in 12 hours preceding the next shift 	<ul style="list-style-type: none"> • Two consecutive days of rest is further defined between shift transitions (e.g., day shift to day shift is 63.75 hours off duty, night to day is 71.75 hours off duty) • Right to refuse unreasonable overtime, except in an emergency
Saskatchewan	<ul style="list-style-type: none"> • No maximum shift length • 15 hours off duty between shifts (12 hours for 12-hour shifts) • No more than 6 consecutive shifts (no more than 4 consecutive 12-hour shifts) 	<ul style="list-style-type: none"> • Two 15-minute rest periods for shifts lasting at least 6 hours • 60 minutes of rest during 12-hour shifts • 2 consecutive days off per week • Minimum of 3 weekends off in a 6-week period 	<ul style="list-style-type: none"> • Right to refuse overtime, except in emergency circumstances

Province	Maximum duty periods	Mandatory rest periods	Other provisions
Manitoba	<ul style="list-style-type: none"> • Maximum shift length of 16 hours • Maximum of 7 consecutive shifts 	<ul style="list-style-type: none"> • Minimum of 15 hours between standard shifts • Minimum of 47 hours off duty during a rotation period 	
Ontario	<ul style="list-style-type: none"> • No maximum shift length • No more than 7 consecutive shifts for standard shifts (7.5 hours) • No more than 3 consecutive shifts for extended tours (11.25 hours) • No more than 4 consecutive shifts for innovative 2 days/2 nights (11.25 hours) rotations • Maximum of 75 hours bi-weekly 	<ul style="list-style-type: none"> • 30-minute unpaid meal break and two 15-minute rest breaks during a standard shift • 45-minute unpaid meal break and another 45-minute paid rest break during extended tours • At least 48 hours off when changing from nights to days • 15 to 16 hours off following standard shift (7.5 hours) • 11 to 12 hours off following extended shift (11.25 hours) 	<ul style="list-style-type: none"> • Right to refuse overtime, except in an emergency • Some collective agreements allow for 8–12 hours off with/without pay after a call back when on standby
Quebec	<ul style="list-style-type: none"> • Maximum shift length of 12 hours • Maximum of 7 consecutive shifts 	Two 15-minute rest periods per shift	
New Brunswick	<ul style="list-style-type: none"> • Maximum shift length of 16 hours (unless due to unforeseen emergency) • Can work no more than 7 consecutive days without day(s) off 	Minimum of 8 hours between shifts	<ul style="list-style-type: none"> • In the event of working over 16 consecutive hours due to unforeseen emergency, employer shall complete documentation before employee begins working • Overtime allowed though no employee shall be required to work a double shift

Province	Maximum duty periods	Mandatory rest periods	Other provisions
Nova Scotia	<ul style="list-style-type: none"> • Maximum shift length of 16 hours • No more than 7 consecutive standard shifts; no more than 4 consecutive extended shifts • No more than 5 consecutive evening or night shifts • Maximum of 75 hours bi-weekly 	<ul style="list-style-type: none"> • Minimum rest period of at least 16 hours between standard shifts (12 hours between extended shifts) • Minimum of 2 days off each week • At least one weekend off every 3 weeks 	Rest interval after call back for nurses working on call, that provides for a rest interval of 8 hours between the time the on-call shift is completed and the commencement of the nurse's next scheduled shift
Prince Edward Island	<ul style="list-style-type: none"> • No maximum shift length • No more than 7 consecutive shifts • No double shifts without employee consent 	<ul style="list-style-type: none"> • Two 15-minute rest periods during each shift • At least 16 hours between shifts (12 hours for 12-hour shifts) • At least 2 consecutive days off each week • Every second weekend off 	No requirement to work double shifts
Newfoundland and Labrador	<ul style="list-style-type: none"> • No maximum shift length • No more than 7 consecutive standard shifts; no more than 6 consecutive evening or night shifts • No more than 3 consecutive 12-hour shifts • Maximum of 75 hours every 2 weeks 	<ul style="list-style-type: none"> • At least 16 hours between shifts (12 hours for 12-hour shifts) • At least 2 consecutive days of rest per week • Two weekends off per month 	No requirement for double shifts

Notably, although five provinces — Alberta, Manitoba, Quebec, Nova Scotia and New Brunswick — stipulate a maximum shift length, only Quebec sets the limit at 12 hours, which the evidence suggests is the safety maximum. Still, Quebec allows for up to a maximum seven consecutive work shifts, which the evidence indicates could be problematic for nurses working extended shifts. Only Nova Scotia and Newfoundland and Labrador have limited the number of consecutive night or evening shifts. Four provinces — British Columbia, Alberta, Saskatchewan and Ontario — have explicitly provided for the right to refuse overtime hours, though New Brunswick, PEI and Newfoundland and Labrador have agreements that stipulate no requirement to work double shifts.

Regulations on work hours in health care in the United States

Like its peer countries, in the United States the work hours of truck drivers, locomotive engineers, and pilots are regulated to protect the public from fatigue-related errors, though hospitalized patients lack similar protection (Page, 2004). At present, there are no restrictions on the number of hours a nurse may voluntarily work in a 24-hour or a seven-day period in the United States, while only minimal restrictions exist on hours worked by physicians (Page, 2004).

As of 2011, recommendations regarding work hours limits on medical residents set by the Accreditation Council for Graduate Medical Education (ACGME) were as follows: a maximum of 16 hours of continuous work for interns, an overall 80-hour workweek limit; maximum shift duration of 24 hours (plus six hours for transitioning care), one day off per week (averaged over a four-week period), and on call no more than once every three nights. Nurses work hours are regulated by jurisdictional governmental agencies known as nursing regulatory bodies (NRB); as such, work hours limits vary by state. It should be noted, however, that none of the jurisdictional restrictions on work hours addresses how long nurses may work on a voluntary basis. An overview of work hours regulations for health care professionals in the US is provided in Table 7.

Table 7 - Work hours regulations for health care professionals, select jurisdictions (United States)

Class of worker	Regulatory body and type of regulation	Maximum work hours in 24 hour period and/or 7 day period	Minimum rest period	Other provisions
Medical residents	No federal regulations	May not work more than 80 hours per week or 24 consecutive hours	Must have at least 10 non-working hours between shifts	No prohibitions on working extra hours (moonlighting)
Registered nurses	No federal regulations	<ul style="list-style-type: none"> • May not work more than 16 hours in any 24-hour period (West Virginia) • No more than 14 consecutive hours on duty (Alaska) • No more than 12 consecutive hours on duty (California, Maine, Massachusetts, Minnesota, New Hampshire, Oregon, Rhode Island) • Limit of 48 hours per week (Oregon) 	<ul style="list-style-type: none"> • If a nurse works after 8 consecutive hours, must be given at least 10 hours off before the next shift (Maine) • If a nurse works after 12 consecutive hours, must be given at least 8 hours off before the next shift (Illinois, New Hampshire) 	Prohibited mandatory overtime (Alaska, California, Illinois, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, Texas, Washington, West Virginia)

In a study of the impact of states' nurse work hours regulations on overtime practices and work hours among registered nurses, Bae & Yoon (2014) found that mandatory overtime and consecutive work hours regulations were associated with a 3.9 percentage point decrease in the likelihood of working overtime mandatorily and an 11.5 percentage point decreases in the likelihood of working more than 40 hours per week, respectively. As such, government instituted mandatory overtime and consecutive work hours policies seem to be effective in reducing nurses' working hours. The consecutive work hours policy appears to be a better regulatory mechanism for limiting work hours for nurses (Bae & Yoon, 2014).

Regulations on work hours in health care in the European Union

Like all safety-sensitive industries in the EU, work hours in health care are regulated in accordance with the European Working Time Directive (EWTD). Instituted in 1993, the EWTD introduced specific measures relating to the scheduling of shifts and rest periods. The objective of these measures was to limit hours worked due to evidence that shift work and excessive work hours can pose a substantial occupational health and safety risk (Harrington, 2001). The work hours of both medical residents and nurses are regulated by the EWTD. The specific requirements of the legislation are given in Table 8.

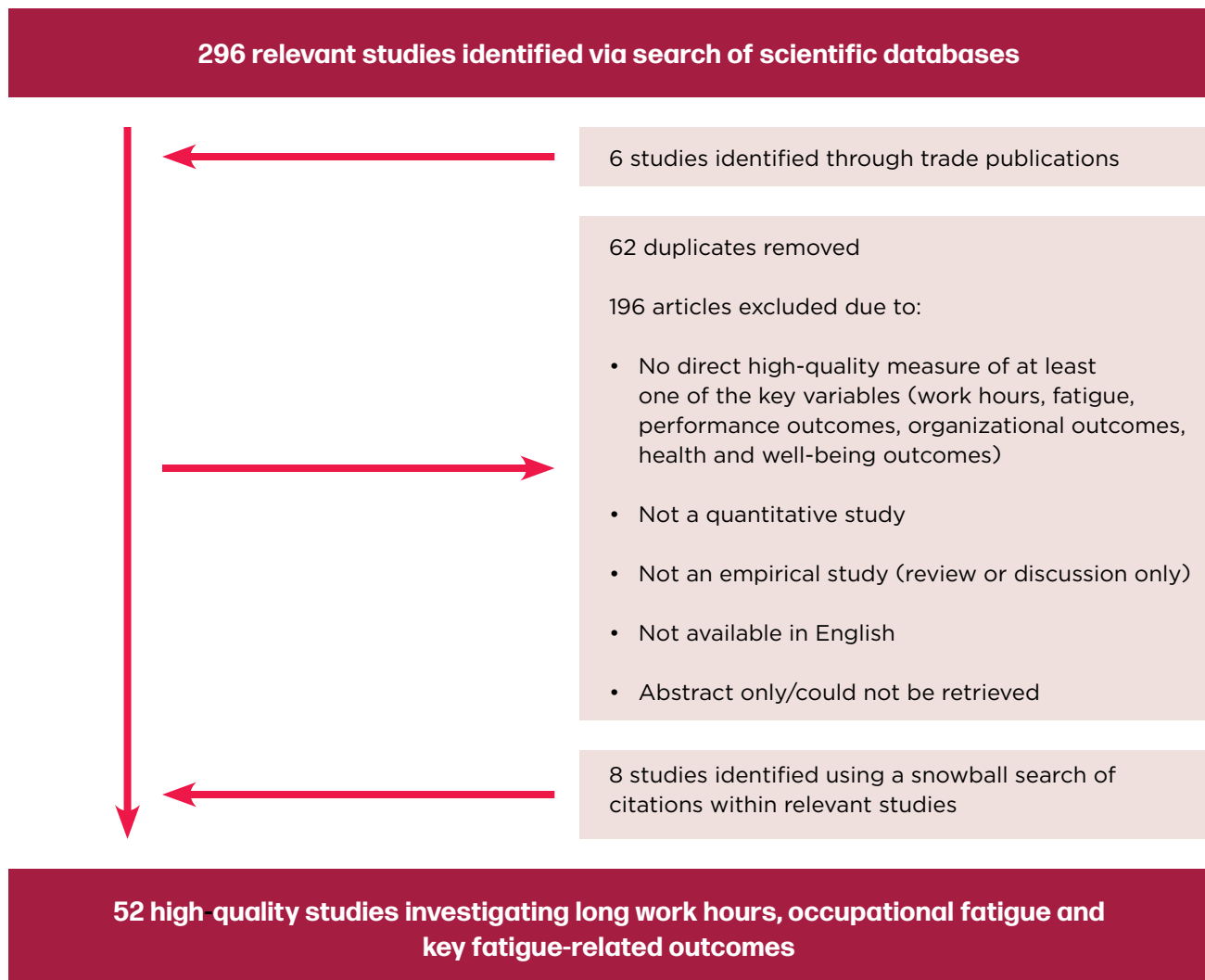
Table 8 – Work scheduling requirements of the European Working Time Directive (EWTD)

Maximum duty hours	Mandatory rest period
<ul style="list-style-type: none"> • Maximum of 8 hours of work if categorized as a night worker • No more than 48 hours per week, including overtime 	<ul style="list-style-type: none"> • 20 minutes of continuous rest every 6 hours • 11 hours of continuous rest in every 24-hour period • Every 7 days a minimum of 24 uninterrupted hours in addition to 11 consecutive hours of rest

Section 2: Review and synthesis of scientific studies on long work hours and occupational fatigue

A comprehensive search of peer-reviewed literature was undertaken drawing on several sources. Scientific databases included: CINAHL, Embase, ProQuest Health, Safety Science Abstracts, Medline, PubMed, Scopus, Web of Science, JSTOR, ScienceDirect, ProQuest (including PsycINFO and Sociological Abstracts), DOAJ (Directory of Open Access Journals), PLOS, and Google Scholar. Focal keywords included: “long/extended work hours”, “shift work”, “rotating shifts”, “work schedule”, “[occupational] fatigue” and “sleep deprivation”. Papers were selected based on their content, relevancy, author and research validity or rigour. Because a key objective of this review is to quantify the effects of excessive work hours and thereby recommend safe work hours limits, only quantitative research articles were considered. With the exception of a handful of early seminal papers on this topic that have cited herein, the review focuses on research published on recent scientific evidence published within the last three decades (since 1990). Some articles were identified during a search for specific authors considered experts within this domain of knowledge. Others were identified through citations and bibliographies of previously accessed professional literature. In all, 52 studies were deemed both relevant and of sufficiently high quality for inclusion in the main review (Figure 1).

Figure 1 – Inclusion criteria



The review of the scientific literature comprises two-layered components based on study type. First, the fundamental drivers of human fatigue are examined drawing on studies from the human factors literature. This research seeks to identify the root causes of fatigue given by basic neurophysiological processes, including circadian function and the homeostatic drive for sleep; such studies provide the basis for understanding how work hours are circumscribed by human biology. The second part of the review examines how excessive work hours give rise to fatigue in specific work contexts, with a focus on safety-sensitive industries, including health care. These studies account for the effects of real-world factors on fatigue-based risk in situ, with implications for occupational safety outcomes at the individual and organizational level.

Human factors research: identifying the fundamental drivers of occupational fatigue

Human factors research is a broad multidisciplinary field that focuses on understanding and optimizing the interaction between humans and aspects of their environment. With respect to work and workplace settings, the goal is to develop work systems that enhance human well-being, performance and satisfaction while minimizing errors, accidents and adverse effects (Vogt, Leonhardt, Köper, & Pennig, 2010).

A key area of human factors research is understanding how to minimize the onset and consequences of work-related fatigue. Broadly, fatigue at work arises from an imbalance between the intensity, duration and timing of work, coupled with an insufficient allotment of time for recovery (Dawson, Ian Noy, Härmä, Åkerstedt, & Belenky, 2011). In real-life work environments, this imbalance is linked to poor scheduling practices that require workers to stay on task for extended periods without sufficient rest-breaks either during or between shifts, and is compounded by high-intensity workloads. From an occupational standpoint, fatigue is commonly described as an individualized experience of lack of energy or tiredness with physical, cognitive and/or psychological manifestations (Sagherian et al., 2018). While there are different dimensions of fatigue (e.g., muscular, mental, psychomotor), human factors studies focus on the condition associated with the “drive to sleep” arising from “neurobiological processes regulating sleep and circadian rhythm” (Dinges, 1995). Fatigue is recognized as a hazard at work due to its association with several sequelae, including diminished cognitive and physical acuity and increased risk of work-related injury or accident (Abe, Mollicone, Basner, & Dinges, 2014; Fan & Smith, 2020; Folkard & Lombardi, 2006; Williamson et al., 2011). In the longer term, occupational fatigue has also been linked with an increased risk of chronic and/or lifestyle-related illness (Chau et al., 2008; Rivera, Akanbi, O’Dwyer, & McHugh, 2020).

Bio-mathematical models of fatigue (BMMF) have been used to isolate the basic human factors that give rise to fatigue among workers across a range of settings. The models are designed around assumptions regarding the interaction of basic neurobiological functions, namely homeostatic drive for sleep and processes of circadian regulation (Abe et al., 2014). Drawing on information related to work/rest patterns, BMMF constitute predictive tools with respect to the level of fatigue associated with different work schedules, and are able to quantify the inferred risk on performance and safety outcomes arising from fatigue (Dawson et al., 2011).

Several studies have used BMMF to evaluate the degree of “hazard exposure” associated with work-related fatigue. These studies quantify the relative risk arising from fatigue across a range of work practices and industry settings. Within health care, a recent study of pediatric hospital nurses used bio-mathematical modeling to examine the association between factors that give rise to fatigue risk and sickness absence outcomes in nurses working extended shifts (Sagherian et al., 2018). Sickness absence is commonly considered an outcome of fatigue and serves as a proxy for general health and well-being (Bültmann, Nielsen, Madsen, Burr, & Rugulies, 2013; Sluiter, de Croon, Meijman, & Frings-Dresen, 2003). Nurses’ work/rest schedules and absenteeism data were extracted from the hospital’s time and attendance system. Fatigue scores were generated using the Fatigue Audit Inter Dyne (FAID) and fatigue/risk index (FRI) software programs. FAID is a bio-mathematical model that has been developed to predict worker fatigue directly from shift schedules. The scale is calibrated such that a fatigue score of 40 represents a standard work schedule of 40 hours per week, Monday to Friday 9:00 am to 5:00 pm. Scores of 80 to 100 represent work-related fatigue arising from 23 to 24 hours of continuous sleep deprivation; scores higher than 120 represent a permanent night shift schedule of six consecutive 12-hour night shifts, with one day off between shifts (Dean, Fletcher, Hursh, & Klerman, 2007).

Findings showed that, compared to a standard 9-to-5 work schedule, for which FAID-fatigue scores typically range between 7 and 40, nurses working 12-hour shifts generated scores of 7 to 154. Moreover, almost one in four (23%) shifts were worked by nurses experiencing very high levels of fatigue (FAID scores of 80 or more, which constitutes the equivalent BAC of 0.05%). Regression analytics found that higher FAID scores were associated with greater likelihood of absence, indicating a dose-response relationship between fatigue and risk of absence. For example, scores of 41 to 79, 80 to 99 and ≥ 100 were predictive of a 38%, 63% and 73% increased risk of absence, respectively. The study provides evidence of the pervasive risk of fatigue in nurses working traditional 12-hour shifts and the implications for worsening staffing shortages due to the significant risk of shift absences (Sagherian et al., 2018).

Bio-mathematical modeling has also identified the risks associated with shift timing in nurses. James et al. (2020) examined differences in predicted cognitive effectiveness among nurses working 12-hour shifts during the day and at night. Nurses' sleep-wake schedules were measured using wrist actigraphy devices with analytics undertaken using SAFTE modelling. Results showed differences in sleep quantity, efficiency and latency based on shift type (day versus night) as well as shift duty (on versus off). The most extreme differences in cognitive effectiveness were observed between shift types, with night shift nurses exhibiting substantial decline — frequently into the “high-risk” zone — throughout their shifts, compared to day shift nurses (James et al., 2020).

Schwartz et al. (2021) used a bio-mathematical approach to predict the effects of duty-hours on performance in surgical residents. Prospective work schedule data of 89 general surgery residents were analyzed over 12 months using the SAFTE-FAST modeling software to predict fatigue risk and performance outcomes. Performance was measured on a standardized “scale of effectiveness”, which has been validated against speed of performance on a psychomotor vigilance task (PVT). In the SAFTE approach, reported measures of effectiveness range from 0 to 100, with a score of 100 indicating peak performance. In keeping with precedence of prior studies which have shown that effectiveness scores below 77 indicate a significant risk for fatigue equivalent to 18.5 hours of continued wakefulness for a fully rested person, or a blood alcohol concentration (BAC) of 0.05 g/dL, Schwartz et al. (2021) set the cut-off criterion for effectiveness in residents at 77 — i.e., operating at 77% of their optimal performance. Findings showed that performance scores decreased with increased shift length; after 16 hours, residents spent over one fourth of their shift (29%) functioning below the critical effectiveness threshold. Introduction of a nap variable into the model found that 90 minutes of napping significantly reduced the predicted percent of time residents spent below the effectiveness criterion, when compared to 30-minute or no-nap conditions. Results suggest that levels of fatigue resulting in depressed performance in surgical residents can be mitigated by including naps during long or overnight shifts (Schwartz et al., 2021).

An earlier study of orthopedic surgical residents used the SAFTE model to predict fatigue and the risk of medical errors (McCormick et al., 2012). Sleep/work schedules were evaluated using a prospective cohort of 27 surgical residents over a period of two weeks. Findings showed that residents were fatigued almost half (48%) of their waking time; moreover, the level of fatigue experienced by residents qualified as “impaired” (fatigue-equivalent BAC of 0.08%) 27% of their time awake. Fatigue in residents was associated with a 22% increased risk of medical errors; residents working night shifts were both more fatigued and exhibited greater risk of medical errors compared to those on day-shift rotations (McCormick et al., 2012).

In a follow-up study, the authors used an experimental methodology to assign orthopedic surgical residents to four types of work shifts: day shift, trauma shift, night shift, and pre-work hours restriction Q3 call (i.e., on call every third night). Work schedule data for each group were collected over a period of 28 days and analyzed using the SAFTE model to simulate fatigue impairment scores.

Significant differences were identified between the four shift types in both daily effectiveness scores and percentage of time spent impaired at work, with residents on day shift performing best (90.3, 0%), followed by trauma shift (82.0, 7.5%), Q3 on-call shift (80.7, 23%), and night shift (68.0, 50%). Residents working night shifts had an average effectiveness score below the critical threshold of 70 and spent fully half of their working time impaired by fatigue. Fatigue countermeasures were found to be highly effective; tests of each of: 30-minute naps before the first night shift and at 3:00 am during the night, replacing 24-hour shifts with 12-hour shifts, sleeping in on off days, and one additional hour of sleep per day for one week found that these measures

improved daily effectiveness scores in the impaired group to 87.1 with time spent working while impaired was reduced to 1.9% (McCormick et al., 2013).

Outside of health care, a recent study of pilots and aircrew employed a bio-mathematical modelling approach to investigate fatigue-related risk during critical periods of flight. Analyses of work schedule data coupled with information on sleep-wake patterns demonstrated two key findings: 1) the relative risk of experiencing fatigue increases linearly with number of consecutive night shifts (from 1 to 13, RR = 23.3%), and 2) there is an exponential relationship between fatigue “hazard” (i.e., the risk of accident or incident arising from fatigue) and the number of critical phases of flight that occur during the window of circadian low (which occurs between 2 am and 6 am). Tests of the effects of fatigue countermeasures, including afternoon naps, found that napping reduced the total fatigue hazard during critical phases of flight from 63% to 43%. Findings from the study help to isolate key neurobiological variables that give rise to fatigue risk, namely: the total number of successive work shifts that occur at night, and the number of critical tasks involving high-intensity work that overlap with a period of diminished circadian function (Rodrigues et al., 2023).

Bio-mathematical models of fatigue in human factors research: synthesis of findings

Human factors studies using a BMMF approach demonstrate the relative risk associated with specific patterns of work/non-work sequences, with a focus on the biological determinants of fatigue. Fatigue risk or hazard refers to the likelihood (probability) of an error/incident and related consequences for a given work context. A key strength of these models is that maximum fatigue levels can be empirically defined such that the pattern of work that results in a work shift with a fatigue score that exceeds a nominal risk threshold is considered unacceptable. Table 1 provides an example of a standardized distribution of model-derived exposure scores with thresholds at different levels of risk.

Table 9 – FAID scores associated with level of fatigue risk

Threat	FAID range	Action
Green	<80	None unless there are clear behavioural indicators, errors or incidents consistent with fatigue
Yellow	80-90	Report and document internally and review and correct if part of a highly consistent pattern of events across the system
Red	90-100	Report and document internally and review and correct if part of a moderately consistent pattern of events across the system
Black	100+	Report and document externally and review and correct immediately

The ‘green zone’ represents an acceptable level of risk that requires minimal hazard controls; the ‘yellow zone’ indicates that risk is moderately elevated but manageable with appropriate interventions; the ‘red zone’ is where risk is high but still considered manageable; and finally, the ‘black zone’ is where risk becomes intolerable and is not considered amenable to mitigation. Using this approach, the total amount of time spent in each zone can be prescribed to a fixed percentage by an internal or external regulatory body (Dawson et al., 2011).

As such, the bio-mathematical modeling of fatigue risk provides a foundational heuristic for developing global standards in fatigue risk management within safety-critical industries. In Australia, for example, the railway industry has used FAID as part of its safety management system (SMS) and set the upper limit of acceptability for shifts at a FAID score between 80 and 90. A handful of other jurisdictions have also adopted fatigue modeling as a part of safety regulation, those include Australia's Civil Aviation Safety Authority (CASA), Australian Maritime Safety Authority (AMSA) and Civil Aviation Authority in the UK, New Zealand and Singapore. Transport Canada has also introduced some fatigue audit tools for aviation workers (Dawson et al., 2011; Transport Canada, 2007).

Based on a review of the empirical literature on BMMF, several critical factors contribute to risk of work-related fatigue that should be actively monitored in shift workers. For example, night shifts are known to increase fatigue risk, particularly where these occur in succession; furthermore, night shifts involving performance of high-intensity work tasks during the window of circadian low (2:00 am to 6:00 am) can accelerate risk of fatigue-related error in an exponential fashion (Rodrigues et al., 2023). In nurses, substantial declines in cognitive effectiveness have been observed among those on regular night shift (James et al., 2020). In turn, researchers have recommended limiting number of night shifts to a maximum of 10 within a 30-day period for any individual, particularly where these involve high intensity tasks during the period of diminished circadian function (Rodrigues et al., 2023). In terms of shift length, evidence from bio-mathematical modeling studies suggests that work periods lasting 12 hours can produce some degree of fatigue risk that should be monitored (Sagherian et al., 2018; Schwartz et al., 2021), while work shifts longer than 16 hours are associated with a drastic increase in the percentage of work time spent in a state of high fatigue risk — i.e., a fatigue-equivalent BAC of 0.05 to 0.08% (McCormick et al., 2012; Schwartz et al., 2021). The risk posed by even traditional 12-hour shifts appears to be cumulative, with additional consecutive shifts linked to greater fatigue and a higher propensity for work absence (Sagherian et al., 2018). Given the normative nature of 12-hour shifts in many industries, including health care, this finding begs the question as to how best to distribute non-work periods (i.e., breaks for rest and recovery) both during and between shifts to mitigate fatigue risk.

This literature also demonstrates the potential effectiveness of fatigue countermeasures as a bulwark against fatigue risk. Napping appears to be one of the most potent modifiers of risk due to fatigue; other effective strategies include setting maximum shift lengths that do not exceed 12 hours, sleeping during days off, and good sleep hygiene practices — e.g., getting at least seven hours of sleep daily, sleeping during darkness and earlier bedtimes (McCormick et al., 2013; Rodrigues et al., 2023; Schwartz et al., 2021). The literature is less clear, however, regarding the impact of rest-breaks during a work shift.

The strengths of the BMMF approach to evaluating fatigue risk are manifold: input data is derived from objective metrics, including work shift schedules (shift timing, duration, time of day) and, in some cases, actigraphy which directly measures workers' sleep-wake cycles; moreover, the model is able to predict neuro-behavioural performance (e.g., psychomotor vigilance task, PVT) and has been validated against laboratory and field studies. In effect, bio-mathematical models provide standardized metrics to support the traditional notion of a work shift being unacceptable because it contains a shift that is too long or has too few hours between subsequent shifts (Dawson et al., 2011). Still, despite these strengths, the approach has some drawbacks that must be conceded. In particular, results are based on averages that do not address the effects of differences at the level of the individual employee. For example, factors such as age, sex, health status and psychosocial determinants of sleep-wake behaviour (e.g., lifestyle choices, family obligations and/or domestic circumstances) can affect fatigue and related risks. At the level of the workplace, factors such as workload, time-on-task, and timing and duration of duty-free rest periods are also relevant. In short, the models may underestimate the impact of work hours on fatigue due to the absence of important contextual information.

Epidemiological studies of health and safety risks arising from overtime and long work hours

There is a large body of epidemiological evidence demonstrating the risk of long work hours across various workplace contexts. In general, these studies are concerned with fatigue arising from a combination of sleep deprivation and circadian disruption, coupled with musculoskeletal strain arising from physical labour. Studies tend to focus on the impacts of occupational fatigue within safety-critical industries such as aviation, transport, mining, heavy manufacturing and health care. Focal outcomes generally fall into one of three categories: 1) risk of workplace safety incident (i.e., accident — including errors — or injury); 2) risk of workplace conflict and lateral violence; and 3) risks to individual health and well-being.

1. The risk of workplace safety incident

There is a large body of evidence studies demonstrating that risk of safety incident may be a function of both total successive work hours and the timing of work. In particular, several high-profile industrial disasters have been attributed, at least in part, to both time of duty and shift length. When the Exxon Valdez ran aground more than three decades ago, a portion of the crew had been awake 18 hours (Alaska Oil Spill Commission, 1990). Likewise, a major contributing factor to the explosion of the Challenger space shuttle has been identified as poor decision-making by mission control staff who had been working through the night (Mitler et al., 1988). Other major system failures (e.g., Three-Mile Island, Chernobyl and the Bhopal chemical plant) have also been at least partly attributed to fatigue and human error (Folkard & Lombardi, 2006; Page, 2004). In health care, an estimated one in 20 patients may be subject to preventable harm while receiving medical treatment (Panagioti et al., 2019). Canadian data show that one in 17 hospital stays involved at least one harmful event (Canadian Institute for Health Information, 2022). At least a portion of iatrogenic incidents is likely due to long work hours and fatigue on the part of health care providers (Rodziewicz, Houseman, & Hipskind, 2023).

Research into the impact of prolonged work hours and the timing of work has quantified the effects of fatigue and associated workplace risks. One notable early study by Folkard (1997) examined the effects of shift timing and duration on the risk of accident in transport operations. The study drew data from multiple earlier studies which were statistically combined to derive an overall trend. Macro analyses confirmed the presence of a circadian rhythm (circa 24-hour) in road accident risk with a major peak at 3:00 am that could not be fully explained by drivers falling asleep at the wheel. Taken alongside sleep propensity data in wakeful subjects, the 3:00 am peak in accident risk was determined to reflect lower performance capabilities during the window of circadian low. Additional spikes in accident risk showed a significant effect of time-on-task (i.e., shift duration). In particular, individuals on duty 12 hours or more exhibited an accident risk exponentially higher than those with shorter work shifts (relative risk [RR] at 12 hours versus eight hours of 2.0 and <1.0, respectively). In turn, a key finding from the study was that the relationship between hours on duty and accident risk follows an exponential curve such that small increases in shift duration are associated with much larger increases in incident risk (Folkard, 1997).

Another early seminal study undertaken by Hänecke et al. (1998) reported a similar observation with respect to the exponential risk of accident beyond the 9th hour of work. The study employed a robust sample of 1.2 million registered accidents among German workers, classified according to both time of day (24 hours) and number of hours at work (1st to 12th hour, >12 hours). Different exposure models were estimated based on relative accident risks calculated from the ratio of accident frequencies to exposure data. In addition to the exponential risk curve associated with work shifts exceeding nine hours, the authors observed a strong and significant interaction effect between number of hours at work and time of day. In particular, with regard to the three “traditional” shiftwork starting times (i.e., 6:00 am, 2:00 pm and 11:00 pm), later start times were associated with a drastic increase in accident risk beyond the 8th hour at work. The authors concluded that the extension of daily work hours to up to 10 hours (excluding rest breaks) can significantly increase the risk of work-related accidents. Moreover, shift timing — particularly when work start times occur later in the day — appear to exacerbate occupational health and safety risks associated with long work hours (Hänecke, Tiedemann, Nachreiner, & Grzech-Sukalo, 1998).

A similar study by Dembe et al. (2005) employed a nationally representative sample of US workers to investigate the impact of overtime and extended working hours on risk of occupational injuries and illnesses. Data regarding job histories and work schedules were collected from ~11,000 workers over a period of 13 years (1987 through 2000). A total of 110,236 job records were analyzed, encompassing 89,729 person-years of accumulated working time. Multivariate analyses were used to estimate the relative risk of long working hours per day, extended hours per week, long commute times, and overtime schedules on reporting a work-related injury or illness after adjusting for age, gender, occupation, industry and region. Results showed a clear “dose response” relationship between number of hours worked per day and frequency of reported safety incidents. For extended hours per day, every additional two hours per day was associated with an average increase of approximately 1.2 injuries per 100 worker hours. Results from Cox proportional hazard modeling showed that working at least 12 hours per day was associated with a 37% increased hazard rate (compared to shifts lasting <12 hours), and working at least 60 hours per week was associated with a 23% increased hazard rate. Jobs with overtime schedules were associated with a 61% higher injury hazard rate compared to jobs without overtime. The authors concluded that a significant portion of the risk associated with demanding work schedules likely arises from the fatigue and stress associated with overtime and long work hours (Dembe, Erickson, Delbos, & Banks, 2005).

In a follow-up study, Dembe et al (2009) employed the same nationally representative panel of American workers to investigate the impact of long work hours on injury risk among health care professionals. A retrospective analysis of 13 years of data identified a total of 545 injuries reported by health care professionals. Cox proportional hazard modeling were used to calculate adjusted hazard ratios compare the risk of job-related injury among health care workers in various types of demanding schedules to employees working conventional schedules. The greatest risk to health care workers were observed in jobs requiring overtime (Hazard Ratio [HR] = 2.11) or 60 or more hours per week (HR = 2.02). Caregivers within medical provider offices had the highest risk of injury relative to those within other types of care settings, including hospitals (HR of 2.86 and 1.64, respectively). The authors suggest that this finding may reflect the fact that hospitals tend to have more infrastructure to devote to injury prevention relative to smaller medical service providers. Analyses segmented by occupation found that physicians and nurses working overtime and long hours had a 72% elevated risk of injury, though the risk was slightly lower than for support personnel (HR = 1.88, or an 88% increased risk). Interestingly, extended shifts lasting 12 or more hours were not found to be significantly predictive of an increased risk of injury. In turn, the authors conclude that the most potent source of fatigue and stress for nurses and other health care workers may arise from accumulated hours over the course of a week or longer periods, rather than from occasional 12-hour shifts worked a few days (e.g., three or four) each week (Dembe, Delbos, & Erickson, 2009).

A study by Dong (2005) also drew on a national panel survey of American workers to investigate the dangers of long work hours among production occupations. Like Dembe et al. (2005), the study presented detailed information for both work hours history and injury data within the same dataset. Multivariate odds ratio analyses were used to evaluate the relationship between length of the workday and injury risk. Findings from the statistical modeling corroborate those of other studies that show that accident risk starts to accelerate once the work shift exceeds eight hours such that the relationship follows an exponential curve whereby small increases in shift duration produce larger increases in accident risk. In particular, Dong reported that the odds of injury or accident approached two (i.e., twice the likelihood) after 12 hours; for shifts lasting longer than 16 hours, the accident risk approached 3.5. Regarding weekly work hours, workweeks of 50 hours or more were associated with an almost two-fold increase in accident risk (OR = 1.98) after adjusting for gender, age and other work-related variables.

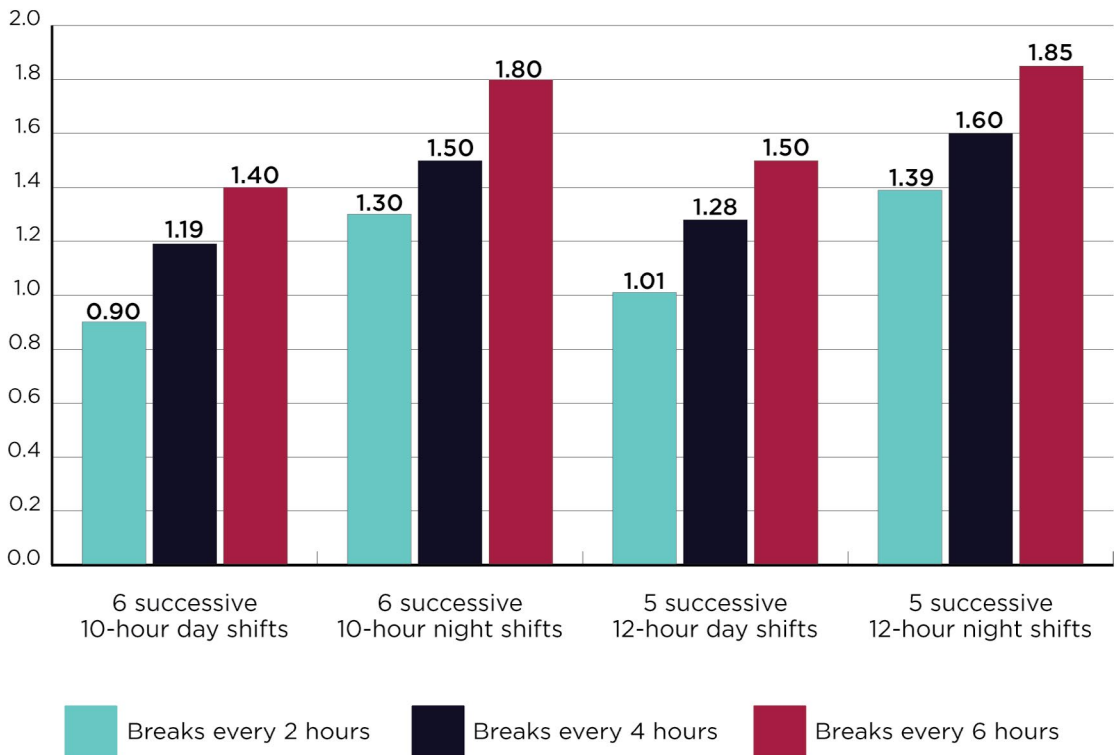
Folkard and Lombardi (2006) employed an advanced analytic approach to investigating the risk of long work hours by pooling data across several key studies, including Folkard (1997) and Hänecke et al. (1998). The authors focused on identifying risk associated with several different aspects of work scheduling, namely: shift duration, number of successive shifts, shift timing, intervals between breaks. Pooled risk estimates for each scheduling feature were used to construct a “risk index” that estimated the level of risk associated with various standard work schedules. Using a “normal working week” comprised of five successive eight-hour day shifts with a single mid-shift break as the reference category (i.e., baseline risk), the relative risks for all other work schedule combinations were calculated. Regarding long work hours, estimates from the risk index suggested that a 48-hour workweek (e.g., as stipulated within the EU’s Working Time Directive) can be safely executed if the schedule is comprised of six successive eight-hour day shifts since this configuration produces

a relative risk only 3% higher than the “standard.” However, if the 48-hour week is worked as four successive 12-hour day shifts, risk of accident increases by 25%. For night shifts, risk increases by 41% for six successive eight-hour shifts, and by 55% for four successive 12-hour shifts relative to the “standard” 40-hour workweek schedule. In a similar fashion, the authors used the risk index to calculate the relative risk associated with a 60-hour workweek. As before, risk of incident relative to baseline was contingent upon the configuration of the work schedule. For six consecutive 10-hour shifts, for example, risk was estimated at 16% higher for day shifts and 54% higher for night shifts. Meanwhile, the risk associated with five consecutive 12-hour shifts was 28% higher for workers on day shifts and 62% higher for those working night shifts.

Overall, results from the study suggest that, in principle, for any given length of workweek a long span of short shifts (e.g., six straight eight-hour shifts) is likely safer than a short span of long shifts (e.g., four straight 12-hour shifts). In addition, it appears that, on average, day shifts are generally safer than night shifts. Folkard and Tucker (2003) reported similar findings regarding the cumulative effects of multiple shifts and shift timing showing that, on average, the risk of incident on successive morning/day shifts is 2%, 7% and 17% higher for the second, third and fourth work shift respectively, whereas for night shifts the respective risk is elevated to 6%, 17% and 36% (Folkard & Tucker, 2003).

Regarding the influence of rest breaks during a shift, Folkard and Lombardi (2006) found that the frequency and duration of work breaks can significantly affect incident risk. Using a Risk Index analysis of rest breaks at intervals of two, four and six hours for shifts comprising a 60-hour workweek, the authors concluded that five successive 12-hour shifts with breaks every two hours is safer than six consecutive 10-hour shifts wherein rest breaks occur at four-hour intervals (Figure 2). Similarly, five 12-hour night shifts with breaks following two hours of work carries less risk than five 12-hour day shifts with breaks after six hours. Hence, the key finding from the risk index modeling is that it is necessary to account for the overall structure of the work schedule and its various components; in turn, single-focused restrictions on weekly or monthly work hours may be of limited value to ensure an acceptable level of workplace safety. Instead, a more optimized approach would target not just weekly or monthly work hours, but also maximum shift length, maximum successive nights, and minimum interval between breaks during a work shift (Folkard & Lombardi, 2006).

Figure 2 - Risk of accident by type of work shift, including rest breaks



Systematic reviews of the literature on work hours and accident risk confirm the cumulative risk arising during the course of a single work shift as well over multiple consecutive shifts. Wagstaff et al. (2011) reviewed 14 high-quality studies on the effects of work hours on various health outcomes, safety and performance. According to their results, both shift work and long working hours present a “substantial and well-documented detrimental effect on safety.” Specifically, work periods lasting more than eight hours carry an increased risk of accident that accumulates over time such that the risk of accident after 12 hours constitutes twice the risk as eight hours. Moreover, shift work including nights carries substantial incremental risk of accidents (Wagstaff & Sigstad Lie, 2011). Another recent review by Matre et al. (2021) confirmed the cumulative risk over consecutive work hours, showing that working >12 hours per day gives rise to elevated risk of safety incidents (RR = 1.24); the review also demonstrated an association between incident risk and cumulative hours over the course of a week, with workweeks lasting >55 hours increasing safety incident risk significantly (RR = 1.24).

The dose-response association between long work hours and reductions in work-related performance due to fatigue has been demonstrated in nurses. Thompson (2019) examined the impact of extended shifts in $n = 26$ nurses and nurses aids on physiologically based performance metrics. Nurses working a single 12-hour shift were compared to those working three successive 12-hour shifts within a 72-hour period. Outcome measures were vigilance-based reaction time, lapses of attention, and muscle function assessments (lower- and upper-body muscle strength, explosive strength and vertical jump distance). With the exception of hand grip strength, all performance metrics showed significant decline following three work shifts. Psychomotor vigilance reaction time and lapses of attention variables also tended to significantly diminish from the end of shift one to the end of shift 3, indicating an accumulation of fatigue in these metrics with increasing number of shifts worked. Muscle function variables responded early in the duty cycle, showing significant decline after a single work shift, but no further decline after the third shift. This study is notable in its use of objective measures to substantiate that fatigue-based impairments arise from working a single 12-hour shift, and in several instances, increase progressively with successive work shifts. The authors concluded that caution should be employed by nurses and personnel administrators when work schedules involve multiple compressed 12-hour shifts (Thompson, 2019).

Other studies have demonstrated the association between long work hours and the risk of a specific type of workplace safety incident within health care settings, namely medical errors. An early study by Gander et al. (2000) evaluated the impact of long work hours on fatigue-related medical errors among medical specialists in New Zealand. A nationwide survey of ~300 anesthetists provided information on work hours, perceptions of safety limits and recollection of fatigue-related errors in clinical practice. A key variable in the study was the gap between physicians' self-defined limits in work hours to preserve patient safety and personal well-being versus actual number of work hours. Findings showed that, in the preceding six months, 71% of trainees and 58% of certified specialists had exceeded their self-defined safety limits for continuous anesthesia administration; likewise, weekly work hours exceeded personal safety limits among 50% of trainees and 27% of specialists. Eighty-six percent of physicians said they had committed a fatigue-related medical errors during their career, including 32% within the past six months. Additional advanced regression analyses found that physicians who had exceeded their self-defined safety limits were significantly more likely to report medical errors (P. H. Gander, Merry, Millar, & Weller, 2000).

A similar study surveyed a national random sample of more than 3,000 medical residents in the US. Participants provided data on work hours, sleep patterns, as well as information on key safety incidents, including medical errors and events of serious conflict with other hospital staff (Baldwin & Daugherty, 2008). First-year residents reported working over 80 hours per week on average, though this figure was slightly lower among those in their second year (~76 hours per week). Total work hours were significantly correlated with reported stress and hours of sleep per week. Residents averaging more than 80 work hours per week were significantly more likely to be involved in a serious accident or injury (OR = 1.58). Long work hours were also predictive of serious conflict events with hospital staff, including other residents (OR = 1.90) and nurses (OR = 1.85). The probability of committing a significant medical error due to sleep deprivation was also heightened among residents working more than 80 hours each week (OR = 1.54), including errors that resulted in adverse patient outcomes (OR = 1.61).

A study by Landrigan et al. (2004) used a prospective, randomized design to investigate the impact of long work hours on medical errors among interns working in critical care units. Interns were randomly assigned to either a traditional schedule that included extended work shifts (24 hours or more) or an “intervention”

schedule that eliminated extended shifts and reduced the number of work hours per week. The study had the advantage of using “blinded” physician-observers that engaged in continuous observation of participants and independently rated each safety incident. Interns were followed a total of 2,203 patient-days which included 634 admissions. Descriptive findings showed that interns on the traditional schedule worked significantly more hours (84.9, compared to 65.4 among the intervention group), and slept an average of 5.8 fewer hours per week. As to the frequency of medical errors, traditional schedule interns committed serious medical errors 35.9% more often than the intervention group, including 56.6% more non-intercepted errors. Interns on the traditional schedule also made over 20% more serious medication errors and nearly six times as many serious diagnostic errors. The authors concluded that eliminating extended work shifts and reducing the number of hours worked per week can reduce the frequency of fatigue-induced medical errors in the critical care setting (Landrigan et al., 2004).

In a study of the impact of extended work shifts and overtime on nursing care outcomes, Rogers et al. (2004) recruited 393 hospital staff nurses to provide information on work hours, shift timing, overtime, days off, and sleep-wake patterns over a four-week period. A binary response item regarding making a medical error during a shift was the primary outcome in the analysis; “near-miss” errors were also documented. On average, participants reported working 55 minutes longer than scheduled each shift. One in four nurses worked more than fifty hours per week for at least two weeks during the observation period. Thirty percent of nurses reported making at least one error during a shift, and a third reported at least one near error. Advanced analytics showed that work duration, overtime and number of hours worked per week had significant effects on error frequency. Regarding shift length, nurses working shifts lasting 12.5 hours or more were more than three times more likely to make a medical error (OR = 3.29). Moreover, working overtime was associated with a two-fold increase in the odds of making at least one error, irrespective of how long the shift was originally scheduled to last (OR = 2.1). The study also provided evidence of a dose-response association between work hours and incident risk, with the likelihood of medical errors increasing for shifts of eight hours, between eight and 12 hours, and 12 hours by 34%, 53% and 326%, respectively. Regarding weekly work hours, results from the analysis showed that nurses working more than forty hours per week were at nearly double the risk of committing medical errors (OR = 1.96) and at significantly increased risk of near errors (OR = 1.42) (Rogers, Hwang, Scott, Aiken, & Dinges, 2004).

Several other studies of extended work hours in nursing have demonstrated similar increases the probability of error in nurses working 12-hour work shifts. In a study of critical care nurses, Scott et al. (2006) investigated the effects of work hours on the occurrence of adverse events in patients. A random sample of 502 critical care nurses from across the US provided information on hours worked, time of day worked, overtime hours, days off, and sleep-wake patterns over a 28-day period. The focal outcome variable was occurrence/no occurrence of an error during a work shift; a secondary outcome examined the frequency of near errors (an error that had been intercepted prior to occurring). A major strength of the study is its use of generalized estimating equations in the analysis to adjust for non-independence across multiple shifts performed by the same nurse; in turn, logistic modeling provided valid and robust estimates of odds ratios across repeated measures.

Over four in five (86%) nurses worked beyond the duration of their shift, with average overtime lasting almost an hour (49 minutes). Two thirds of nurses reported struggling to stay awake at work at least once during the observation period with one in five (20%) falling asleep at least once during their work shift. Risk of drowsiness increased by 50% when work shifts exceeded eight hours, while the risk of falling asleep at work almost doubled (OR = 1.9). Of note is the fact that occurrences of drowsiness and sleep episodes were not confined to night shifts with 40% of reports of feeling drowsy and 23% of sleep events occurring between 6:00 am and midnight. Still, consistent with findings from other studies that demonstrate the reduced capacity for work at night due to circadian dis-synchrony and the homeostatic drive for sleep, the vast majority of drowsiness and sleep episodes occurred between midnight and 6am.

Regarding frequency of medical errors, more than one-quarter of nurses (27%) reported at least one error during the study period, and another 38% reported at least one near error. Results from the statistical modeling demonstrated that longer shift durations increased the risk of medical errors, with shifts lasting ≥ 12.5 hours predictive of nearly twice the probability of the occurrence of an error (OR = 1.94) compared to eight-hour shifts. The likelihood of near errors also increased during extended shifts by almost two-thirds (64%). Work hours per week were also significantly related to the likelihood of medical errors with nurses who worked more than 40 hours per week at much higher risk of both errors and near errors (OR = 1.46 and 1.93, respectively).

A study of hospital nurses in three countries — the US, Japan and Chinese Taiwan — reached similar conclusions regarding the effects of long working hours on patient safety. The research used a specially designed cross-country survey (i.e., Hospital Survey on Patient Safety Culture) to investigate the impact of nurse working hours on patient safety culture within health care settings. The study employed a robust sample of nurses from each country (n = 4,407 in Japan; n = 106,710 in the US; n = 5,714 in Taiwan). Key patient safety outcomes were number of safety events reported and overall perceptions of patient safety. Other variables of interest which were included in the analysis included a measure of the level of cooperative teamwork within nursing units, and staffing sufficiency to handle workloads. Generalized linear mixed modeling was used to evaluate the impact of working hours on the outcome variables. Results from the analysis showed that nurses working ≥ 60 hours per week (in Japan and the US) were significantly less likely to achieve high scores for patient safety. Across all three countries, nurses working ≥ 40 hours per week reported a higher number of safety events. Additional analyses showed that average scores for staffing sufficiency and teamwork were significantly lower among nurses working ≥ 60 hours compared to those working < 40 hours. Based on their findings, the authors suggest patient safety culture deteriorates with longer working hours, a conclusion that is supported by the greater number of safety events reported in these environments (Yinghui et al., 2013).

At least one study has directly linked long work hours in nurses with mortality outcomes in patients (Trinkoff et al., 2011). A survey of n = 633 hospital nurses collected data on number of hours worked per day, hours worked per week, weekends worked per month, number of breaks lasting 10 minutes or more, including meals during a shift, and shift rotation. Other variables taken into consideration included how often nurses worked 13 or more hours at a stretch, had fewer than 10 hours off between shifts, and the typical number of days worked in a row. Generalized estimating equations were used to test relationships between work schedule characteristics, patient mortality rates from specific conditions, and hospital-level mortality. Results showed that, after adjusting for staffing characteristics (e.g., levels and skill mix) and hospital characteristics, work schedule was significantly related to mortality outcomes. In particular, pneumonia deaths were significantly more likely in hospitals where nurses reported schedules that included long work hours and a lack of time away from work (OR = 1.42 and 1.24, respectively). Mortality from acute myocardial infarction was associated with weekly hours burden — i.e. hours worked per week; days in a row (OR = 1.33).

A review by Muecke (2005) examined 10 years of scientific literature on the effects of rotating night shifts on fatigue in nurses with a focus on outcomes associated with both individual well-being and patient safety. A synthesis of the findings across studies demonstrated that disruptions to sleep-wake cycles arising from rotating schedules is associated with higher levels of fatigue, with implications for the quality of patient care. In particular, studies included in the review demonstrated a link between fatigue, inferior levels of alertness and performance, and failures in attending to changes in patient condition, medication errors and patient mortality (Muecke, 2005).

Other studies have investigated the impact of extended work hours on risk of work-related injury in nurses. In a secondary analysis of 11,516 registered nurses, Olds et al. (2010) examined the association between long work hours and adverse events such as needlestick injuries. A series of regression analyses found that the probability of adverse events was significantly higher among nurses working more than 40 hours per week. Needlestick injuries and medication errors exhibited the strongest relationship with extended work hours (OR = 1.28 for each outcome, respectively). Risk of adverse event was also found to be elevated in nurses working voluntary overtime — e.g., working more than four hours of overtime was predictive of a 30% increased risk of medication error and 20% increased risk of needlestick injury. In turn, the authors concluded that extended work hours, even when voluntary, can negatively impact nurse and patient safety (Olds & Clarke, 2010).

Another study more than 19,000 bedside nurses in Taiwan reported similar findings regarding the link between long work hours and work injury in nurses. Participants were surveyed regarding issues related to work hours, chronic insomnia, needlestick injuries and sharps injuries during the prior year. Multivariate logistic regression models were used to estimate the effects of long work hours and chronic insomnia on needlestick and sharp injuries after adjusting for sex, marital status, education, age, years of practice, work unit and hospital type/level. Over 70% of nurses worked long hours in the previous week (> 50 hours), and 15.5% reported chronic insomnia. Results from the regression modeling showed that nurses working 41 to 50 hours per week, > 50 hours per week and with chronic insomnia were 1.17 times, 1.51 times and 1.45 times more likely to experience needlestick injuries, and 1.29 times, 1.37 times and 1.56 times more likely to experience sharps injuries, respectively, compared to nurses working fewer hours and not having insomnia. The authors concluded

that the demonstrated risks associated with long work hours and chronic insomnia among nurses should be addressed by optimizing shift schedules and enforcing regulations on work hours in nurses (Lo, Chiou, Huang, & Chien, 2016).

Mandatory overtime hours have also been linked to work injury in nurses. In one study, after weekly work hours, shift length and demographic variables were accounted for, frequency of working mandatory overtime on a monthly basis was associated with increased risk of work-related injury (OR = 1.22), work-related illness (OR = 1.19) and missing more than two days of work because of a work-related injury or illness (OR = 1.25) (de Castro et al., 2010). Likewise, in their investigation of predictors of percutaneous injuries in nurses, Gershon et al. (2009) reported that mandatory overtime increased the risk of this type of work injury more than two-fold (OR = 2.44) (Gershon et al., 2009).

Other studies have demonstrated that the risks associated with long work hours are not constrained to accidents at the workplace. For example, Barger et al. (2005) used a prospective case-control study to investigate how work hours and extended schedules among medical interns influence the risk of motor vehicle accidents post-shift. A nationwide sample of more than 2,000 interns provided detailed reports on work hours, motor vehicle accidents, and near miss incidents on a monthly basis. Odds ratio analytics showed that, compared to non-extended shifts, shifts lasting longer than 24 hours were predictive of an over two-fold increased risk of road accidents (OR = 2.3), and a nearly six-fold increase (OR = 5.9) in near-miss incidents following their work shift (Barger et al., 2005). Other studies have demonstrated similar risks associated with post-shift fatigue (S. James & Vila, 2015), particularly for workers on night shift (Lee et al., 2016).

Among nurses, at least one study has demonstrated the risk of drowsy driving post-shift. Scott et al. (2007) followed $n = 895$ shift-working nurses over a period of four weeks collecting data on work hours, sleep duration, and drowsy episodes at work and while driving. Drowsy driving was measured using a combination of reported motor vehicle crashes (MVCs) or near-MVCs occurring post-shift. A full two thirds (66.6%) of nurses reported at least one episode of drowsy driving during the observation period; just under 5% of nurses reported struggling to stay awake while driving home after every shift. A key finding from this study was the dose-response association between work hours and driving risk. While all nurses reported drowsy driving after working shifts of 8.5 hours or less, the risk of reporting a drowsy driving episode doubled among working 12.5 hours or more (OR = 2.0). Moreover, working at night significantly increased the risk of drowsy driving with nurses reporting difficulty staying awake while driving home during 30% of post-shift periods (Scott et al., 2007).

Epidemiological evidence of the impact of long work hours and fatigue on workplace safety risks: synthesis of findings

For the most part, there appears to be scientific consensus regarding the relationship between consecutive work hours (shift length or duration) and the risk of fatigue and fatigue-related safety incident. Moreover, the risk of incident appears to increase exponentially over time. Multiple studies converge on nine hours as a critical threshold whereby incident risk begins to accelerate on an exponential curve, with risk doubling after 12 hours (Folkard, 1997; Folkard & Lombardi, 2006; Hänecke et al., 1998). For example, Folkard & Lombardi (2006) have reported that, when compared to shifts lasting eight hours, 10-hour and 12-hour work shifts increase the risk of incident by 13% and 28%, respectively. Other studies have shown that the risk of workplace safety incident due to fatigue can increase at least three-fold between 12.5 and 16 consecutive hours on shift (Akerstedt, 1994; Dong, 2005; Rogers et al., 2004). In addition, overtime hours, where individuals are working beyond their originally scheduled hours, have also been linked with incident risk (Dembe et al., 2009; Olds & Clarke, 2010; Rogers et al., 2004; Scott et al., 2006). Hence, taken collectively, there is strong evidence to support critical thresholds with respect to the number of consecutive work hours that can significantly affect the onset of occupational fatigue and fatigue-based risk.

Several studies have also demonstrated that time of day (or shift timing) constitutes a significant driver of fatigue-based risk. In particular, compared to day shifts, risk of incident is at least 15% higher for evening shifts and 28% higher for workers on night shifts (Folkard & Lombardi, 2006). There is also strong evidence of a significant interaction between work hours and time of day with higher risks associated with shifts that are

both long and during the night (Folkard, 1997; Folkard & Lombardi, 2006; Hänecke et al., 1998). The number of consecutive work shifts is also important to scheduling safety, with longer spans of short shifts generally considered safer than shorter span of long shifts (i.e., shifts lasting 10 or 12 hours). Other evidence shows that permanent nights shifts tend to be safer than rotating shifts (Berger & Hobbs, 2006; Muecke, 2005); however, where rotating shifts are either necessary or considered more practical, it is recommended that these be implemented in a forward “rapid” rotation consisting of two days, followed by two nights, with at least two days off between rotations (Bambra, Whitehead, Sowden, Akers, & Petticrew, 2008; Costa, Anelli, Castellini, Fustinoni, & Neri, 2014). Both forward and rapid rotation schedules have been found to be less disruptive to circadian function and bodily rhythms such that these tend to be better tolerated and have fewer adverse effects (Canadian Centre for Occupational Health and Safety, 2023). The research also shows that frequency and duration of rest breaks should also be considered vis-à-vis the overall structure of the work schedule, including shift duration. Moreover, each of these aspects of the overall work schedule — shift duration, timing, number of successive shifts — must be considered simultaneously, taking into account the potential for interaction effects. For instance, Folkard & Lombardi (2006) have demonstrated the incremental and synergistic risks associated with shifts that are long, successive and occur at night.

Multiple studies have also demonstrated the effects of excessive weekly work hours on safety risk. Weekly hours burden has been shown to interfere with the ability to recover between shifts (Trinkoff et al., 2011). The evidence indicates a dose-response relationship whereby the risk of incident increases as weekly work hours increase (Dembe et al., 2005; Folkard & Lombardi, 2006; Rogers et al., 2004; Scott et al., 2006; Trinkoff et al., 2011; Yinghui et al., 2013). In general, working over 40 hours per week appears to be a critical threshold predictive of greater risk of work-related injury, medical errors and even patient mortality (Lo et al., 2016; Olds & Clarke, 2010; Rogers et al., 2004; Scott et al., 2006; Trinkoff et al., 2011; Yinghui et al., 2013). Other research on the cumulative effects of fatigue in nurses has demonstrated the progressive decrements in performance associated multiple successive work shifts (Thompson, 2019).

Importantly, a handful of studies has also demonstrated the safety risks arising from occupational fatigue as not confined to the workplace. In particular, the risk of vehicle accidents following a work shift appears to be elevated among individuals working long hours, especially at night (Barger et al., 2005; S. James & Vila, 2015; Lee et al., 2016).

2. Risk of workplace conflict and lateral violence

In addition to physical manifestations of fatigue, long work hours have been linked with mental and emotional exhaustion (Dall’Ora, Ejebu, Ball, & Griffiths, 2023). In nursing, excessive work hours are a key component among a concatenation of other work-related factors (e.g., high-intensity work; heavy workloads; high stakes outcomes with respect to patient well-being) known to be predictive of high levels of stress and burnout (Shah et al., 2021; Stimpfel, Sloane, & Aiken, 2012). In turn, high levels of stress and burnout among staff profoundly shape the organizational climate and provide fertile ground for interpersonal workplace conflict and psychological bullying (Baillien, De Cuyper, & De Witte, 2011; Salin & Hoel, 2020).

Studies of workplace conflict among health care workers have found that several organizational factors are predictive of lateral violence and bullying among work peers. These factors include shift work, long work hours, high-stress work settings, heavy workloads and poor working conditions (Ariza-Montes, Muniz, Montero-Simó, & Araque-Padilla, 2013; Trépanier, Peterson, Fernet, Austin, & Desrumaux, 2021). Excessive work hours, in particular, tend to increase stress and fatigue, which can lead to breakdowns in communications among staff, reduced empathy and patience for the collaborative needs of others, and an increase in general irritability and conflict triggers (Ku & Smith, 2010; Rosta & Gerber, 2007). Studies have shown that the poor working conditions of nurses can deplete mental and emotional resources, making them more prone to negative mood (Healy & McKay, 2000; Trépanier et al., 2021). Collectively, the impoverished psycho-social conditions of the work environment can significantly diminish the quality of the relationships within nursing units and increase the likelihood of hostile and abusive behaviour among staff (Trépanier et al., 2021).

Regarding the effects of excessive work hours, one previously cited study (Baldwin et al. 2003) demonstrated the link between long work hours and propensity for serious conflict among staff within health care settings. Drawing on data from a national survey of over 3,000 medical residents from across the US, the researchers

found that working in excess of 80 hours per week significantly increased the likelihood of experiencing a serious conflict with a colleague or other hospital staff. Sleep deprivation and fatigue were identified as key mechanisms underlying the relationship (Baldwin, Daugherty, & Tsai, 2003).

Another previously cited study of nurses investigating the effects of long work hours on patient safety included “teamwork within units” as a focal variable (Yinghui et al., 2013). Although not an explicit measure of conflict, teamwork assessed the level of supportiveness, respect and cooperation among nursing staff. Average scores for teamwork were found to be significantly lower among nurses working longer hours (≥ 60 hours per week), compared to those working < 40 hours per week. The degradation of key aspects of teamwork caused by long work hours — e.g., treating coworkers with empathy and respect, demonstrating willingness to collaborate on tasks, etc. — represent an important leading indicator of the potential for breakdown of productive working relations that can give rise to interpersonal workplace conflict, with implications for patient safety (Baldwin & Daugherty, 2008; Yinghui et al., 2013).

Studies of the impact of work overload, including the impact of work schedule and long hours, have demonstrated similar associations between stressful working conditions and interpersonal workplace conflict. A recent study of workers in the health sector examined the link between job stress, and interpersonal conflict at work (Palancı, Mengenci, Bayraktaroğlu, & Emhan, 2021). A total of 708 workers in health care (nurses, physicians, health technicians) were surveyed regarding their working conditions (organizational commitment to health and safety practices, including protections for employee well-being), occupational stress levels and tendency to conflict with others at work. Both poor working conditions and high levels of work-related stress were found to be significantly associated with a greater likelihood of conflicting with colleagues. The relationship between work stress and interpersonal conflict was especially pronounced among individuals working more than 16 hours of overtime each week. Working conditions and stress were also found to be predictive of higher turnover intention suggesting that, over time, exposure to stressful working conditions may contribute to attrition in health care settings (Palancı et al., 2021).

Another study used an advanced structural equation modeling (SEM) approach to investigate the links between organizational factors such as work scheduling, workload and interpersonal conflict within the rail industry. A sample of 248 locomotive engineers and conductors from across the US were surveyed; a structural equation model was used to examine the direction and magnitude of relationships among the key variables. Findings showed that organizational factors, including work scheduling and length of working hours, were significantly associated with propensity for interpersonal conflict among coworkers. Notably, about one in four respondents felt dissatisfied toward the rest window provided between duty periods. A key finding from the study was the mediating role of social well-being (a variable linked to well-being outside of work, namely through marital relationships and amount of time spent in leisure pursuits), which was found to attenuate the adverse effects of organizational factors, including the tendency for interpersonal conflict (Ku & Smith, 2010).

At least one longitudinal study has investigated the risk factors associated with interpersonal conflicts at work (De Raeve, Jansen, van den Brandt, Vasse, & Kant, 2008). Longitudinal data from the Maastricht Cohort Study on “fatigue at work” ($n = 9421$) collected data from a representative sample of workers within both blue- and white-collar occupations. Respondents who had reported an interpersonal conflict at baseline were excluded from the sample to limit the possibility of selection effects. Logistic regression analyses were used to determine the role of several work-related factors at baseline in the onset of a conflict with coworkers or supervisors after one year. Outcomes from the modeling showed higher psychological job demands, the presence of physical work demands, higher musculoskeletal demands, poor physical working conditions, shift work and overtime hours were significantly predictive of the occurrence of conflict with both a co-worker and a supervisor. Other variables found to have a positive association with interpersonal workplace conflict were higher levels of role ambiguity and job insecurity. A key strength of this research is its prospective design which allows for causal inferences between workplace risk factors and the outcome measure. Moreover, the study is notable in that the identified risk factors (from psychological and physical job demands to shift work and overtime hours) have obvious direct relevance to the working conditions of nurses.

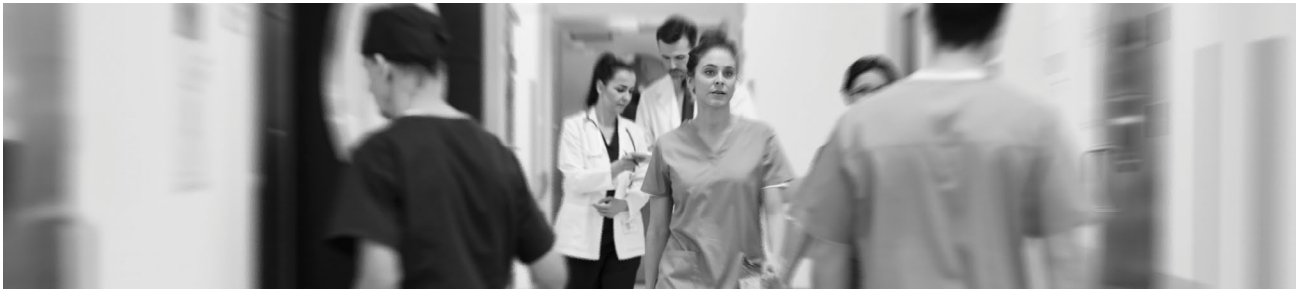
A review of empirical studies examining antecedents (sources, causes, predictors) of interpersonal conflict in health care foregrounded the importance of contextual workplace factors (Almost et al., 2016). Aspects of the work environment predictive of inter-collegial conflict were identified as: workload, job stress, staffing/understaffing/scheduling, shift work, long shifts, fast pace of work, time pressures, complexity of care and

working overtime. Inter-collegial relationships also significantly influenced conflict, particularly poor unit morale, mistrust, poor communication and a lack of willingness to collaborate as a team. Importantly, the review also identified several key mitigators of conflict among health care staff which focused on leadership providing practical and emotional supports for staff and creating work cultures rooted in fairness and respect.

There is a growing body of literature that shows how low levels of autonomy — including lack of control over work schedule — and high workloads contribute to a climate wherein lateral violence, or bullying, among nurses can flourish (Baillien et al., 2011; Giorgi et al., 2016; Notelaers, De Witte, & Einarsen, 2010). A recent Canadian study surveyed $n = 279$ nurses and followed them over one year to examine the effects of workload, including work-related time pressures, on bullying incidents. The authors note that nurses typically work long hours — regularly more than 10 hours consecutively during shifts — which are often extended due to overtime. In turn, they hypothesized that the physical and psychological resources required to meet demanding job conditions deplete nurses' energy reservoir, rendering them at-risk for stress, fatigue and negative emotions. Controlling for exposure to bullying behaviors at baseline, results from structural equation modeling found that workload positively predicted exposure to bullying behaviours over time under conditions when both job recognition (i.e., perceived social rewards from others at work) and social support were low (Trépanier et al., 2021).

Another recent study of nurses in the US reported similar findings regarding the association between nurses working conditions, work scheduling and reports of bullying (Pogue et al., 2022). A survey of $n = 943$ nurses showed that 40% reported that they had experienced bullying at work. Results from random effects modeling showed that nurses were more likely to experience workplace bullying if they worked more hours per week or more overtime hours per week. Poor/undesirable working conditions were also associated with an increased likelihood of reported bullying. The study is notable in that it also investigated the impact of bullying on patient outcomes. Findings from the analysis showed that nurses who experienced bullying were less likely to report good/excellent quality of care within their unit (OR = 0.28), or a favourable patient safety grade (OR = 0.36).

Finally, at least one multi-country study of health care workers has also reported an association between working conditions and risk of bullying. Ariza-Montes et al. (2010) used data from the 2010 European Working Conditions Survey (EWCS) to identify consistent predictors of workplace bullying within a set of job-related organizational contexts. Regression modeling within a sample of $n = 284$ health professionals found several factors that significantly increased the risk of bullying, namely: work stress, shift work and poor working conditions (OR = 4.96, 2.68, and 2.43, respectively).



3. Risks to individual health and well-being

Long hours and compressed work schedules are common in nursing; still there is accumulating evidence as to the potential adverse impacts on mental and physical health of such scheduling practices. A large body of epidemiological research has demonstrated links between non-standard work hours, including long hours and shift work, and risk of a range chronic health conditions, including sleep disorders, anxiety and depression, cardiovascular disease, cancer, diabetes and poor health behaviours. Following is a description of the evidence regarding the impacts of long hours, shift work and identified health outcomes.



Sleep disorders

Long work hours and overtime work reduce the amount of time that can be devoted to sleep, resulting in fatigue. Evidence shows that few shift-working nurses obtain the recommended seven to eight hours of sleep during recovery periods (Watson et al., 2015). Self-reported sleep times range between 4.3 and 6.7 hours, with nurses who work night shifts typically obtaining somewhat less sleep than nurses who work during the day. A meta-analysis of findings from 36 studies found that, on average, permanent day shift workers slept an average of 7.0 hours per day, permanent and rotating evening shift workers slept 7.6 to 8.1 hours, permanent night-shift workers slept 6.6 hours, and rotating night-shift workers slept least at 5.9 hours (Drake, Roehrs, Richardson, Walsh, & Roth, 2004). As a consequence, night-shift nurses typically report higher levels of fatigue and can be more vulnerable to cumulative adverse effects (Rogers, 2019).

There is general agreement across the literature that long hours and shift work have a deleterious impact on sleep. An early authoritative review by Akerstedt (1990) concluded that sleep loss is a major consequence of shift work. Quantity of sleep can be reduced by up to two hours a day; moreover, sleep tends to be of diminished quality due a lack of REM and stage 2 sleep (Akerstedt, 1990). Other studies confirm that long weekly work hours and overtime are associated with shorter sleep duration and sleep disturbances (Caruso, 2014). In an investigation of sleep duration in nurses across a series of work shifts, Geiger-Brown et al. (2012) reported an average sleep duration of 5.5 hours between 12-hour shifts (Geiger-Brown et al., 2012). Other key studies of the effects of shift work in nurses have shown that sleep deficits arising from long work hours can lead to sleepiness at work and the risk of involuntary napping, both of which are linked to medical error (Scott et al., 2006). Prolonged sleep disorders can also lead to chronic insomnia, which has been identified as a significant problem in shift-working nurses (Lo et al., 2016).



Mood disorders

A growing body of evidence has linked long work hours with the onset of mood disorders, including anxiety and depression. This literature suggests that individuals working more than the standard 40 hours per week are at increased risk of anxiety and depression (Afonso, Fonseca, & Pires, 2017; Virtanen et al., 2011). One notable cohort study of the psychological effects of long work hours followed an unusually robust sample of workers (n = 2960) over five years. Working hours, anxiety and depressive symptoms were measured at baseline followed by two subsequent measurements of anxiety and depressive symptoms. Hazard analyses adjusting for baseline covariates showed a 1.66-fold increase in the risk of depressive symptoms and a

1.74-fold increase in risk of anxiety symptoms among employees working more than 55 hours per week, compared to those working 35 to 40 hours per week. Sex-stratified analyses showed an excess risk of depression and anxiety associated with long working hours was especially pronounced in women (OR = 2.67) (Virtanen et al., 2011).

A case-control study by Kleppa et al. (2008) reported similar results. The study compared overtime workers to workers on standard schedules to investigate symptoms of anxiety and depression in each group. Findings from comparative analyses showed that overtime workers exhibited both higher prevalence and greater severity of anxiety and depressive symptoms relative to those working standard hours. The study also identified a dose-response relationship between the variables, with more work hours associated with a higher level of anxiety and depression (Kleppa, Sanne, & Tell, 2008). Finally, a recent systematic review concluded that there is evidence of a link between long work hours and depression onset (Rivera et al., 2020).

Hu et al. (2016) has also reported an association between long working hours and mental burnout. A comparison of high- and low-burnout groups revealed that long working hours were associated with burnout in a dose-dependent manner. While the odds of high levels of burnout was significantly greater in individuals working over 40 hours per week (OR = 1.58), this relationship was even stronger among those working more than 60 hours per week (OR = 2.29). Based on their findings, the authors recommend implementation of policies limiting working hours to 40 hours per week to help forestall the onset of burnout (Hu, Chen, & Cheng, 2016).



Cardiovascular disease

A body of international literature has demonstrated the relationship between long working hours and increased risk of cardiovascular disease. A recent review of the evidence by Rivera et al. (2020) undertook a systematic review of 48 individual systematic reviews investigating several chronic disease outcomes, including cardiovascular disease. The authors concluded that there is low-grade evidence to suggest that both shift work and long work hours may be linked to low to moderate increases in the risk of cardiovascular disease (Rivera et al., 2020). Frost et al. (2009) has also reported evidence linking shift work to risk of ischemic heart disease (Frost, Kolstad, & Bonde, 2009).

A large systematic review and meta-analysis by Kivimäki et al. (2015) employed data from over 600,000 participants from studies out of the US, Europe and Australia to investigate the effects of long work hours on incident coronary heart disease and stroke. In cumulative meta-analyses adjusted for age, sex and socio-economic status, compared with standard hours (35 to 40 hours per week), working long hours (≥ 55 hours per week) was associated with increased risk of incident coronary heart disease (RR = 1.13) and incident stroke (RR = 1.33). A dose-response association was also identified for stroke, with relative risk estimates of 1.10 for 41 to 48 working hours, 1.27 for 49 to 54 working hours, and 1.33 for 55 or more working hours per week (Kivimäki, Jokela, et al., 2015).

Convergent conclusions were reached by at least two earlier meta-analytic reviews. Drawing on results from 12 observational studies, Virtanen et al. (2012) reported that working long hours (>50 hours per week) was associated with a 40% increased risk of coronary heart disease (Virtanen et al., 2012). Likewise, Kang et al. (2012) utilized evidence from 11 individual studies to conclude that the effect of long (≥ 50) weekly work hours on cardiovascular disease was 1.37 (Kang et al., 2012).

A definitive study by Dembe & Yao (2016) examined disease outcomes in a large cohort of respondents ($n = 7,492$) over more than three decades. Logistic regression analyses established a clear dose-response link between average weekly work hours and reported prevalence of heart disease: 51 to 60 work hours per week elevated risk by 1.68, and over 60 hours elevated risk by 1.74. The authors concluded that working long-hour schedules over decades increases the risk of some specific chronic diseases, including coronary heart disease (Dembe & Yao, 2016).



Cancer

Several studies have also linked long work hours and shift work with several forms of cancer. In their cohort study following workers over 32 years, Dembe & Yao (2016) found that decades of exposure to long-hour work schedules was associated with a significantly elevated risk of non-skin cancer. The relationship was cumulative with individuals working 51 to 60 hours per week experiencing a two-fold increase in the likelihood of cancer diagnosis (OR = 2.03), and workers exposed to >60 hours per week exhibiting a risk increase of nearly three-fold (OR = 2.83).

Another multi-cohort study by Heikkila et al. (2016) examined the effects of excess working hours and on incident cancer risk among workers who were cancer-free at baseline. Drawing on data from 12 separate prospective studies, the authors employed random-effects meta-analysis to examine cancer rates among a total of 116,462 over a period of 10.8 years, on average. Although the study showed no clear evidence of an association between working hours and overall cancer risk, the authors did find an association between working ≥ 55 hours per week and female breast cancer risk (OR = 1.60) (Heikkila et al., 2016).

A meta-analysis of 13 studies on the effects of shift work reported that night work increased cancer risk by 48% (Megdal, Kroenke, Laden, Pukkala, & Schernhammer, 2005). Another study of nurses on night-shift rotation found an increased risk of colon cancer in nurses working three or more nights per month for 15 years or more (OR = 1.35). Several observers have posited possible mechanisms for this relationship as related to gastrointestinal disturbances arising from disturbances to circadian rhythms involving eating and digesting food, sleep deprivation leading to stress response, changes in immune function and types of foods available during night shifts (Caruso, 2014; Knutsson & Bøggild, 2010; Schernhammer et al., 2003).

The review by Rivera et al. (2020) also reported an increased risk of cancer associated with shift work. In their analysis of 17 systematic reviews on cancer outcomes in individuals working non-standard schedules, the authors found moderate-grade evidence linking shift work to female breast cancer. Likewise, Bonde et al. (2012) has reported that statistically significant increases in risk for breast cancer were seen in people working night shift for 20 years or more; in turn, they conclude that “women with previous or current breast cancer be advised not to work night shifts because of strong experimental evidence demonstrating accelerated tumor growth by suppression of melatonin secretion” (Bonde et al., 2012).

In 2007, the International Agency for Research on Cancer (IARC) of the World Health Organization announced sufficient evidence supports that shift work with circadian rhythm disruption (i.e., occurring at night) is a probable carcinogen (Erren et al., 2010). They concluded data from human studies suggest the link is possible, while evidence from animal studies is sufficient (Caruso, 2014).

Poor health behaviours and metabolic syndrome

Research has linked long work hours and shift work to behaviours known to have a deleterious impact on health. An investigation by Bushnell et al. (2010) examined the effects of different types of work schedules on the rate of poor health behaviours. A total of 26,442 responses from workers regarding work schedule and health behaviour were collected between 2000 and 2008. After adjusting for potential confounders, risk ratio modeling showed that, compared to an eight-hour day shift, the 12-hour rotation shift schedule (considered the most demanding schedule type) was associated with significantly higher rates of: smoking (RR = 1.60), lack of physical activity/exercise (RR = 1.30), short sleep duration of six hours or less per night (RR = 1.30) (Bushnell, Colombi, Caruso, & Tak, 2010).

Another study by Artazcoz et al. (2009) examined the relationship between weekly work hours burden and several health indicators, including health-related behaviours. The sample comprised over 7,000 salaried workers aged 16 to 64. Weekly work hours were categorized as 30 to 40 hours per week, 41 to 50 hours per week, and 51 to 60 hours per week. Findings from the analysis showed that, among men, working 51 to 60

hours per week was predictive of elevated risk of self-reported hypertension (OR = 1.60), smoking (OR = 1.33), shortage of sleep (OR = 1.42) and no leisure time physical activity (OR = 2.43). Among women, excessive work hours were associated with increased risk of shortage of sleep (OR = 2.21).

Other studies have also demonstrated an increased risk of smoking due to long work hours. Shields (1999) has reported that, for both sexes, changing from standard to long hours (over 40 hours per week) is associated with increased smoking. Among men, long work hours were predictive of more than twice odds of increased daily smoking; among women, the corresponding odds were more than four times higher. The study also found that daily alcohol consumption increased among women who changed from standard to long-hour schedules.

Metabolic syndrome and its risk factors have also been associated with work schedule. For example, Shields (1999) has reported that, among men, increased work hours are associated with unhealthy weight gain (Shields, 1999). Other studies have likewise linked increased body mass index to shift work and excessive work hours (Antunes, Levandovski, Dantas, Caumo, & Hidalgo, 2010; Nakamura et al., 1998). In a meta-analysis on the health effects of work-related factors, Watanabe et al. (2018) demonstrated a significant positive relationship between shift work and metabolic syndrome (RR = 1.59) (Watanabe et al., 2018). Likewise, a recent meta-analysis examining the effects of long working hours has reported an association between longer work hours and risk of metabolic syndrome (OR = 1.10). (Wong, Chan, & Ngan, 2019).

A handful of studies have also identified work schedule as a risk factor in the onset of type 2 diabetes. In their meta-analysis comprising data from more than 200,000 participants, Kivimäki et al. (2015) reported an association between long working hours (≥ 55 hours per week) and type 2 diabetes diagnosis (RR = 1.29), although the relationship was significant only among lower socioeconomic groups (Kivimäki, Virtanen, et al., 2015). A more recent study over exposure to excessive work hours over three decades found a significant increase in diabetes risk among individuals working more than 50 hours per week (Dembe & Yao, 2016). Observers hypothesize that the mechanism underlying the relationship could be poor sleep quality and reduced sleep duration, causing an imbalance in appetite hormones that increase feelings of hunger and metabolic changes, leading to obesity, insulin resistance and reduced lipid tolerance (Spiegel, Tasali, Leproult, & Van Cauter, 2009).

Individual and organizational factors affecting fatigue risk

Empirically established thresholds with respect to the effects of working hours on fatigue provide critical guidance for how to construct safety limits. However, several factors can exacerbate occupational fatigue and, in turn, may accelerate fatigue-based risk. At the individual level, factors that can affect the onset of occupational fatigue include age, biological sex, health status, sleep habits, and personal circumstances that can influence opportunities for sleep and recovery (e.g., caregiving responsibilities). At the level of the organization, factors that contribute to fatigue risk can include stressful working conditions, heavy workloads and work schedules that provide insufficient recovery periods between shifts. We will consider each, in turn.



Age

With age, periods of sleep become shorter and more fragmented (Harrington, 2001), and insomnia is more common (Caruso, 2014). Hence, it becomes more difficult for older workers to achieve adequate recovery between work shifts (Åkerstedt, Fredlund, Gillberg, & Jansson, 2002; Hulsegge et al., 2019). Research on sleep deprivation resulting in performance deficits equivalent to a BAC concentration of up to 0.10% show that more mature nurses reach this limit in less time than their younger workmates (Dawson & Reid, 1997a). Other empirical studies show that the adverse physical and psychological effects of shiftwork-related fatigue is more pronounced in nurses over age 40 (Muecke, 2005). Though research has demonstrated the potential protective effects of experience and improved safety performance that may accrue with older age and longer work tenure (Namian, Ghorbani, Taherpour, Ghiasvand, & Karji, 2022), the cumulative effects of fatigue associated with shift work and long work hours may work to offset incremental benefits associated with age (Brighenti-Zogg et al., 2016; Clendon & Walker, 2013).



Biological sex

There is some evidence to suggest differences between men and women in the ability to tolerate long work hours and shift work. Some studies show that women working long hours or shift work have sleep periods that are shorter and of diminished quality relative to their male counterparts (Åkerstedt et al., 2002; Artazcoz, Cortès, Escribà-Agüir, Cascant, & Villegas, 2009; P. Gander, Briar, Garden, Purnell, & Woodward, 2010; Lecca et al., 2023). Long working hours have also been found to be linked with greater likelihood of depressive symptoms (Choi et al., 2021; Shields, 1999; Virtanen et al., 2011) and diabetes (Gilbert-Ouimet et al., 2018) in women, although at least one study has reported that adverse mental and physical outcomes arising from excessive work hours tend to be more pronounced in men (Artazcoz et al., 2009). Weekly work hours have also been shown to have a stronger association with women's risk of work injury (Smith, Ibrahim-Dost, Keegel, & MacFarlane, 2013; Wirtz, Lombardi, Willetts, Folkard, & Christiani, 2012). At least some of the differences between women and men and in susceptibility to the effects of extended work hours likely result from differences in childcare responsibilities and domestic workload, which disproportionately reduce the amount of time women are able to devote to sleep and recovery from work (Caruso et al., 2006).



Health status

Research has shown that some forms of chronic diseases (such as arthritis, asthma, chronic fatigue syndrome, chronic obstructive pulmonary disease (COPD) and rhinitis) can contribute to daytime sleepiness and compromise cognitive functioning (Smolensky, Di Milia, Ohayon, & Philip, 2011). As the population ages, the incidence of chronic morbidity due to various health conditions has risen. Currently, about one in three Canadians (33.7%) lives with a chronic condition, including CVD, cancer, diabetes, and mood and/or anxiety disorders (Branchard et al., 2018). The physical and psycho-social stresses associated with non-standard work schedules are known to be less well tolerated by individuals with chronic health issues (Åkerstedt et al., 2002; Caruso et al., 2006). For example, at least one study has reported that night shift workers suffering from type 2 diabetes have more difficulty controlling glucose levels (Manodpitipong et al., 2017). Other research has demonstrated less tolerance to non-standard work hours among workers with higher levels of mood disorder due to anxiety (Costa, Lievore, Casaletti, Gaffuri, & Folkard, 1989). In all, the presence of chronic conditions depletes the body of critical physiological and psychic resources thereby requiring more time for sleep and recovery, more difficult to achieve among workers on non-standard schedules (Caruso, 2014). Moreover, the relationship between work hours and health is likely circular in that long-term exposure to excessive work hours has been found to be a significant causal factor in the onset of chronic health problems (Bannai & Tamakoshi, 2014).



Sleep habits and circumstances that impact opportunity for sleep and recovery

There is strong evidence to indicate the heightened importance of good sleep hygiene practices among individuals working extended hours or shift work. Insufficient or poor sleep related to insufficient recovery can be a common pathway from long work hours, shift work and work stress to various forms of illness (Härmä, 2006). Non-work factors such as domestic and caregiving responsibilities can significantly impact the opportunity for recovery, as well as the quality and duration of sleep during recovery periods. Competing work and family responsibilities can give rise to significant levels of physical and psychological strain that can affect fatigue (Mohamed, Ghaith, & Ahmed, 2022). In studies of the effects of work scheduling on nurses, work-family conflict has been identified as a significant predictor of poor sleep quality (Berkman et al., 2015). Moreover, sleep disruption arising from the strain of work-life conflict has been shown to have deleterious impacts on nurses' mental health (Mohamed et al., 2022; Zhang, Punnett, & Nannini, 2016).



Work stress and physically demanding work

Hectic work characterized by high work demands under fast-changing circumstances is physically and psychically draining and can lead to high levels of fatigue in nurses (Gifkins, Johnston, Loudoun, & Troth, 2020; Ross et al., 2021). Both hectic work and work that is physically strenuous have also been linked to poor sleep quality affecting work recovery (Åkerstedt et al. 2002). In their synthesis of studies on work-related fatigue, Sluiter et al. (2003) reported strong associations between level of work demands and need for recovery across six different occupations. Nurses typically face heavy physical workloads as well as situations that require a high degree of emotional regulation to maintain attention and focus. The intensity of the work demands in nursing can accelerate states of occupational fatigue resulting in quicker onset of fatigue-based risk (Barker & Nussbaum, 2011). In particular, nurses working in acute care environments with a high proportion of patients in danger of rapid deterioration tend to be under greater strain and are more prone to fatigue (Cochran, 2021; Wu, Ge, Xu, Zhang, & Lang, 2020). In turn, research on managing stress and fatigue in nurses recommends monitoring individual nurses' level of fatigue during a work shift, as well as using tools to predict fatigue risk (Gifkins et al., 2020; Steege, Pinekenstein, Rainbow, & Arsenault Knudsen, 2017).



Work schedule

Shift work and particularly rotating schedules and night shifts are known to contribute to poor sleep quality and work-related fatigue (Lee et al., 2016; Muecke, 2005). Long work shifts comprising 12 hours or more have been linked with fatigue-related safety risks (Dong, 2005; Folkard & Lombardi, 2006; Rogers et al., 2004), with heightened risk for shifts occurring at night (Wagstaff & Sigstad Lie, 2011). Number of consecutive work shifts and weekly work hours burden are also associated with heightened risk of work-related accident and injury in a cumulative fashion (Karhula et al., 2013; Yinghui et al., 2013). Another key aspect of work scheduling linked to fatigue in nurses is “quick return” where nurses have fewer than 11 hours between the end of one shift and the start of the next. In view of the optimal sleep periods (seven to eight hours is the recommendation for most adults), schedules that prescribe quick return to work do not allow for sufficient recovery between shifts (Gifkins et al., 2020). The frequency of quick returns in rotating shift-working nurses has been found to limit opportunities for recovery as well as diminish quality and quantity of sleep (Gifkins et al., 2020). Insufficient opportunities for recovery can have a greater impact on fatigue levels than shift work alone (Dahlgren, Tucker, Gustavsson, & Rudman, 2016). Quick returns are also linked to a poorer ability to recover from fatigue (Karhula et al., 2013). Other research has linked quick returns to a higher incidence of sick leave due to the reduced amount of time nurses are able to sleep and recover from fatigue (Vedaa et al., 2017).

The significant positive effects of rest breaks during a shift are well-documented. In a large study of hospitalized workers with severe injury, Lombardi et al. (2014) demonstrated that even minimal rest breaks of less than 30 minutes had a significant effect on delaying the onset of work-related injury (Lombardi et al., 2014). Likewise, Tucker et al. (2003) have reported that regular rest breaks constitute an effective way of controlling accumulation of risk during shift work (Tucker, Folkard, & Macdonald, 2003).

Discussion

As we have seen, the body of evidence regarding the adverse occupational health and safety impacts of excessive work hours is both clear and compelling. Shifts lasting longer than 12 hours tend to put workers at risk of occupational fatigue, which gives rise to several fatigue-based risks. Key proximate outcomes of fatigue at work contain heightened risk of injury or accident, including accidents that can occur outside of the workplace post-shift (e.g., due to drowsy driving). Over time, the cumulative effects of excessive work hours can adversely affect workplace culture and work group cohesion due to a tendency for chronically fatigued workers to have less empathy for peers and lower inclination to cooperate. The individual health-related effects of excessive work hours range from disorders of sleep and mood to serious chronic illness, including a heightened risk of cardiovascular disease, metabolic disorders and cancer. The fatigue arising from long work hours tends to be exacerbated by shift work, with rotating schedules including night shifts interfering with normal circadian function. Neurophysiological rhythms governing sleep reduce the body's physical capacity to work at night, particularly during what the research has identified as the "window of circadian low" (2:00 am to 6:00 am). In turn, night shift workers are at heightened risk of workplace injury or accident and have more difficulty with personal health concerns over time. A great deal of practice-specific evidence among nurses has demonstrated the deleterious effects of abnormal work schedules on both personal and patient safety.

While the known occupational health and safety risks of long work hours and occupational fatigue are cited as evidence for governmental restrictions on work hours in safety-critical industries such as transport, aviation and nuclear, to date health care remains for the most part unregulated. Limits on the work hours of medical residents have been put in place via jurisdictional regulatory bodies, though, with the exception of Quebec, in most provinces residents can still work up to 24 hours consecutively, a practice lacking support from the evidence. In addition, outside of health care, federal regulations on work hours require that operators in safety-critical industries have in place specific protocols for fatigue risk management in employees. In particular, awareness of the causes and consequences of fatigue and how to recognize fatigue in oneself and others are key components of worker training in fatigue safety management. Indeed, fatigue risk management interventions are common practice in much of the developed world out of a concern for public safety. Several international standards related to fatigue risk management currently exist in an effort to address the risks associated with fatigue in various sectors to ensure safety and well-being (Dawson et al., 2011). For example, ISO 45001 (Occupational Health and Safety Management Systems) provides a framework for organizations to manage health and safety risks, including those related to fatigue. It encourages employers to identify and assess potential fatigue hazards and implement controls to manage fatigue-related risks. In view of the public safety interest associated with health care and hospitalization, implementing minimum standards for fatigue risk mitigation is a crucial step towards ensuring the health and safety of employees and patients alike. Hence, in addition to seeking government legislative action on limiting long work hours for health care professionals, stakeholders should consider advocating for the certification of hospitals and other health care settings in accordance with international standards for mitigating fatigue risk.

Although a meaningful long-term solution to the current structural problem of staffing shortages in health care demands focus on increasing the number of nurses and allied health professionals in the system, the implementation of formal protections against excessive work hours constitutes a key step toward improved working conditions, a prerequisite in retaining staff and incentivizing recruitment. Ensuring safe high-quality care into the future requires nurses be provided with adequate supports and fair scheduling practices.



PHASE 2: IN-DEPTH INTERVIEWS WITH KEY INFORMANTS ON SAFE WORK HOURS SCHEDULING AND PRACTICES

Phase 2 of the research involved primary data collection via interviews with key informants. A total of 18 interviews were undertaken with a range of stakeholders in nursing and health care between July 31st and August 31st, 2023. Interviews were between 30 and 45 minutes in duration, and informants received a \$100 honorarium for their participation. Informants were queried regarding a range of topics related to work hours safety and fatigue-related risks. All interviews were conducted by the Principal Investigator.

Interviews were fully transcribed, and data were analyzed using a grounded theory, an inductive approach which allows for the data to “speak for itself.” Several key themes were identified; themes are discussed and contextualized using verbatim quotations from participants. As a point of process, the perspectives of frontline nurses are considered somewhat distinct from other stakeholders (academic researchers, OHS experts, and representatives of professional organizations and unions) due to their proximity to the issue of excessive work hours and its sequelae. In turn, the perspectives and voices of nurses versus allied stakeholders are denoted as nurses or stakeholders at the beginning of each corresponding section of text.

Key themes

Five major themes emerged across the interviews with nurses and allied stakeholders, namely: structural deficiencies in health care that have driven staffing shortages; work hours as a determinant of fatigue, well-being and the links to patient safety; the role and responsibility of employers; the role of regulation and legislative action; and the need for effective planning to improve working conditions and remedy staffing shortages.

1. Structural deficiencies in health care as a determinant of staffing shortfalls in nursing

Asked to characterize the state of health care and nurses' working conditions at present, observers identified staffing shortages and a lack of nurses working in the public system as a central issue. Although the onset of COVID was acknowledged as an inflection point in the health care staffing crisis, participants described staffing shortfalls as steadily worsening over the past decade due to both underfunding as well as failures in planning around demographic shifts that have affected both patient mix and the number of nurses transitioning into retirement. Relevant excerpts from conversations with stakeholders include:

"In our province over the last 12 to 13 years we were in austerity measures... There was cost-cutting of 1.5 to 2 billion dollars in the health care system across the board, and unfortunately, when you're cutting at that magnitude ultimately, it's not the brick and mortar you're cutting, you're cutting in terms of care, you're cutting in terms of positions, you're cutting in terms of hours of care... It's a number in the thousands of nurses that were let go." (Union leader)

"We saw the shortage coming... we saw the population aging, more complex chronic conditions coming down the pipeline... The pandemic really put a spotlight on all of the issues that nurses had been commenting about for decades and then made these worse." (Executive at a professional association)

"I don't think it's controversial to observe that the [health care] workplace was in crisis mode in terms of sustainability due to successive cuts, efficiency measures and so on, and that nursing always bears the brunt of hospital budget cut constraints... That's been true for several years... For decades we have been predicting the retirement of the baby-boomers... and then came COVID on top of that." (Academic researcher)

Among nurses, all had been directly affected by insufficient staffing with a direct impact on their workload. As one long-term care nurse from BC put it, "It's primarily a body problem, when we're short-staffed, if someone doesn't come in, it is double the workload." Some of the more senior nurses described the staffing problems within health care as having persisted for at least a decade; still, the onset of COVID was viewed as a sea change in the crisis.

"When I first started in 2009, it was very different; in the ICU setting the rule was that, if you had an intubated patient, you were one-to-one, that was the golden rule. COVID changed that... In our facility it was so backed up, and the sheer volume of patients in the facility meant in the ICU you had two intubated patients that you would have to take care of at times... Since 2020 we lost about 80 senior staff from our department." (RN, emergency and trauma care)

"Since COVID, every other shift in the [LTC] unit is short-staffed whether it be the health care aides, the LPNs or the RNs... If there's a nurse that called in sick, they have a hard time filling it, and they just tell us when we come in that they couldn't fill it and just try to make do..." (RN, long-term care)

"Post-COVID a lot of people left ... We see a constant shortage." (RN, long-term care)

"I've been nursing for 42 years and seen the number of nurses go up and down, and we have seen times when there was a little bit less staff available to us, but I have never seen it to the level of now... We are dealing at the moment with a 60% vacancy rate in our facility, so it's enormously high." (RN, emergency and acute care)

2. Work hours as a determinant of fatigue, well-being and the links to patient safety

Staffing shortfalls were viewed as the main structural determinant of increasing workloads in nursing, which was linked directly to pressures to work more hours. Nurses described the strain associated with insufficient staff and the impact on their work schedule, with nurses working longer hours without sufficient rest breaks.

“A lot of nurses are forced to work overtime because you can’t abandon your post... When you work a 12-hour night shift and then you have to stay four more hours, that’s brutal.” (RN, emergency care)

“When I first started as a nurse, you would have overtime, and people would be like ‘oh yeah, I’m going to pick up and work overtime’, and it would go in waves, and there would be a lull again; but it has gotten to the point that people don’t even want to pick up overtime because there is so much available and you just can’t fill it all... I find myself pick up an extra eight-hour shift, and it’s 11:30 at night but I end up staying till 3:30 am because we’re so short-staffed.” (RN, emergency and trauma care)

“Every other shift on the unit we are short-staffed... So if it is short, I’m just running the entire day, and there have been many shifts where I haven’t gotten a break because there is no time... There are occasions where there you have an eight-hour turnaround after working a 16-hour [double] shift, and you have to come in for another eight hours, then you don’t get a proper recovery, like you probably get five hours of sleep at best.” (RN, long-term care)

“We are working too many hours, but you feel obligated to pick up all of these extra shifts... or you do four extra hours in the morning after a 12-hour night shift because a sick call came in and you really can’t find anybody.” (RN, emergency and acute care)

Some nurses also described how the lack of adequate staff within their unit affects their ability to adequately recover between shifts due to frequent calls from their employer to work additional shifts.

“You’re sort of on call because of short-staffing; even though you’re not scheduled to work, they call you — and you feel you need to go... We’re called every day, multiple times a day.” (RN, emergency care)

Asked about the effects of growing work demands and extended hours on personal well-being, nurses described the toll on their mental, emotional and physical health. The most common complaint was feeling fatigued — or “burnt” — both physically and mentally. Key comments include:

“Everybody’s just so done and burnt... It’s sort of contagious.” (RN, long-term care)

"It is so bad for nurses personally, for their health, their mental health... There are just biological limits, right? On even just attention or physical strength... I am exhausted, but I also feel very flat... I don't really feel anything." (RN, emergency care)

"It is very busy, very heavy, and it's too much physically and emotionally for a lot of nurses... It is hard to find a work-life balance, especially if you have children." (RN, community mental health)

Some nurses also credited rising work demands with the onset of chronic stress and other health-related problems, physical and emotional. Sequelae described by nurses include:

"I'm stressed out, it's a lot of workload... We are finding with all our nurses right now the stress is so much; with COVID, and we've also had fires, floods, these big global events, and it's accumulated... The stress is compounding." (RN, community mental health)

"I'm young but I already feel like I have back problems... I know we should be putting self-care practices in place, but by the time I come home I just want to sleep; I don't have the energy to do anything else for myself." (RN, long-term care)

"I am a living, breathing example of that [poor health outcomes due to working too many hours]... especially my sleep patterns; 10 years ago, I had no issues with sleeping... Sleep is the biggest battle for me now, getting to sleep, staying asleep. Physically it's just the exhaustion; but I also feel anxiety and anger." (RN, emergency care)

The fatigue-related risk to nurses' health and safety was not constrained to the workplace; several observers flagged post-shift "drowsy driving" as a major concern. One nurse described "getting on the road after 16 hours" as a "real danger" to the nurse as well as others on the road. Some powerful excerpts from conversations with nurses follow.

"I couldn't drive myself home after those long shifts... Lucky for me, my parents were able to pick up my car and then pick me up in the morning because at that point I had reached 22 hours without sleep, and I don't want to drive myself home... No, that is very risky." (RN, long-term care)

"You're working with all these meds and yet you can't even drive yourself home... That post-shift period of drowsy driving, the increase of risk of accident is something like tenfold; I mean it's absolutely crazy, especially if you have been working nights and you don't even know if your car is moving toward the middle of the road... Some of us turn up the radio and roll down the windows, but I still always tell myself it's the grace of God sometimes because you're physically so compromised." (RN, community health nursing)

Nurses were also very concerned about the impacts of workload and extended work hours on patient care; all expressed a keen awareness regarding the risks to standards of care associated with nurses being fatigued, from deficits in “attention or physical strength” to declines in the “compassion aspect of nursing.” Relevant excerpts from conversations with nurses follow.

“If someone is working 16 hours, their thinking process is impaired a little bit... Also the compassionate approach... like you know the call bell goes, and it’s like oh no, I have to go and see that person again. You know, I always say there’s taking somebody to the bathroom, then there is another thing taking somebody to the bathroom in a compassionate way.” (RN, emergency and acute care)

“We are working too long; it is not safe for us; it is not safe for our patients... When I started 20 years ago, understaffing was not a problem... In the past eight years or so not having enough nurses has had a huge impact on what we can do at our job.” (RN, emergency and acute care)

“The worst of it is that we are so short-staffed that we’re finding situations where nurses are so pressed that they have no choice but to lower patient care standards... There is no time, it’s more like just go, go, go... this patient, then the next patient, then the next patient... There is no time for relational practice anymore... It causes a lot of ethical dilemma for nurses because they are having to practice differently than we’re taught in school.” (RN, community mental health)

“The shortage has severely affected patient care to the point that we were actually taken to HR because we had so many pressure sores being found and skin breakdown problems that were being reported.” (RN, emergency and trauma care)

Another key consequence of excessive work demands articulated by nurses is the effect on work culture; in particular, some nurses considered fatigue to be a major driver of dissension among nurses within their unit. One nurse described the increase in “lateral violence” among her work peers due to “stress and workload.” Other illustrative comments include:

“Because I’m stressed out, I just don’t have time to be diplomatic with my colleagues — for lack of a better word — so I just can’t control it; and we’re finding with all the nurses the stress is so much it affects how they are with their colleagues. It is causing a lot of workplace environment investigations because this person said this or that.” (RN, community mental health)

“It’s created an us-versus-them environment; it was kind of that way between employer and employee, but now it has reached into the different units, and sometimes it’s nurses against nurses... It has become very toxic.” (RN, emergency care)

Stakeholders likewise spoke to the issues of workload, work hours and fatigue as risks to both nurse and patient safety. All viewed insufficient staffing as the major culprit.

Regarding the direct impacts on nurses:

“The workload is much greater now, and there is a shortage of health care professionals... so we have a lot of mandatory overtime, where at the end of a shift there is no nurse to replace them, and they are forced to work additional hours... and it creates additional strain on your daily work. When you’re working emerge and you’re minus five or six nurses, that is a huge strain cognitively, mentally and psychologically.” (Union leader)

“The major issue is the workload and the short-staffing; it is taking a mental, emotional and physical toll... especially in the past two years when a lot of accommodations have been mental health-based... Trying to get nurses back to the bedside in an environment where you can’t control the stressors.” (OHS expert)

“Right now, there is no balance between their life and their work, so this can have a negative impact on their life physically and emotionally.” (Academic researcher)

“They are very tired... I spoke to one retired nurse, and she said the mental toll over time has been dramatic... You go in, and it’s short-staffed, so the shift demands and expectations have escalated... especially in hospitals, nurses are not seeing any of that psychological support.” (Executive at a professional association)

Regarding the impacts to patient safety:

“In places where there are not enough nurses... they might have been working a 12-hour shift, but now it’s a 16-hour shift or a 20-hour shift because there is nobody to come in and relieve them... Extending those hours frustrates me because in this country we have folks that work in professions that have limitations for so many hours... You can only fly a plane for so many hours, right? Nurses are dealing directly with people’s lives... and somebody has gone to work tired... I knew a nurse that had got kept back to work a 24-hour shift. She said she was fine until she got to hour 20, and then she got a little bit dozy, confused, a little bit hazy. Would you want a nurse looking after you that was functioning in that way?” (OHS expert)

“I remember when I was nursing, I stayed up for 96 hours in a row... and I knew that I wasn’t providing care, I wasn’t giving medication; I was providing narcotics and could have made a mistake drawing insulin. It could mean the death of a patient.” (Union leader)

"If you're forced to work overtime through the night, you have to keep working and caring for patients and assessing the physical and psychological needs of patients, administering medications... You're increasing the risk by a huge level of magnitude." (Union leader)

"What we're seeing when we look at cumulative load within 12-hour shifts... when we draw on the research data, of course we see higher error rates with increased fatigue in nurses." (Academic researcher)

"Staffing and safe patient care, those things go hand in hand... That's the approach we need to take on extended hours and mandatory overtime." (OHS expert)

"If you think about the airline industry, you wouldn't say 'you can't take your break' to a pilot... You have a backup pilot, you have all this great technology, you have air traffic control because you don't want the plane to drop out of the sky and kill 300 people. However, if you look at health care, we probably kill that number of patients a day because we don't think about quality and safety, we don't think about what's best for nurses." (Academic researcher)

Stakeholders were also well-aware of the risks to nurses post-shift due to more nurses driving home while severely fatigued. One participant equated the driving risk associated with fatigue with the risk posed to patient care:

"There is research, if you haven't slept in so many hours, it's like you have been drinking, and you have this much alcohol in your blood... If they're not safe to drive home, how are they safe to provide care?" (Executive at a legal support organization)

Other informative comments from stakeholders in this context include:

"In the rural areas, you know, there could be 20 miles of highway between you and your home, and if you're working a double shift that night... The hazards of driving home and not remembering... especially in the fall with all of the deer running around." (OHS expert)

"When they are forced to do overtime, what if you have to drive home 30 minutes, 45 minutes, an hour? You could fall asleep at the wheel." (Quebec union leader)

More broadly, both nurses and allied stakeholders expressed a great deal of concern regarding how the adverse impacts of extended work hours and poor working conditions are functioning to push more and more — mostly senior — nurses out of the public system, or away from the profession altogether, with implications for a slide toward the “collapse” of health care.

Several striking comments from nurses illustrate the point.

“It [health care] is collapsing... We see a constant shortage... The nurses burn out, and then they are off sick... There is too much stress on one nurse, so she is sick the following day... They end up spending more money.” (RN, long-term care)

“We’ve had eight to 12 senior nurses leave... Now we’re really stretched... There were points where we were closing half of our department... Normally it takes 20 nurses to run the department, and we were running with 12... There are just not enough senior nurses... and junior nurses are taking on too much responsibility, and there are mistakes being made. But it comes to a certain point when enough people leave the department — you just set people up to fail.” (RN, emergency and acute care)

“It’s a difficult environment for new grads since they are like ‘what am I supposed to do here’, and the most senior nurse has only two- or five-years’ experience; we don’t have mentors anymore because the majority of them are leaving, they are retiring early.” (RN, community mental health)

“I do plan on staying in health care, but I hope the conditions improve, because if it gets worse than this — I don’t know. I’ve heard of nurses not even trying to enter full-time work after education because they are just exhausted... Like for me, I had to take the summer off because I was just exhausted.” (RN, long-term care)

Some nurses made note of the increasing reliance on agency nurses within their units and the potential corrosive effects within the public system. Key issues in this context include high levels of turnover, a lack of consistency in nursing experience and lower continuity in standards of care.

“What worries me now is that they are trying to solve staffing shortages with agency nurses... We are getting agency nurses coming in from everywhere, including internationally trained nurses, and everybody’s experience level is different. We’re struggling with an enormous high turnover of staff... Almost half of your staff is new every three months... You have to learn what their capabilities are, what their skills are.” (RN, emergency and acute care)

“We have more and more agency nurses coming in... so when they come in, sometimes they are getting double, sometimes triple, so it’s no wonder so many nurses are leaving the public system for private agencies; and they have more control over their schedule... It’s the ideal situation.” (RN, emergency care)

Allied stakeholders expressed a similar level of concern toward the ability to maintain the integrity of the public system going forward given trending rates of attrition among nurses. A key issue relates to the nature of the incentives, with private agency nurses generally receiving better pay and having more autonomy over work schedules.

“With the pandemic, it has led to an exponential growth in private agencies, because people were able to manage their working conditions, which is not the case when they’re in the public sector. So, they resign from the public sector on Friday, and on Monday they are working for an agency. It’s public funds that are paying a private, for-profit organization to staff public institutions.” (Union leader)

“With the overtime now, there is a huge reliance on agency nurses... We’ve incentivized nursing to the point where our members are working in the same unit with a nurse from out of town... She’s getting a hotel room and 20 bucks more an hour and not paying any union dues. So they’ve created this monster.” (OHS expert)

“There is such frustration [among public sector nurses] now with all of the agency nurses that they are bringing in because they are here for a short time... They get set shifts, and they don’t work outside those hours. And they get paid a whole lot more. It’s an expensive short-term fix, but it is not fixing anything.” (OHS expert)

“With so many hours here and so many hours there, is it any wonder why nurses turn around and do agency work? If you’re going to be sent to any unit in the hospital anyway, why not do it for three times the money, right? So I think we’ve deconstructed the stability in the workforce.” (Academic researcher)

3. The role and responsibility of employers

Nurses generally described their relationships with employers in “us versus them” terms. Despite mounting workloads, greater patient acuity and the pressure to work more hours, the pervasive sense from nurses was that employers mostly lacked empathy and failed to “respect” their efforts.

“You know, we deal with sick people, we deal with death, we deal with anything... It isn’t a normal profession. There should be more appreciation of nurses; they should be mindful of what we are going through.” (RN, long-term care)

“They really did not care if you’ve had a break or not... They just cared if a resident received whatever they needed to receive.” (RN, long-term care)

“I’d say three quarters of my shifts I don’t even get a break, you know? And you have to explain why you did take a five-minute break today, like in great detail... There’s no respect.” (RN, emergency and acute care)

Nurses agreed that they should have the right to refuse what they perceive to be work that is unsafe due to feeling fatigued. Some acknowledged that while technically they may have leverage to decline to work under such conditions (e.g., by appealing to their union via “heavy work forms” etc.), for the most part they felt pressured to continue working due to not only fear of abandoning patients and colleagues in need but also the risk of reprisal from the employer.

“There is the right to refuse if care is not safe, all of those unsafe work processes... but if the employer says ‘can you stay?’, sometimes they don’t ask, and you can’t really leave because you’re the RN, and if I walk away, it’s patient abandonment, as well as the staff who are still there and they can’t report to anybody... We remind them of their rights, but a lot of nurses are also afraid of employer retaliation.” (RN, community mental health)

“You can’t abandon your post, you can’t leave. You’re forced to work... unreasonably forced. We are threatened with it [censure or having license revoked] constantly.” (RN, emergency care)

Some nurses directly accused employers of unreasonably using staffing/overtime mandates, while discounting their responsibility to nurse and patient safety.

“You do it for your colleagues... but when management mandates it [overtime], this falls away... They will mandate you, and you have no choice. I believe that if you tell management that you’re too tired and that you’re unsafe to work, they should not mandate you.” (RN, emergency and acute care)

"We're told outright, if we don't agree to stay, then our manager or management has to mandate us to stay. Many times I've had them say to me, 'well, I don't need to mandate you because you can't leave anyway...' [Interviewer: 'It's borderline abusive...'] It sure is." (RN, emergency care)

"Employers don't feel like there's any obligation to the nurse's personal safety or to the patient's safety to make sure that you're not too tired to actually do your work... They don't care, I'm sorry — they don't care." (RN, community health nursing)

One nurse described her situation with an employer that allowed a clinic to operate without sufficient staffing, despite the fact that highly vulnerable patients were unable to access care in a timely manner.

"I work a day shift and was supposed to be done by 3:30, and it was 6:30 at night, and there wasn't someone coming for an hour; we still had someone waiting... so I got the patient settled and I just said 'you know, the next nurse will come in'; and it was awful. I remember leaving that day thinking 'okay, now I have physically harmed this patient,' I felt like I was abandoning that patient." (RN, emergency and acute care)

Over time, this individual came to feel that working in this type of environment meant that she had been "enabling" a system that provides poor quality care.

"There was a group of us who decided that we can't do this anymore; if we do it, we're enabling the system, we're enabling them to make poor choices for patient care." (RN, emergency and trauma care)

Nurses were also asked about the degree to which they believe employers are responsible, or liable, for their safety when they are working fatigued. In particular, most of the nurses we spoke to believe that employers share responsibility for the risk posed to nurses from driving home sleepy post-shift.

"If you work 16 hours, that should be an option [for employers to offer nurses a drive home to make sure they get there safely]." (RN, emergency and acute care)

"If you're exhausted, it can be a danger when people get on the road after 16 hours." (RN, emergency care)

"I've literally been told [by my manager] to roll down my window and 'it'll keep you awake...' I've texted my colleague to say 'hey, I got home alright.' I've never been offered a taxi, but I think they should make that option possible... so you leave your car and get a taxi or Uber or whatever, and they will pay for it." (RN, community mental health)

Stakeholders agreed that employers must take responsibility for tired nurses driving home post-shift. Excerpts from conversations with stakeholders illustrate the general sentiment.

“If they’ve got really tired nurses working mandatory overtime, they are very sleepy, and then they have to provide a drive home; you know, they are almost drunk with fatigue. If they don’t feel safe to get home, the employer should provide taxi tickets.” (Union leader)

“You can get in your car and drive home and not even remember getting there... It’s a dangerous situation... I’m going to relate it to if somebody were so intoxicated and whoever was with them put them in their vehicle and let them drive home. Why would that be any different than somebody who is so fatigued that they can hardly walk straight? Having them walk out the door, get in their vehicle and drive home? So if there’s an expectation that you’re going to work those hours, then it is reasonable to put that nurse in a cab and make sure they get home. I wouldn’t want to see it abused... but there is a responsibility on employers to keep their employees safe.” (OHS expert)

“There is data that shows that your risk of accident is like tenfold or something if you’re driving drowsy... I think [the employer] does have an obligation to make sure their employees are safe. It would be no different than the fact that they have an obligation when they have social functions for their employees and alcohol is served; they have to make sure they don’t drive home drunk.” (Executive at a professional association)

Other employer obligations identified by stakeholders included providing nurses meals, since many — especially when on night shift — do not have access to fresh nutritious food. As noted by one participant:

“The employer should be responsible for meals as well. I’ll give you an example. I work evenings, full time. I bring my lunch. I finish at midnight... Now I’m forced to do an extra eight-hour shift. The cafeterias are all closed... Well, now I don’t have a meal; my body needs food... We’re humans, right? For my mind to function. That obligation should go to the employer.” (Union leader)

Improving relationships with employers was considered central to forestalling attrition and retaining nurses within the public sector. Among nurses, direct indications that their employer is “listening” to them and their concerns, coupled with explicit demonstrations of “empathy” and “respect”, are key.

“The biggest thing is employers need to be working with the frontline [nurses] on ways in which they can improve... There needs to be a collaborative approach where leadership is sitting down with us; our managers are great, but there is a disconnect with leadership.” (RN, emergency and trauma care)

“The unit culture aspect is important, supporting you to take breaks and asking: ‘Is there any way I can support you? Let’s figure out a plan.’ From what I’ve experienced, where I’ve worked before where the unit culture is better, more nurses are willing to stay longer or pick up an extra shift.” (RN, long-term care)

Specific provisions from employers that nurses said they would like to see included “professional development opportunities,” “staff appreciation days,” and designated sleep spaces to recover from long shifts. Comments from nurses in this vein include:

“Most nurses want to eventually do more than shift work, so it’s good for the employer to offer opportunities for nurses to engage in additional education and additional professional development, things that would really help nurses to define their own practice and feel like they’re growing professionally.” (RN, long-term care)

“The doctors and residents get a place to sleep if they are working an extended shift, but nurses have to sleep in the family waiting room in makeshift beds... I didn’t want to have to figure it out, so I just didn’t sleep. I think that would help.” (RN, long-term care)

“I would recommend what I like to call staff appreciation day; I know some managers try to do that, they try to do BBQs, little gifts, gift cards; but it’s the little things, right? It’s like, ‘oh wow, somebody recognizes me, there is some gratitude that you matter, and respect for what you do.’” (RN, long-term care)

Nurses also described how even “little gestures” of appreciation from employers can “go a long way towards building trust and respect.”

“Even little gestures, like nurses are so happy with food, or once in a while if it’s too hot and you give out popsicles. Then people start to smile, and it changes the atmosphere among staff... A popsicle is not going to make a dent in their budget, but it shows that you definitely care... It’s a respect issue.” (RN, long-term care)

“I can’t imagine my manager coming down the hall with a tray of fresh fruit or a nice lunch and say ‘go eat, clear your head,’ or for those people who have to drive an hour outside of town — ‘we’re driving you.’ My God, that would be amazing. Just little things like that go a long way towards building respect and trust and a better environment.” (RN, emergency care)

Allied stakeholders concurred with their frontline counterparts that retaining nurses requires that employers build better relationships by creating “safe and supportive work environments” that facilitate direct “engagement” between management and frontline staff. Comments from stakeholders in this vein include the following:

“We have to ask ourselves, ‘what are we doing in terms of engagement surveys?’ Creating a safe, supportive work environment is job number one... You can’t deliver your business without people, so you have to look after the people.” (Executive at a regulatory agency)

“Giving nurses resources, food, caring managers... It’s about trying to retain who we’ve got, right? They [the nurses] need to feel cared for.” (Academic researcher)

“We need the employer to say ‘we’re here to help you, we want to keep you here; how can we support you?’” (OHS expert)

4. The role of regulation and legislative action

Nurses and stakeholders were queried as to the utility and practicality of setting regulatory limits on work hours in nursing. As an analogy, participants were presented with current federal mandates that set work hours maximums within safety-critical industries such as aviation, nuclear and transport, and asked whether these types of legislative limits would be feasible in health care.

First regarding setting reasonable work hours limits, there was some variation in what nurses consider “safe.” With respect to number of consecutive work hours (i.e., shift length), responses ranged from eight hours to 10 or 12 hours, though to some extent appeared to be contingent upon practice area/work context. Some nurses also noted shift timing (i.e., day versus night) constitutes a relevant factor. Excerpts in this context follow.

“I would say that for long-term care the eight-hour system makes sense because of how they organize things; in hospitals I’ve noticed the 12-hour style of care is more manageable and makes more sense because, at least for the critical unit I was on, you could get a week off, and it’s like a mini vacation to recover.” (RN, long-term care)

“I’ve always worked 12-hour shifts, and generally I think that most, myself and my coworkers, feel like that’s the best for patients too.” (RN, emergency care)

In general, there was consensus among nurses that, although 16 hours is sometimes worked in practice and is even stipulated within some collective agreements as the de facto “safe” maximum, in general this number of work hours exceeds the limits of safety for most nurses.

“For our contract, it’s 16 hours in a 24-hour time period, but it [the maximum number of hours a nurse can work consecutively and stay safe] is 12 hours.” (RN, emergency and acute care)

“I do work 16s, but some people are like ‘oh my goodness, I can’t do more than 12’; I think it is really dependent on where you work too... I can say that I’ve never worked so hard until I worked in emerge.” (RN, emergency and trauma care)

“I’ve done 16 hours before, and I hated it... You’re too tired to actually do your work.” (RN, community mental health)

“In eight-hour settings, they’re doing double... and it’s too much... When I’ve worked 12-hour shifts, I’m definitely like ‘okay, my body is tired, I’d really like to go home.’ Extending that to 16-hour shifts, there is really no energy left in you... It’s heavy work.” (RN, long-term care)

“When you work a 12-hour night shift, and then you have to stay four more hours, and for the day, and you’ve been working all night, that’s brutal. That’s really not safe.” (RN, emergency care)

Nurses also had a firm sense of what constitutes safe maximums for number of consecutive shifts and weekly work hours.

“Working 10-hour shifts for four days is not too far from 37.5-hour workweek for those who work Monday to Friday, which is reasonable... Anything above a 40-hour workweek, you feel physically you’re compromised.” (RN, community mental health)

“The max I worked [on 12-hour shifts] was four in a row... They did that for night shifts, and I feel like for night shifts it was easier for me personally; but by the fourth shift it was pushing it, maybe, near the end.” (RN, long-term care)

“I’ve done six 12-hour shifts in a row; that’s too much. I think five, but not six. At the end of it you’re just exhausted.” (RN, emergency and acute care)

With the exception of one stakeholder, who stated that “the maximum for safe practice, safe care, human care should be 16 hours,” allied stakeholders agreed that the maximum shift length for nurses should be set at 10 or 12 hours.

“Beyond 10-hour shift is probably where we are getting unsafe for patients and unsafe for us... I spoke to one nurse who agreed with me that the sweet spot is probably 10 hours.” (Executive at a professional association)

“I think 12 hours is a safe and reasonable maximum.” (OHS expert)

“After 12 hours you’re physically tired, you’re less apt to jump in and help; so yeah, definitely I would say 12 hours is the max.” (OHS expert)

All participants — stakeholders and frontline nurses — agreed that nurses should have the right to refuse additional work hours if so fatigued that they believe they may be putting themselves or their patients at risk. Some pointed to protections that already exist within collective agreements in some provinces (e.g., Manitoba’s 16-hour maximum), as well as federal and provincial occupational health and safety policies that endow workers with the right to refuse work that they deem “unsafe or dangerous to themselves or others.” However, many agreed that in the interest of protecting nurse well-being as well as public/patient safety more broadly, an additional layer of regulation like that which currently covers workers in federally regulated safety-critical industries could be very helpful.

Among nurses, relevant comments include:

“They have those [hours] limits for public safety, like because truckers that are tired are going to be killing people on the road... I think 100% [the same limits should be implemented in health care]; I have a brother who is a pilot, and he tells me that all the time how the same thing should be done for nurses. It should be mandated somehow... It’s to protect the public.” (RN, community mental health)

“I really don’t understand why it isn’t [mandated like in other safety-sensitive industries], I mean even the medevac teams and pilots, they are capped at 16 hours, they do not fly. They are not threatened with abandoning their post.” (RN, emergency care)

“Absolutely [there should be hard limits on work hours in health care as in other safety sensitive industries]. Actually, after the CFNU conference one of my flights got delayed because the pilots reached their 13-hour limit... and that’s for a safe reason, like, after 13 hours that’s a fair limit because I don’t want to crash. So why are we expecting health care workers to provide sometimes very dangerous drugs with no safeguards?” (RN, long-term care)

Among stakeholders, comments in this vein include:

“I frequently talk about pilots, truck drivers — there is lots of evidence to suggest what is safe work and how much rest is needed for them to be safe... and it’s a more vulnerable population, and it’s a patient safety issue... It’s a public safety issue for trucking... and it’s a public safety issue for health care and nursing as well.” (Executive at a professional association)

“I think there’s room in collective agreements... but enforcing it there... even though there’s that concept of obey and grieve, if you’re asked to do it and you can’t refuse it, then you have to grieve it. So I’d love to see additional protections in health care, I’d be a big advocate for it from a health and safety perspective.” (OHS expert)

“I think it [legislation] is the next step where we have to go to the next level. It’s only when you place a framework and conditions that employers will have an obligation to respect these criteria. Why is it in aviation? They put it in place for pilots because it is a question of safety. Well, for nurses it’s the same question of safety.” (Union leader)

“I think there needs to be a cap [on hours] just like there is for pilots and for truck drivers and everybody else, because why are nurses being treated any differently? There are high-capacity units with high levels of equipment and medications, and they are not 100% there. It’s no different than if you’re drunk, you’re intoxicated because you’re overly tired.” (OHS expert)

In a similar vein, most participants agreed that even in the presence of regulatory limits on work hours, the use of methods for directly monitoring fatigue in nurses would be prudent since, as one nurse put it, “you know yourself best.” In particular, for the most part, nurses and stakeholders supported the implementation of fatigue risk management (FRM) tools, including fitness for duty protocols such as those used in rail and aviation.

Factors that contribute to perceptions of a variation in the ability to tolerate extended shifts included age, domestic/family circumstances and work assignment/care specialty. In turn, some viewed fitness for duty tests involving validated sleepiness scales as a key way of managing dangerous levels of fatigue in nurses. Relevant excerpts from conversations with nurses include:

“I think young people can do it more easily; for older people the 12-hour stretch is quite long.” (RN, long-term care) [MAJOR FACTOR: AGE]

“I think that 12 hours is the maximum... I’m still doing night shifts, but there is a position coming open that is days only, and I applied for it because I’m tired, I’m exhausted... I think it’s my old age [laughs]... and being in the profession for so many years.” (RN, emergency and acute care) [MAJOR FACTOR: AGE, CUMULATIVE IMPACT]

“The maximum number of hours a nurse can work really depends on multiple things... I have little kids at home... and I’ve never worked so hard until I worked emerge.” (RN, emergency and trauma care) [MAJOR FACTOR: FAMILY CIRCUMSTANCES, WORK ASSIGNMENT/CARE SPECIALITY]

Allied stakeholders were largely in agreement that individual differences in the ability to tolerate extended hours, coupled with variations in workload, make fitness for duty assessments a good idea in nursing and health care.

“The self-auditing for ‘I’m too tired to continue’, fitness for duty, those kinds of measures would be extremely useful, I would be in support of all of those types of things.” (OHS expert)

“Truly the best way to go is to set a maximum [on number of work hours]... but I still think that that maximum may not be for everybody... You might be telling me that you can schedule me for that many hours because that’s what you need, but I’m telling you that I’m not going to be safe to practice for that many hours. So I think it’s a combination of things.” (OHS expert)

“Regulatory authorities want to provide safe care; I think mandatory overtime is a measure of last resort, and so integrating [fatigue monitoring] tools sounds to me like a great idea... It would have a much better chance of success if it’s integrated with a broader plan.” (Executive at a legal support organization)

5. The need for effective planning to improve working conditions and remedy staffing shortages

There was consensus across participants that excessive work hours in nursing stems from a broader systemic problem of too few nurses working in the public system. In turn, it was generally understood that ensuring safe work hours requires long-term planning around resolving staffing shortages. Still, in the interim, addressing adverse working conditions in health care was viewed as critical to retaining nurses and forestalling the potential “collapse” of the system.

In addition to the implementation of work hours protections, near-term remedies that participants said would help to mitigate the impacts of rising workloads and unsafe work hours, while forestalling attrition in nurses, were: regulation of agency nurses; mandated nurse-to-patient ratios; and workplace-level efforts to promote healthy working conditions and nurse well-being.

Regarding agency nursing, nurses and stakeholders alike said that while private agencies are filling an immediate need, the growing presence of agency nurses is contributing to diminished morale among public sector nurses and may ultimately have a deleterious impact on the public system as a whole. Key issues in this vein were disparities in pay and degree of scheduling autonomy, such that the incentives for nurses to choose to work in the public system appear to be waning.

Some illustrative comments from nurses include:

“We have more and more agency nurses coming in... They’re getting in some cases double [the pay], sometimes triple... They also want to have a life outside of work. It’s a tough pill to swallow. They have the ideal situation.” (RN, emergency care)

“They’re not bad nurses... but they come to these assignments to make money... If everybody would be paid the same and the conditions would be the same all over the country, we wouldn’t have to rely so much on agencies.” (RN, emergency and acute care)

“So they’re willing to pay agency nurses double or triple, why am I bending my back just to work every day and they’re not doing something astronomical? The agency nurses are treated first-class, and we’re all second-class interns. They pay them all these big bucks... they never get reassigned, we get reassigned... they shuffle us around. So we have no control, and they have all the control.” (RN, community mental health)

Stakeholders echoed nurses’ sentiments regarding the threat posed by the increased use of agency nurses:

“There is the problem around pay equity with the private agency nurses. I was speaking to some nurses who are working alongside agency nurses who are there for just a short assignment, and they are making two to three times what the public sector nurses are making... One of the agency nurses said, ‘you know, I’ve got it made.’” (Executive at a professional association)

“There is a huge divide right now. And I’ve talked to nurses that say there is a tension there between publicly funded nurses and agency nurses... They’re making three times as much, they’re able to make their own hours, and they’ve got so much more autonomy... There is some resentment that’s building in the system because of it.” (Executive at a regulatory agency)

“I think there is a tension there... It irritates the nurses that are in the public system that there’s someone working beside them that is getting paid more than them.” (Executive at a professional association)

“Right now, where there is so much frustration with all of the agency nurses they are bringing in... They get set shifts... they don’t seem to work outside of those hours. And they get paid a whole lot more.” (OHS expert)

“With the pandemic, it’s only led to the exponential growth in private agencies because people are able to manage their working conditions, which is not the case when they’re in the public sector, and it’s a revolving door. So they resign on the Friday, and it’s ironic that on the Monday they’re working in the same place via an agency. So it’s public funds that are paying a private organization for profit to staff public institutions. So the nurse resigns on a Friday and ironically, she’s back at work on Monday, and she puts in conditions: ‘I’m only available on these days.’ So that creates huge frustrations within our members.” (Union leader)

Some participants identified mandated nurse-to-patient ratios as a mechanism for mitigating workloads with the potential to accelerate efforts to deal with nurse shortages. One nurse in BC, which recently announced their intention to institute mandatory nurse-to-patient ratios, described her elation at finally getting this layer of protection in her workplace this way: “It’s like a miracle, I’m so excited to see it come to fruition; there is clarity there now that will help a lot of nurses.” Stakeholders felt similarly regarding the positive impact of ratios on nurse morale and the potential to “attract [more] junior nurses” to the public system.

Relevant comments from stakeholders follow:

“For us it’s ratios, safe staffing care... When I speak to our minister of health or our government, they say ‘well, if we put in place ratios, we’re already short-staffed, so you’re going to get grievances’, and we’re saying ‘no, no, we’re putting in place safe care, safe staffing ratios, so you’re going to attract junior nurses.’” (Union leader)

“In British Columbia our provincial government in the last round of bargaining introduced patient-to-nurse ratios as a policy commitment. I was fairly pleased to see that... I’ll call it like ‘chewed around the edges’ of understanding better the impact of longer hours on patient safety. I believe that when California introduced their patient-to-nurse ratios, they actually attracted nurses back to practice because they were like ‘oh, finally you get it, I’m not going to be alone with 40 patients.’” (Executive at a regulatory agency)

“I think... patient ratios and set hours are two things we desperately need... The workplace, it's quite chaotic and it's extremely difficult for new graduates and likely a significant retention issue.” (Academic researcher)

Additional strategies identified as key to improving working conditions with the concomitant benefit of achieving better rates of retention and recruitment included workplace-level interventions to ameliorate workloads and promote nurse well-being. Stakeholders described the effectiveness of using a “team approach” in nursing, with RNs able to utilize “more pairs of hands” to do their work.

“In many countries the registered nurse will have a team of people working with them... It would make sense to be more hierarchical like Brazil, where you would have an LPN working with you and three assistants; if you have a team, and it's your team, not just an abstract team where the manager says ‘we're all a team.’ Now you actually have more pairs of hands to do your work. More structure to the workplace where the registered nurse has more person power at their disposal to do the work would hopefully make for retention at the bedside, instead of everybody burning out in parallel.” (Academic researcher)

“I really believe in team-based care because it's more than one set of eyes and ears and whatnot. We start with the team, and how can we distribute work and how can we give breaks and how can we prioritize what nurses should be doing during the prime time of the eight hours? You have to be really strategic in the absence of enough staff... In any setting we're in, whether it's the community, acute care — you have to think about workload distribution, and sometimes you have to extend your staff so that the less essential work is done by people who can do it with some training...” (Academic researcher)

In this vein, some participants raised the concept of the “Magnet hospital” as the “gold standard” for structuring work and work culture in a manner that empowers nurses their area of practice.

One stakeholder described one key area in which the Magnet model functions to protect working conditions is established rules around “no new admissions, no transfers within the last two hours of the shift.” According to this participant:

“The end of the shift was for nurses to get their charting done, to tighten up loose ends and talk to families... What the literature suggests is that there needs to be that buffer time of nurses coming on and nurses going off — and you're both there, and new nurses are getting into the groove. It's a good time for care aids to help answer bells, stock rooms and take care of some of the structural issues nurses don't want to have to deal with... It helps nurses to really focus on the prime time in between when the majority of care is going to happen.” (Academic researcher)

“We have suggested a Magnet-like accreditation program in Canada, which is based on humanistic relationships, better leadership, so nurses can feel safe. They work in a high-quality environment, so they can feel motivated and safer to work; it has a positive impact on nurses, their co-workers and their patients... So it is going to attract nurses to work.” (Academic researcher)

In addition to encouraging hospitals to seek Magnet accreditation, one academic researcher suggested that there should be quality assurance standards in health care, “similar to the recent CSA standard that has been implemented for first responders” — i.e., the first responder fatigue risk management system — or the international standards for managing occupational health and safety risks related to fatigue, such as those provided by the ISO 45001 Occupational Health and Safety Management Systems.

Other smaller-scale fixes at the workplace level mentioned by participants included building in career advancement ladders within or across units, that provide nurses with professional development opportunities and allows them to “refine their practice” and “expand their capacity.” This was viewed as something that could benefit not just nurses but was also “good for the system overall.”

In addition, providing direct psychological supports was identified by some participants as a way to both improve nurse well-being and heighten morale among work teams. An executive working for a professional organization representing mental health nurses described the benefits of offering a psychological “debrief” this way:

“It’s in the literature, it’s a highly evidence-based process... The best I have seen, it is with the emergency task force with the police, they unpack all of their calls, and they deal with the emotional piece, they ask her ‘how are you doing? what is the impact?’ There are learnings there because all nurses are seeing the same stuff... Even if you’re a cardiology nurse, you’re seeing all kinds of stuff, you’re seeing death.” (Executive at a professional association)

A nurse that had benefited from a workplace psychological support program described its impact:

“We’ve had COVID, floods, fires — all of these big global events, and it’s accumulated, so they’ve started this new program, and it’s a good thing because at least it recognizes compounding stress.” (RN, community mental health)

Discussion

Key informants were unanimous regarding staffing shortfalls as the fulcrum of excessive growth in workload and work hours in nursing, with the potential for serious adverse safety consequences for both nurse well-being and patient care. Though it was acknowledged that it will take years to remedy the structural-level deficiency associated with too few nurses working in the public system, there are several more proximate interventions that governments, regulators and employers could work collaboratively to substantially improve working conditions, retain/attract nurses and help to ensure delivery of high-quality patient care. Key areas identified in this vein were: the role of employers in creative supportive work cultures based on “respect” and “engagement” with frontline nurses; introducing additional layers of protection against unsafe work hours via legislated work hours maximums; monitoring nurses’ level of fatigue using validated tools and accounting for individual factors such as age, work intensity and circumstances that can impact sleep (e.g., having small children at home), that may accelerate fatigue and fatigue-based risk; regulating use of agency nurses; instituting nurse-to-patient ratios; and providing ready access to wellness counseling and other forms of psychological care.

Finally, in closing, participants were asked to give their view on where health care in Canada is headed and whether they felt “hopeful.” All, including nurses, indicated that there was still “hope” and that, despite the current state of “exhaustion” in health care workers, they trusted that both government and the relevant “experts” will come together to make improvements. One veteran nurse summarized the overall sentiment of participants as follows:

“I would say health care is at a crisis point... but there is a little bit of hope left, and I’m hoping we’re at a point where the government will have discussions with experts and see where the gaps are, what are the needs, and listen to the nurses and actually apply those hopeful solutions for the future of health care.” (RN, community mental health)





CONCLUSIONS AND SYNTHESIS OF FINDINGS, PHASES 1 AND 2

The goal of this study has been to identify evidence-based thresholds for what constitutes “safe” work hours in nursing. Drawing on occupational fatigue and fatigue-based risk as focal constructs, three outcomes were examined: risk of safety incident; risk of workplace conflict and lateral violence among work peers; and risks to health and well-being. A comprehensive review of the scientific literature reveals clear limits on the number of work hours that can be performed safely; with respect to shift length, there appears to be consensus that the risk of safety incident increases exponentially after eight hours, with risk doubling after 12 hours and as high as three times by hour 16. Moreover, there appear to be safety risks associated with work hours burden of more than 40 hours per week. Shift timing constitutes another critical factor, with night shifts associated with increased vulnerability to adverse safety consequences, particularly within what has been identified as the “window of circadian low” (roughly between 2:00 am to 6:00 am). Factors that can increase susceptibility to fatigue and fatigue risk include age, biological sex, health status, sleep habits and level of work intensity. Additional evidence shows that, over time, chronic exposure to excessive work hours can contribute to the erosion of a healthy work culture, increasing the risk of conflict and lateral violence among work peers; there is also a well-established link between long-term exposure to long work hours and several adverse health outcomes ranging from sleep and mood disorders to heart disease, metabolic syndrome and cancer. In turn, the literature recommends setting limits on successive work hours at no more than 12, with no more than three to four consecutive work shifts. Monitoring of fatigue levels is recommended during extended work shifts (>8 hours), particularly those that occur at night. Duty-free recovery breaks during a shift, including the opportunity for napping, have been demonstrated to significantly reduce safety risk.

Current federal regulations of safety-critical industries such as motor vehicle operations/trucking, rail, nuclear and aviation have already incorporated much of this evidence into their fatigue-related protocols. In the interest of public safety, workers in these industries face strict limits on total number of consecutive work hours (shift length), number of successive shifts and mandatory minimum periods of recovery. These industries also employ fatigue risk management programs, including fitness-for-duty protocols that monitor sleepiness and fatigue (e.g., Karolinska Sleepiness Scale) in individual workers. Similar restrictions exist within safety-critical industries in peer countries (US, UK), though only the UK has instituted broad territory-wide regulations covering workers in all industries, including health care (i.e., European Working Time Directive).

Evidence from in-depth interviews with frontline nurses and allied stakeholders provided a window into the real-world consequences of excessive hours as well as what these individuals consider “safe.” Conversations with key informants indicate convergence with maximums we see in the literature, with consensus around a limit of no more than 12 hours. Beyond this, nurses we spoke to described their state of being using phrases such as “just coasting,” “not fully there” and “too tired to actually do my work.” For the most part, allied stakeholders agreed that 12 hours constitutes a “safe and reasonable maximum.” All participants were in support of legislation to set maximums on work hours in health care since it viewed as a “public safety issue for health care and nursing as well.” All agreed that individual differences in the ability to tolerate extended shifts due to variables such as work assignment/care speciality, age and individual circumstances that impact sleep and recovery indicate a need to monitor fatigue levels in nurses using established fitness-for-duty metrics and protocols. Instituting limits on work hours was viewed by participants as a key mechanism for improving working conditions and forestalling rates of attrition among nurses. At present, mounting workloads and concomitant increases in work hours are considered a “push factor” that is driving nurses out of the profession or at least away from the public sector. At the same time, participants noted that the co-incident growth in private agencies has created a perverse incentive that functions to pull nurses out of the public system due to factors such as higher pay and more control over work hours and assignments. One participant described the “revolving door” that is currently in place, where nurses “resign on a Friday” and “return to the same workplace on the Monday” as agency employees that are able to “set conditions” regarding their work circumstances. As a consequence, all participants, including nurses, view the status quo as potentially setting public health care on course toward “collapse” in view of ongoing losses within the profession coupled with greater difficulty attracting new nurses. Still, for the most part, nurses and allied stakeholders said they remain “hopeful” that implementation of some key legislated protections, alongside workplace-level efforts to promote healthy working conditions and nurse well-being, can function to stem the flow of nurses out of the public system while incentivizing recruitment. Regarding legislated protections, in addition to setting statutory limits on work hours, specific recommendations included the regulation of agency nursing and mandated nurse-to-patient ratios. At the workplace level, specific measures identified by participants included: adoption of accredited standards in workplace safety (e.g., Magnet hospital accreditation, CSA/ISO standards in occupational health and safety, and fatigue management); greater use of a “team-based” distributed-workload approach to nursing; and providing nurses’ access to professional development opportunities that offer the prospect of career advancement. Overall, there was a sense of optimism among participants that the implementation of deliberate thoughtful and effective measures to improve working conditions for nurses can go a long way toward building morale, improving patient safety and quality of care, and fortifying Canada’s health care system for the long term.

Implications for future research

This study identified clear safety limits on work hours due to the risks arising from occupational fatigue. The shortage of nurses working in the public system constitutes the fulcrum of the problem of long work hours and remains a barrier to comprehensive use of safe scheduling practices. Still, while attracting more nurses into the profession represents the key long-term goal, in the interim, several specific provisional or “stop-gap” measures may prove helpful for substantively improving working conditions for existing nurses while mitigating rates of attrition. Key areas for action recommended by nurses and allied stakeholders include employer/workplace-level policies to provide nurses with educational opportunities, implementation of team-based models of nursing practice, and adoption of recognized standards of practice or accreditation (e.g., CSA, Magnet hospital status). More broadly, additional layers of regulatory protection via safe work hours limits and mandated nurse-to-patient ratios were also identified as key to ameliorating excessive work demands. In future, it would be helpful to undertake tracking surveys using metrics derived from the qualitative research to identify the significance and magnitude of their impact on key outcomes such as turnover intention. For example, quantitative data on the desirability and perceived need of key provisions (e.g., team-based model, educational opportunities, safe work hours mandates) can be used to investigate the linkage with likelihood to remain in one’s current job. In turn, the application of regression modeling using odds ratios will allow us to identify specific measures with the highest probability of retention — e.g., the institution of safe work hours protection is predictive of an ‘X’-fold increase in the intention to remain in the public sector. These metrics can be tracked over time such that, as new measures and protections for nurses come online, we will be able to quantify their impact on turnover rates and intentions.

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