Health and Wellness of Commercial Motor Vehicle Drivers in Canada: Literature Review, Discussion and Directions for Further Research

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Executive Summary

Background: The current project was precipitated by a 2011 report prepared by Dr. Pierre Thiffault (Transport Canada, Chair of CCMTA's Human Factors and Motor Safety Task Force) concerning the role of human factors in the Canadian motor carrier industry. Phase I assessed the human factors associated with commercial vehicle crashes, as well as efficient interventions to address these issues. Phase II investigated how these human factors were being addressed by Federal and Provincial programs and regulations, as well as by voluntary initiatives within the motor carrier industry (MCI) in Canada. Phase III presented a gap analysis. The report proposed 44 action items to address fatigue, distraction and risky driving. One of the action items called for the development of a cutting-edge health and wellness (H&W) program for commercial motor vehicle (CMV) drivers in Canada, which in turn, led to the RFP for the current project.

As noted in the RFP, research and interventions on CMV drivers, at least in the U.S., has shifted to a broader emphasis on overall H&W. Although there is recognition that the H&W of CMV drivers is important and related to both road safety and the economic viability of the industry, there has been little systematic research in the area in Canada.

Purpose: As stated in the RFP, the statement of work was to prepare a discussion report that contained three primary components:

1) a review of the literature on the issue of H&W for CMV drivers (past 10 years) showing how the field has evolved; documenting potential relationships with road safety, productivity, driver retention and worker compensation costs; summarizing key findings from epidemiological studies; and discussing intervention and program evaluation studies reported in the literature.

2) a plan for a national study concerning the H&W of CMV drivers in Canada to collect baseline data on health risk factors, as well as information to guide the development, implementation and examination of H&W initiatives that have high potential for efficacy, effectiveness and efficiency, as well as feasibility and acceptability.

3) a discussion concerning the relevance and justification for developing further H&W interventions specifically targeting CMV drivers (both truck and bus drivers) in Canada with respect to impacts on safety, productivity, driver shortage and possibly other areas, as well as potential gains for multiple stakeholders (drivers themselves, carriers, provincial and federal government bodies, as well as the Canadian population in general).

Literature Review: A search of the academic journal literature was conducted using MEDLINE (PubMed), CINAHL, PsycINFO and Scopus, to retrieve articles published from 2000 to February 2014, in the English language. The search yielded 37 peer reviewed journal articles relevant to H&W of commercial drivers including 10 literature reviews, 14 intervention and 13 non-intervention studies. In addition, a search for grey literature (i.e., conference proceedings,
reports) was conducted in a variety of sources including the TRID database and the Canadian Research Index yielding 20 reports. Of these reports, three were interventions, 8 were surveys or other designs, and 9 were literature reviews.

The findings show that commercial drivers have multiple risk factors (i.e., smoking, obesity, hypertension, poor diet, lack of exercise and sleep) that can lead to various medical conditions (i.e., cardiovascular disorders, diabetes) and adverse events (i.e., crashes and falls). Sleep apnea is particularly problematic and is associated with increased crash risk and greater worker compensation claims. Screening and treating sleep apnea is paramount among commercial drivers due its high prevalence (up to 70% of CMV drivers), as well as reducing common risk factors associated with sleep apnea such as obesity, lack of exercise, poor diet and fatigue. This review also found that falls occurred in 25% of all commercial drivers (especially long haul truck drivers) and is a leading cause of worker compensation claims.

Several interventions such as the BP Downshift program and the North American Fatigue Management Program show preliminary evidence in reducing hypertension and fatigue in commercial drivers, respectively. Other interventions have also shown success in improving health behaviours, however, they are limited by self-report measures and various confounding variables. Additionally, there is a paucity of evidence on the effectiveness of interventions on workers compensation claims and health care costs. Most importantly, while there are many U.S. based studies, there is little information on the H&W of Canadian commercial drivers, particularly among bus operators. As will be stated, there is a critical need for a national epidemiological study to profile the commercial driver population in Canada, including short and long-haul drivers and various bus operators (i.e., school bus, transit and coach).

**Plan for a National Study:** The primary objective of a Canadian national epidemiological study would be to determine the most prevalent risk factors in different CMV drivers (i.e., short and long-haul truck drivers; transit and coach operators) who work in different provinces and work environments. This baseline data is needed to design interventions that address the most prevalent and most severe risks facing Canadian drivers. As CMV drivers are a large and diverse population in Canada (over 300,000) no one study design is perfectly ideal for recruiting participants in a way that would lead to a nationally representative sample. Thus three design approaches are described, each with unique strengths and weakness. However, before a final study design is selected and developed in detail it is recommended that a Research Advisory Committee of collaborating scientists as well as a Project Planning Committee with key industry stakeholders be formed. These committees would ensure the planned research would be scientifically rigorous yet be participatory with key stakeholders playing an active role in all aspects of the study (including design). Additionally, an environmental scan to gather existing information on CMV drivers, the companies they work for, their work environments, as well as organizational resources that may impact their H&W is needed to inform the final study design.
The first of the three approaches for an epidemiological study design would be to use a two-stage cluster sampling method to randomly select company representatives then CMV drivers to complete self-administered questionnaires. First, a sample frame of all companies employing Canadian CMV drivers would be developed using a variety of information sources and databases. Companies that are identified through a cluster sample approach would be contacted with a representative from their Joint Health and Safety Committee (or other company representative) invited to complete a questionnaire designed to obtain company level information about their CMV drivers and company characteristics. Commercial drivers within each of the selected companies would then be surveyed either using a census approach or a random sampling technique. The surveys would be developed and tailored to specific commercial vehicle drivers and company representatives (i.e., short and long haul drivers, bus operators, bus management, and truck management). The primary aim of this approach would be to obtain a nationally representative sample of transportation companies and CMV drivers across Canada (recruiting companies and drivers from all provinces).

The second approach, a mixed methods study, would recruit CMV drivers at truck stops, ferry terminals, and/or other locations (i.e., bus terminals, vehicle inspection stations) with each participant undergoing objective measurements of height, body weight, blood pressure and heart rate, in addition to completing a structured interview. The details provided for this approach are focused on truck drivers as this is a known at risk population and findings from the proposed environmental scan would be required to fully develop a recruitment approach that would generate a nationally representative sample of all CMV drivers.

The third proposed approach would collect health data from national surveys which could be linked with other databases to gather more comprehensive data on occupational health and wellness in commercial drivers. For example, data from the Statistics Canada Canadian Community Health Survey can be merged with data collected on CMV drivers from health care utilization and mortality databases to determine the associations between health conditions (hypertension, diabetes, heart disease, stroke, lung cancer), disability (i.e., from accidents, falls, musculoskeletal disorders, work stress), health services, and occupational characteristics (type of driving, tenure as a driver, etc.).

**Targeted H&W Interventions:** Our review supports the work of other investigators that CMV drivers are an underserved and at risk population. Their poor health results from unsupportive environments that do not promote physical activity, good nutrition, quality sleep, or access to health information or preventative health care. The health trajectory of Canadian CMV drivers has not been studied but is likely similar to commercial drivers in the U.S. who suffer high rates of injury and chronic diseases and die 12 to 20 years before they should. It is ironic that CMV drivers, who are integral to the vitality of the Canadian economy and to the economic well-being of all Canadians, suffer such a burden of injury and ill health. Interventions that address H&W of CMV drivers are needed in Canada to address this inequity.
CMV drivers make up a substantial proportion of the workforce and the Canadian population. Statistics on the number of CMV drivers in Canada is challenging to obtain but with over 300,000 truck drivers in the “for-hire” trucking industry and in private trucking, the number is large. Given the prevalence of CMV drivers in Canada, the consequences of this disproportionally high morbidity and mortality are profound. While the adverse impacts fall primarily on drivers and their families, the economic consequences for transportation companies, governments, and society cannot be ignored. Although there is no empirical evidence regarding the magnitude of the economic and quality of life impacts of interventions that would improve the H&W of CMV drivers, the few studies conducted suggest that tremendous benefits would accrue.

A recent report from the Canadian Trucking Alliance, titled the Report of the CTA Blue Ribbon Task Force on the Driver Shortage in Trucking, identified that perceptions of poor quality of life is one explanation for the inability to recruit new drivers. This task force recommended that interventions to improve driver H&W be implemented to address the shortage of drivers which is seen as the industry’s greatest long term challenge. The Conference Board of Canada predicts that in 2020 the driver shortage will be over 25,000. The difficulties in recruiting new drivers has led to an upward shift in the mean age of the CMV driver workforce; this presents another challenge as older drivers are particularly susceptible to occupational-induced health conditions leading them to leave the profession early. As H&W interventions for CMV drivers will improve the quality of life and reduce premature morbidity and mortality in long-time drivers, such interventions have the potential to play an important role in solving the driver shortage.

Due to the limited knowledge of commercial driver risk factors in Canada, findings from the epidemiological study of CMV drivers across Canada would inform the development of future interventions. Based on intervention findings from the literature, there are a few options that are supported by some evidence of effectiveness. The first option would be to target new commercial drivers, providing educational materials and resources that incorporate H&W beyond the traditional driver training, typically focused on injury and crash prevention. The second option would be to implement a comprehensive health promotion program targeting diet, exercise, smoking cessation and fatigue in all commercial company settings with continuous evaluation and monitoring of health and economic impacts.

Next Steps: CMV drivers are widely considered a vulnerable population with unacceptably high risks of injury, morbidity and mortality. Based on our review of the literature, further research is needed to characterize the work environment and lifestyle practices (particularly sleep, smoking, diet and exercise) of CMV drivers in Canada as well as to understand the interactions between various risk factors and the health and well-being of drivers. Obtaining baseline information, including national prevalence rates of health issues, is vitally important for public health, regulatory organizations, and industry to coordinate prevention efforts. This report presents a
number of options for collecting national epidemiological and other important data on Canadian CMV drivers in Canada.

The involvement of key stakeholders in the planning process (i.e., a participatory approach) is essential for ensuring buy-in for research studies (national survey, in-depth examination and/or linked databases) and ultimately for developing and implementing effective, efficient, feasible and acceptable H&W programs. We need to know what is currently being done to address driver H&W by provincial and territorial governments and other federal agencies and the various CMV sectors in different parts of the country. We also need information on the perceived need and demand (e.g., carriers and fleets of various sizes and their drivers, as well as owner/operators and bus drivers) for additional H&W programs and services. Thus, one of our recommendations for moving forward is to establish a Research Advisory Committee that includes representation of key stakeholder groups. Although not exhaustive, Appendix E lists the government bodies, as well as industry associations and non-profit organizations in Canada who we believe have a vested interest in the safety, productivity and health and well-being of commercial vehicle drivers.

Our review of the peer reviewed and grey literature indicated that little research has focused on the health of Canadian CMV drivers. Through preliminary analyses of a number of Statistics Canada databases we also found that it is extremely difficult to obtain statistics on specific occupational categories of CMV drivers (such as long versus short-haul truck drivers, or school, public transit versus coach bus drivers). Other investigators have overcome this challenge by linking databases from different organizations and one of the study options focuses on linked datasets. Given CMV drivers are understudied and their specific occupational groups are not well represented in health databases, a second recommendation for moving forward is to conduct an environmental scan. The environmental scan would identify all information sources that are necessary to effectively design and conduct the epidemiology study (i.e., number/types of drivers visiting specific truck stops; approaches for sampling transit and intercity bus drivers etc.).

The formation of a Research Advisory Committee as well as a Project Planning Committee and the completion of an environmental scan are the logical next steps for developing proposals for funding agencies. Through the use of teleconferencing and webinars, the costs of bringing key stakeholders together would be substantially less than face-to-face meetings. We believe that both these steps could be accomplished within four to six months. The main deliverables would be an environmental scan and a detailed research proposal for an epidemiology study of CMV drivers in Canada that reflects the needs of key stakeholders.
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1. Introduction and Overview

Truck driving is the second most common occupation in Canada (following retail sales), employing of 1 in 35 adult men (Ministry of Industry, 2008), and has the highest number of lost time claims (WSIB, 2006). The nature of the job exposes drivers to long work hours (up to 14 hr/day), excessive noise and vibration, prolonged sitting and unhealthy lifestyles. As a consequence, CMV drivers are at higher risk for adverse health outcomes such as psychological and psychiatric disorders, as well as detriments resulting from disrupted biological cycles, musculoskeletal disorders, cancer and other respiratory morbidities, cardiovascular disease, risk-laden substance use and sexual practices (e.g., Apostolopoulos, 2010). Also common among CMV drivers are unhealthy lifestyles such as tobacco use, physical inactivity, and poor diet. In the U.S., the life expectancy of CMV drivers is 12-20 years lower than the average population (Saltzman & Belzer, 2007). Consequently, CMV drivers are now considered a “vulnerable” or “high-risk” segment of the population” (FMCSA, 2007; Krueger, 2012) by the US Federal Motor Carrier Safety Administration (FMCSA), the Transportation Research Board of the National Academies (TRB), and the National Institute for Occupational Safety and Health (NIOSH).

The first International Conference on Commercial Driver Health and Wellness was sponsored by the FMCSA, The US Department of Transportation and NIOSH in 2010. Several priority areas emerged from this conference, particularly the need for a better understanding of the combined impact of multiple risk factors (i.e., irregular schedules, long hours of work, poor diet and nutrition, stress) on driver H&W, as well as productivity and safety. Recently, a national survey on the health, risk factors and safety of CMV drivers was conducted in the U.S. (Apostolopoulos et al. 2013; Sieber et al. 2014). This work was undertaken to provide baseline data for designing targeted interventions and programs to improve the H&W of CMV drivers.
As will be argued in this report, a similar nation-wide study is required in Canada to identify the major health risk factors and associated driver characteristics (baseline data), as well as to document current practices and programs offered by motor carriers and other transportation companies to increase the H&W of their employees. The H&W of CMV drivers has significant implications for worker productivity, absenteeism and turnover rates, insurance and health care costs, road safety, as well as the quality of life of CMV drivers and their families. The Conference Board of Canada (Gill & MacDonald, 2013) projects that by 2020 there will be a shortage of 25,000 to 30,000 truck drivers due to an aging population and fewer young drivers entering the field.

To set the stage for this report, it is important to define CMV drivers, as well as other key concepts and variables within the scope of this report. It is also important to describe licensing regulations for CMV drivers as these vary from province to province. Prior to outlining the purpose and objectives of this report, the human factors report by Dr. Pierre Thiffault (2011) which provided the impetus for the current project is briefly summarized.

1.1 Operational Definitions

Commercial Drivers: A commercial driver's license is determined in accordance with the National Safety Codes (NSC) standards. The NSC is a comprehensive set of 16 standards that provides minimum operational and performance requirements for all important aspects of commercial vehicle, driver and motor carrier safety, with the objectives of reinforcing truck and bus safety, promoting efficiency in the motor carrier industry, and ensuring the implementation of consistent safety standards across Canada. These standards apply to truck drivers and carriers operating commercial vehicles with a gross weight over 4,500kg and is intended for both extra and intra-provincial operations. Buses, meanwhile, are defined by a designated seating capacity
of more than 10, regardless of weight. Based on this definition, the report includes studies related to both short and long haul truck drivers, buses (school and transit operators, motor coaches) and utility vehicles (repair, maintenance or operating trucks).

**Short Haul Drivers:** A person employed to drive a truck, usually for a distance within a 150-160 km radius of their home terminal (Gill & Macdonald, 2013).

**Long Haul Drivers:** A person employed to drive a truck, usually for a distance exceeding a 150-160 km radius from their home terminal.

**Owner Operator:** A truck driver who supplies his or her own truck (Gill & Macdonald, 2013).

**Driver Safety:** being a safe and responsible driver using a combination of knowledge, skill and attitude. Drivers must obey the traffic laws and driving practices that help traffic move safely.

**Driving time:** time spent at the driving controls of a CMV in operation.

**Employee:** an operator of a CMV (including an independent contractor when operating a CMV) who is employed by an employer.

**Employer:** a person (including the government) that owns or leases a CMV or assigns employees to operate a CMV.

**Health and wellness (H&W):** H&W is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 1988).

**Productivity:** An economic measure of output per unit of input. Inputs include labor and capital, while output is typically measured in revenues.

**Absenteeism:** The number of days missed from the workplace (Burton & Conti, 1999). It can be attributed to workers’ compensation, short term disability, long term disability, sick leave, Family Medical Leave Act, paid time off, unpaid leave, and death.
Direct Costs: dollars that are paid to others for health services. This can include medical insurance benefits (medical, pharmacy, dental, mental health), disability payments, and workers' compensation losses (Greenberg et al. 1995).

Indirect Costs: The costs associated with replacement workers, overtime premiums, productivity losses related to unscheduled absences, and productivity losses of workers while on the job (Goetzel et al. 2001).

Employee Turnover: the ratio of the number of workers that had to be replaced in a given time period to the average number of workers.

Return on Investment: the return on investing in health, wellness, and safety programs.

1.2 Commercial Licensing Policies and Regulations in Canada

As licensing policies and regulations fall under provincial and territorial jurisdictions, these vary widely (Myers et al. 2011). All provinces/territories have regulations to ensure that drivers have adequate knowledge, vision and skills to safely operate a motor vehicle when first obtaining their licenses. Most, but not all, have mandatory policies that physicians must report patients who they feel may be unfit to drive. As certain medical conditions can compromise driving safety, some provinces require commercial drivers to undergo a formal medical review. For example, in British Columbia, having high blood pressure or being obese may preclude drivers from obtaining/renewing a commercial license (ICBC, 2014).

The most comprehensive data on license renewal periods and medical review requirements for both private and commercial class drivers in all 13 provinces and territories is contained in a report by Myers et al. (2011). This data was gathered as part of a larger project examining licensing policies and procedures for determining fitness-to-drive across Canada, primarily for private class license holders (Myers et al. 2011). Electronic surveys were sent to
licensing authorities and medical review personnel in each jurisdiction in 2009 for verification of information with follow-up phone calls for clarification, yielding a 100% response rate.

As shown in Table 1.1, in eight provinces/territories, the license renewal period (which ranged from 1 to 5 years) was the same for private class and commercial drivers. However, five jurisdictions had a shorter license renewal period for commercial drivers once they reached a certain age. In Alberta, Manitoba and New Brunswick, more frequent license renewal for commercial drivers began at age 45; in Nunavut and Ontario, these began at age 65. In several of these provinces, annual renewal was required for commercial drivers once they reached 65.

Table 1.1. Standard License Renewal Period by Province/Territory

<table>
<thead>
<tr>
<th>Province</th>
<th>Private Class License</th>
<th>Commercial Class License</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Columbia</td>
<td>5 years unless license cancelled. Re-issued for 2 yrs, then 5 years.</td>
<td>Same as for private license</td>
</tr>
<tr>
<td>Alberta</td>
<td>5 years until 80, then every 2 years</td>
<td>5 years until 45, then every 2 years until 65, then annual</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>Annual</td>
<td>Same, annual</td>
</tr>
<tr>
<td>Manitoba</td>
<td>Annual</td>
<td>5 years until 45, every 3 yrs to 64</td>
</tr>
<tr>
<td>Ontario</td>
<td>5 years. 70+ with at-fault collision: road test. Senior Driver Renewal Program starts at 80, then every 2yrs.</td>
<td>5 years until age 65, then annual</td>
</tr>
<tr>
<td>Quebec</td>
<td>4 years</td>
<td>Same as for private license</td>
</tr>
<tr>
<td>Nfld/Labrador</td>
<td>5 years</td>
<td>Same as for private license</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>4 years</td>
<td>4 years until 45, then every 2 years except Class 3: 4 years until 65, then every 2 years</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>5 years. Drivers &gt; 65 in a collision: written and road test.</td>
<td>5 years. Medical Report (separate) required annually at 65</td>
</tr>
<tr>
<td>PEI</td>
<td>3 years</td>
<td>Same as for private license</td>
</tr>
<tr>
<td>Yukon</td>
<td>5 years; 2 years for non-Canadians</td>
<td>Same as for private license</td>
</tr>
<tr>
<td>NWT</td>
<td>1, 3, or 5 years (driver’s choice)</td>
<td>Same as for private license</td>
</tr>
<tr>
<td>Nunavut</td>
<td>3 years</td>
<td>3 years until 65, annually after</td>
</tr>
</tbody>
</table>

Reprinted from Myers et al. (2011).

Commercial driver training in Canada is not mandatory and “drivers are in fact trained with a view to succeed in testing and licensing processes” (Thiffault, 2011, p. xiv). Recently
(beginning October 1, 2013), however, the Ministry of Transportation Ontario (MTO, 2014) implemented a Commercial Vehicle Operators’ Registration (CVOR) program that requires new applicants for a commercial license to complete a one-time written test to demonstrate knowledge of Ontario’s safety laws.

Table 1.2 shows the provincial requirements for medical reports and vision testing for commercial drivers, which typically begin earlier (than private class license drivers) and are more frequent as the driver ages.

Table 1.2. Medical Review Requirements by Province/Territory

<table>
<thead>
<tr>
<th>Province</th>
<th>Private Class versus Commercial Class Licenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC</td>
<td>Medical exam and vision test at 80, then every 2 years (period may be shortened for those with some medical conditions) Commercial: medical exams 5 yrs (age 25-45), 3 yrs (48-63), yearly (age 66+)</td>
</tr>
<tr>
<td>AB</td>
<td>Medical report at 75, 80, then every 2 years Commercial: medical reports at same intervals as renewal (see Table 1)</td>
</tr>
<tr>
<td>SK</td>
<td>Commercial: medical reports at same intervals as renewal (see Table 1)</td>
</tr>
<tr>
<td>MB</td>
<td>Commercial: medical reports at same intervals as renewal (see Table 1)</td>
</tr>
<tr>
<td>ON</td>
<td>Commercial: vision, written and road test for 65+</td>
</tr>
<tr>
<td>QC</td>
<td>Medical report and vision test at 75, 80, then every 2 years Commercial: medical report 6 months prior to 75, again at 80, then every 2 years</td>
</tr>
<tr>
<td>Nfld/Lab</td>
<td>Medical report at 75, 80, then every 2 years Commercial: medical reports upon initial application, 5 yrs (to age 45), 3 yrs (48-65), yearly (age 66+)</td>
</tr>
<tr>
<td>NB</td>
<td>Commercial: class 2 (school bus) assessed annually, class 3 &gt;65 every 2 years</td>
</tr>
<tr>
<td>NS</td>
<td>Commercial: medical report at 65, every 3 yrs; bus driver annually</td>
</tr>
<tr>
<td>PEI</td>
<td>Commercial: medical reporting cycle only</td>
</tr>
<tr>
<td>YK</td>
<td>Medical review and vision test at 70, 75, 80, then every 2 years Commercial: medical reports upon initial application, 5 yrs (to age 45), 3 yrs (45-65), yearly (age 65+)</td>
</tr>
<tr>
<td>NWT</td>
<td>Medical review at 75, 80, then annually Commercial: medical report every 5 yrs to age 45, 3 yrs to 65, then annually</td>
</tr>
<tr>
<td>NU</td>
<td>Medical review at 75, 80, then every 2 years Commercial: medical report every 3 yrs to age 65, then annually</td>
</tr>
</tbody>
</table>

Reprinted from Myers et al. (2011).

As the above data was collected in 2009, it must be kept in mind that requirements may have changed in some jurisdictions. A check of Ontario’s current policies showed that commercial
drivers aged 46 to 64 are now required to submit a medical report every three years; drivers aged 65 and older are still required to submit a report annually as there is no mandatory retirement age for CMV drivers (MTO, 2014).

1.3 Human Factors Report

The current project was precipitated by a recent report prepared by Dr. Pierre Thiffault (Transport Canada, Chair of CCMTA’s Human Factors and Motor Safety Task Force, see Thiffault, 2011). This report contains the findings from a three-phase study of the role of human factors in the safety performance of the Canadian motor carrier industry. Phase I consisted of an in-depth assessment of the human factors associated with commercial vehicle crashes, as well as the most efficient interventions addressing these issues. Phase II investigated how human factors involved in commercial vehicle crashes are currently addressed by Federal and Provincial programs and regulations, as well as by voluntary initiatives within the motor carrier industry in Canada. Phase III merged the findings of phases I and II (gap analysis) to formulate a strategy for intervention. A set of 44 action items were proposed to address fatigue, distraction and risky driving. One of those recommendations called for the development of a cutting-edge H&W program for CMV drivers in Canada, which led to the current project.

1.4 Purpose and Objectives

Using information from a comprehensive review of the literature, the broad aims of this project were to discuss the relevance and need for a national epidemiology study concerning the health status of Canadian CMV drivers as well as provide recommendations and directions for further interventions and associated studies to improve their H&W. The specific objectives, as outlined in the statement of work, were as follows:
1. **provide a comprehensive review of the literature** in the area of CMV driver H&W which (a) provides an overview of the evolution of the field in past 10 years, (b) documents potential relationships between the H&W of CMV drivers and (i) road safety, (ii) industry productivity, (iii) driver retention and (iv) workers compensation costs, (c) describes existing epidemiological studies and summarize key findings, and (d) discusses current intervention strategies while covering, if available, the result of program evaluations.

2. **discuss why it would be relevant to produce a H&W intervention** for CMV drivers in Canada, covering benefits in safety, productivity and driver shortage, as well as in other areas.

3. **recommend a research design for a national epidemiological study** including budget considerations and timeframe, possible collaborators, research instruments and data gathering protocols, sampling methodology, data analysis procedure, expected outcomes and format of potential interventions that could be developed on the basis of the data.

Section 2 describes the literature review process, detailing the search methodology and the number of articles and reports retrieved from peer-reviewed journals, conference proceedings and government reports. The following section (Section 3) provides a review and summary of the literature describing risk factors and interventions to improve H&W of commercial drivers. Section 4 provides the rationale for conducting a national epidemiological study in Canada, as well as describing possible designs, recruitment and sampling procedures, data collection tools, analyses and so forth. Section 5 discusses the need for further H&W intervention directed at CMV drivers in Canada. Lastly, Section 6 outlines the next steps in this process.
2. Literature Search and Review Process

2.1 Search Strategy for Peer-Reviewed Articles

A search for relevant studies published in peer reviewed journals and conference proceedings was conducted in February, 2014 using the following databases: MEDLINE (PubMed), CINAHL (Ebsco), PsycINFO (PsycNET) and Scopus. The search was limited to English language materials published since January, 2000. The search strategies, developed by a health sciences librarian in consultation with the research team, consisted of keywords and database specific subject headings for the following main concepts: truck or bus drivers, traffic accidents or occupational health related to trucks and buses, health issues for commercial drivers related to road safety, industry productivity, driver retention and workers compensation.

In MEDLINE, there were no MeSH headings for truck or bus drivers as the only options were “motor vehicles”[MeSH] or “transportation”[Mesh]. Only general search terms were used. No CINAHL headings were found for truck or buses and overall, only a small number of articles were retrieved. MEDLINE articles were excluded from CINAHL search (as these articles would be retrieved in the MEDLINE search), however, the search could include sources from the grey literature. The PsycINFO search consisted of keywords for truck and bus drivers, as well as traffic accidents and occupational health related to trucks and buses. Three fields were searched simultaneously (title, index terms and keywords). Scopus was used to search the general literature, as well as the journals related to engineering and business for health issues related to road safety, industry productivity, and driver retention and workers compensation. Detailed search strategies including search terms and dates for the all databases are provided in Table 2.1 below.
<table>
<thead>
<tr>
<th>Database</th>
<th>Time Frame</th>
<th>Search Strategy and Key Words</th>
<th>No. of Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEDLINE (Pubmed)</td>
<td>2000-2014</td>
<td>(truck OR lorry OR bus OR buses OR tractor trailer OR heavy vehicle) AND (driver OR driving) OR (trucker OR trucking OR commercial driver OR commercial motor vehicle driver) OR (accidents, traffic OR accident prevention OR accidents, occupational OR occupational diseases OR traffic accident OR occupational health) AND (truck OR bus OR buses OR heavy vehicle OR tractor trailer)</td>
<td>1369</td>
</tr>
<tr>
<td>CINAHL (Ebsco)</td>
<td>2000-2014</td>
<td>(truck OR lorry OR bus OR buses OR tractor trailer OR commercial driver OR commercial motor vehicle) OR (truck OR lorry OR bus OR buses OR tractor trailer OR commercial driver OR commercial motor vehicle)</td>
<td>545</td>
</tr>
<tr>
<td>PyscINFO (PsycNET)</td>
<td>2000-2014</td>
<td>Any Field Index terms: (Accident Prevention OR Accidents OR Highway Safety OR Motor Traffic Accidents OR Occupational Health OR Occupational Safety OR Occupational Stress OR Quality of Work Life OR Safety OR Work Related Illnesses OR Working Conditions) OR (driver OR driving behavior AND Subject: truck OR trucks OR heavy vehicle OR bus OR buses OR lorry OR tractor trailer OR commercial motor vehicles) OR Abstract: truck OR trucks OR heavy vehicle OR bus OR buses OR lorry OR tractor trailer OR heavy vehicle OR commercial motor vehicles</td>
<td>637</td>
</tr>
<tr>
<td>Scopus</td>
<td>2000-2014</td>
<td>(health OR illness OR medical OR wellness OR wellbeing OR wellbeing OR fitness OR exercise) OR (diet OR obese OR obesity OR overweight) OR (fatigue OR sleep OR sleepiness OR drowsiness OR exhaustion OR stress) OR (mental OR psychology OR diabetes OR musculoskeletal OR posture OR postural OR pain OR hearing) OR (cardiovascular OR</td>
<td>1322</td>
</tr>
</tbody>
</table>
2.2 Selection Criteria (screening process/study characteristics)

The results from the database searches were managed using RefWorks, a bibliographic management software. References retrieved from each search were downloaded into a RefWorks account and duplicates were removed for the screening process. Titles and abstracts were reviewed as part of the initial screening phase to identify potential relevant studies. The first 150 articles were screened by two reviewers to ensure consistency using the inclusion/exclusion criteria. The two researchers had a 95% level of agreement. Any disagreement for article inclusion was discussed and a decision rendered via consensus. The remaining articles (n=2677) were divided among the two reviewers and assessed independently. In the second stage of screening, the full text articles of those deemed relevant were obtained and reviewed using our pre-determined inclusion criteria, namely: published in English between 2000 and present, pertained to commercial vehicle drivers' H&W, and relevant to the Canadian context. Examples of articles that were seen as not being relevant to the Canadian context included studies on heat-risks to drivers in Jinan, China; or HIV prevalence of truck drivers in South Africa. This screening process shown in Figure 2.1 yielded a total of 37 published articles.
2.3. Search Strategy for Grey Literature

Grey literature (reviews or studies contained in reports as opposed to peer-reviewed journals) was retrieved using: 1) Transport Research International Documentation's (TRID) combined database of the records from the Transportation Research Board's (TRB) Transportation Research Information Services (TRIS) Database; 2) the Organization for Economic Co-operation and Development (OECD) Joint Transport Research Centre’s International Transport Research Documentation (ITRD) Database; and 3) the Canadian Research Index (CRI; Canadian government and research publications). The TRID database
includes reports, books and collections published from National Institute for Occupational Safety and Health (NIOSH), TRB, Universities, U.S and Canadian government bodies. The CRI, meanwhile, includes research publications (i.e., non-depository publications; scientific and technical reports; political, social economic reports; Statistics Canada monographs and serials) issued by the Canadian Federal government and all Provinces and Territories. Search terms and strategies using TRID and CRI as shown in Table 2.2.

Table 2.2. Grey Literature Search Strategy

<table>
<thead>
<tr>
<th>Database</th>
<th>Time Frame</th>
<th>Search Strategy and Key Words</th>
<th>No. of Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRID: Common Keywords used for both searches:</td>
<td>2000-2014</td>
<td>Keywords: truck drivers OR trucking OR commercial drivers OR bus drivers OR heavy vehicles OR freight transportation</td>
<td></td>
</tr>
<tr>
<td>Search 1</td>
<td></td>
<td>Index Terms: safety programs, health, stress (psychology), occupational diseases, occupational safety, obesity, public health, sleep disorders, sleep deprivation, sleep, musculoskeletal system, fatigue, workers compensation, personnel management, personnel retention, turnover, recruiting, economic conditions.</td>
<td>273</td>
</tr>
<tr>
<td>Search 2</td>
<td></td>
<td>Index Terms: Canada, Canada Western, Ontario (Canada), Ontario (province), Quebec (Province), Quebec (Canada), Nova Scotia, Nova Scotia, Canada, Prince Edward Island, Newfoundland and Labrador, New Brunswick, New Brunswick, Canada, Manitoba, Saskatchewan, Canada, Saskatchewan, Alberta, Alberta, Canada, Alberta (Canada), British Columbia, British Columbia, Canada, Canada, Northwest Territories, Nunavut.</td>
<td>100</td>
</tr>
<tr>
<td>Canadian Research Index</td>
<td>2000-2014</td>
<td>All (truck driving OR truck drivers OR trucking OR bus drivers) AND All (health OR wellness OR sleep OR fatigue OR stress OR occupational safety OR obesity OR workers compensation OR retention OR recruitment OR turnover OR productivity OR safety OR accident OR musculoskeletal OR drowsiness).</td>
<td>31</td>
</tr>
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</table>
Reports from the grey literature were managed using RefWorks. In total, 404 reports were retrieved and 356 reviewed after removing 48 duplicates. Following a full review, 321 articles were excluded using the same selection criteria above. The reports excluded were either not published in English, published prior to 2000, and/or did not pertain to commercial trucks or buses (e.g., reports on taxis), and/or were not related to health or wellness or considered relevant to the Canadian context. A total of 20 reports that met the inclusion criteria are included in our systematic review.
3. Literature Review Findings

A database search yielded 37 peer reviewed articles relevant to H&W of commercial drivers. All studies were published in English between the year of 2000 and 2014. These articles were further separated into various categories: intervention (n=14), non-intervention studies (n=13) and literature reviews (n=10). Intervention studies are those that examined the effects or impacts of an intervention or program on health related outcomes of drivers and/or cost savings. Conversely, non-intervention studies examined risk factors in commercial drivers using an observational, survey or database analysis (cross-sectional) design.

3.1 Intervention Studies

As shown in Appendix A, intervention studies included samples ranging from 29 to over 18,000 participants with the majority of studies occurring in the USA (9 of 14). The remaining five studies were conducted in South Korea, Brazil, New Zealand, Denmark and Sweden. Studies conducted were pre-post interventions (n=8), retrospective (n=3), and a randomized control trial (n=1). Two studies had an experimental design (i.e., used a driving simulator; screening for sleep apnea).

3.1.1 Blood Pressure/Hypertension Interventions

Five studies examined educational interventions related to blood pressure/hypertension regulation (Doyle et al. 2010; Greene et al. 2009; Harshman et al. 2008; Hwang et al. 2012; Zavanela et al. 2012). Three of these studies focused on bus drivers (Doyle et al. 2010; Harshman et al. 2008; Hwang et al. 2012) and three studies (Doyle et al. 2010; Greene et al. 2009; Harshman et al. 2008) focused on one specific intervention (BP DownShift program). One study included an exercise program (described first), followed by the BP Downshift program and a description of a multi-component intervention by Hwang et al. (2012).
3.1.1.1. Exercise Intervention

Zavanela et al. (2012) examined the effects of exercise on health and fitness using a randomized control trial design. Participants receiving the exercise component (24 week resistance program) had significant reductions in their systolic and diastolic blood pressure, improved muscle endurance and flexibility, and had less work absenteeism compared to controls (Zavanela et al. 2012).

3.1.1.2 BP Downshift Program

The BP Downshift program is specific to commercial drivers and provides educational materials in the mail. The program aims to improve knowledge of blood pressure management (i.e., reducing risk factors, blood pressure guidelines for CDL, how to manage and track hypertension) to reduce cardiovascular complications and to maintain commercial driving privileges. Harshman et al. (2008) examined changes in blood pressure, height and weight in 501 male bus drivers (Mean age 42.5 years; range 19 to 62; 90% were overweight or obese) pre and post intervention (i.e., receiving counselling for 5-10 minutes on individual health and employment status as part of the BP Downshift program). After receiving the intervention, fewer bus drivers had uncontrolled blood pressure (26.1% versus 17.2%) and were more likely to take their anti-hypertensive medication (42.5% versus 25.4%). Blood pressure control also increased in bus drivers with diabetes and obesity (16.8% versus 51.6%; 20.6% versus 33.6%), respectively.

Doyle et al. (2010) and Greene et al. (2009) both examined blood management after the BP Downshift program in drivers from an electric utility company. Doyle et al. (2010) found that participants (N=120; Mean age 50±9; 73% female; 81% overweight or obese; 72% African American) had a reduction in systolic and diastolic blood pressure, reported a healthier diet and
engaged more in exercise. However, Greene et al. (2009) did not find any changes in systolic or
diastolic blood pressure after the BP Downshift program in 499 participants (Mean age 42.5;
100% male) although there was an estimated cost savings of $552.103 over a two year period
from improvements in worker’s productivity and a reduction in lost time (Greene et al. 2009).

3.1.1.3 Multi-Component Cardiovascular Intervention

Hwang et al. (2012) developed an intervention to reduce cardiovascular risk factors (i.e.,
physical activity, diet, smoking habits, alcohol consumption) in middle to old bus drivers
(sample was ≥ 45 years of age). The intervention was comprised of a team including a physician,
dietician, nurse, physical trainer and a therapist, providing participants with health consultations
(i.e., disease control), diet and educational information (i.e., negative effects of smoking and
alcohol), an aerobic fitness program (3-5x per week; 35-60 minutes per session) and how to
apply laughter at the workplace, respectively. Of the 248 participants, 163 participated in a post-
intervention assessment and reported being more physically active, had a healthier diet, and
reduced their smoking and alcohol intake. Systolic blood pressure and high density lipoprotein
(HDL) also significantly decreased after the intervention.

3.1.2 Healthy Eating and Weight Loss Intervention

Gill and Wijk (2004) implemented a program informing staff of healthy food choices
(and menu changes) at a large truck stop. Through direct observation and interviews, staff
changed their food preparation routines which resulted in healthier eating practices in
commercial drivers, as well as a reduction in time preparation for menu items (cost savings in
goods and labour).

Olson et al. (2009) incorporated a combination of computer-based training (covering
topics of exercise, diet and workplace safety, behavioural self-monitoring and motivational
interviewing) using a competition model between employees of four different truck companies. In the sample, 22 of 29 participants completed the post-intervention assessment. Participants had lost weight and survey findings showed a reduction in fat and sugar consumption after the intervention.

**3.1.3 Obstructive Sleep Apnea/Fatigue Interventions**

Two studies examined interventions to reduce obstructive sleep apnea (OSA). Gurubhagavatula et al. (2008) performed an experimental trial examining the cost effectiveness of screening for OSA. Not screening for OSA and screening using only polysomnography were both not cost effective. However, selective polysomnography based on a three tiered approach (high, intermediate and low risk), in addition to using scores on the Epworth Sleepiness Scale was cost effective, provided 73.8% of those considered at risk for OSA undergo treatment.

Hoffman et al. (2010) examined disability and health care costs of commercial drivers with OSA using continuous positive airway pressure (CPAP) treatment and bi-level positive airway pressure (BiPAP). Drivers undergoing CPAP or BiPAP treatment had lower health care costs, missed fewer workdays and had fewer short-term disability claims 24 months after treatment compared to controls, resulting in $6000 cost savings per treated driver.

One study examined the role of a simulator to predict accidents (Moore-Ede et al. 2004) using a pre-determined algorithm of employee work schedules, sleep and alertness patterns. The Circadian Alertness Simulator (CAS) provides an indicator (i.e., fatigue score) that can predict fatigue and accident risk, as well as an optimal work schedule. CAS scores (from the algorithm), when used by managers and dispatchers, reduced the frequency and severity of accidents in commercial drivers by reducing the amount of driving performed under a fatigued state. Reduced
accidents rates and improved attention resulted in significant yearly cost savings of $14,088 to $4,820 and $1,187,699 to $226,627, respectively.

3.1.4 Other Interventions

Four studies described the implementation process of various interventions but provided few or no findings (Bunn et al. 2001; Kashima, 2003; Mackie & Moore, 2009; Poulsen et al. 2007). For example, Poulsen et al. (2007) used action research to develop specific interventions for bus drivers (Healthy Bus Project). The authors reported that almost 50% of the bus drivers noted an improvement in workplace conditions, and had reduced stress and pain, as well as improved job satisfaction and amendments to the driver’s cabin.

Bunn et al. (2001) implemented a health and productivity program that included cardiovascular risk management and individualized rehabilitation plans to address musculoskeletal injuries. Employees reported improved health and had less absenteeism while employers reported greater costs savings (a two-fold return on investment).

Mackie et al. (2009) designed a year long program with monthly themes (i.e., nutrition, smoking, wellness at work) delivered via the mail. These mailings were supplemented by individual activities to change food, exercise and lifestyle patterns and were also provided with a toll free number for professional support. Although the study includes an experimental (n=45) and control group (sample not reported), no results are presented.

Kashima (2003) designed an intervention to reduce the amount of back pain experienced in commercial drivers. Implemented by Chevron Texico, the “Medical Fitness for Duty Program” includes a physical examination, education and a physical fitness component. Baseline results are shown, however, no findings from the intervention are provided.
3.2 Non Intervention Studies

There were 13 studies classified as non-interventions, as shown in Appendix B. Five survey studies were conducted with a sample range of 50 to 1,670. Six studies performed a retrospective database analysis with samples ranging from 150 to 25,609. One study reported psychometrics of a new fatigue scale and one study used direct observation. The majority of studies were conducted in USA (n=9) while two were conducted in Canada, one in the UK and one joint study between the UK and Sweden.

3.2.1 Survey Studies

3.2.1.1 Smoking

Four studies reported a range of tobacco use with rates ranging from 31.5% (Angeles et al. 2013) to 51% (Sieber et al. 2014). The authors found that heavy smokers were more likely to be Caucasian, were less likely to get adequate sleep, were more likely to report poorer job satisfaction and consider smoking as socially acceptable. Alternatively, commercial drivers who did not view smoking as socially acceptable were more likely to quit smoking and enroll in a cessation program.

3.2.1.2 Obesity and Nutrition

Three studies examined obesity and all three found that more than 50% of their respective samples were obese (Apostolopoulos et al. 2013; Angeles et al. 2013; Sieber et al. 2014). One study found that 83.4% of 316 truck drivers were obese (Apostolopoulos et al. 2013). Another study of 406 commercial drivers found that 48.4% had poor nutrition with 96% having consuming more salt than the recommended daily amount (Angeles et al. 2013).
3.2.1.3 Other Risk Factors

Three studies reported other risk factors in commercial drivers. Both Apostolopoulos et al. (2013) and Angeles et al. (2013) reported rates for sleep problems (57.9% versus 17.2%), respectively. Apostolopoulos et al. (2013) also found that 42.5% had musculoskeletal and 40% had cardiovascular disease. Meanwhile, Angeles et al. (2013) found low rates of diabetes (7%), heart disease (4.1%), stroke (0.6%), arthritis (10.8%) and lung problems (2.8%). Sieber et al. (2014) found that only 4.4% and 22% had heart disease and hypertension, respectively. These rates are similar to the general population although diabetes rates (14.4%) are higher. Additionally, 22% of the sample reported high cholesterol, 27% averaged less than 6 hours of sleep per night and 27% did not regularly exercise (Sieber et al. 2014). Comparably, rates of physical inactivity occurred in 70% and 58% of drivers in Apostolopoulos and Layne et al. studies (2013). Sieber et al. (2014) found that 61% of commercial drivers had 2 or more of these risk factors (i.e., hypertension, obesity, smoking, high cholesterol, no physical activity, less than 6 hours of sleep).

3.2.1.4 Access to Health Care

Insurance coverage and/or access to health care were reported in four studies. Sieber et al. (2014) reported that 38% did not have health insurance, similar to that of Layne’s (2009) and Apostolopoulos (2013) studies (42% and 32.3%), respectively. Respondents in Angeles et al. (2013) study reported that 90% had access to a family physician although half would not access health care if they became ill on the road. Nearly 70% of Layne’s (2009) and 21% of Apostolopoulos (2013) participants were also not satisfied with health care access on the road.
3.2.2 Data Analysis: Crash and Claim Records

Six different studies used database records to examine crash risk (Wahlberg & Dorn, 2009; Staplin & Gish, 2005; Anderson et al. 2012), workplace injuries (Jones & Switzer-McIntyre, 2003; Smith & Williams, 2014) and medical costs (Martin et al. 2009).

3.2.2.1 Obesity

Commercial drivers who are obese have higher crash rates. Heavy truck drivers who were classified as stage II (BMI ≤ 35) and III (BMI ≥ 40) obesity had a relative risk of 1.55 and a 1.54 of being in a crash compared to those with a normal BMI (Anderson et al. 2012). Overweight and obese commercial drivers also have higher medical costs from a higher prevalence of hyperlipidemia, diabetes and hypertension than normal weight individuals (Martin et al. 2009). Health care costs were significantly higher in overweight and obese truckers ($1613 and $1792) compared to normal weight truckers ($1012).

3.2.2.2 Crash Risk

Two studies examined if job change and absenteeism were independent predictors of crash risk in bus drivers. Staplin and Gish (2005) found that crash risk begins to rise when a person changes jobs more than twice per year, with crash risk increasing two-fold if drivers hold more than three jobs per year. However, odds ratios were not provided due to the small number of participants who incurred a crash and/or who have changed jobs more than 3 times.

Walhberg & Dorn (2009) examined two samples from the UK and one sample from Sweden. No correlation between absenteeism and crash risk was found in the Swedish sample although a fair correlation (r=.26) existed in one UK sample. In the second UK sample, crash risk was only correlated within the first three months of driving compared to other time periods (within 6, 9 and 12 months).
3.2.2.3 Work Related Injuries

Two studies examined work related injuries. Musculoskeletal injuries of the neck, back and upper extremities were common reasons for claims. Truckers had the highest number of claims and costs associated with workers compensation than any other occupation (i.e., waste, recycling). Falls from a high elevation had the highest medical cost of all occupations except for those injured in a vehicular accident (Smith & Williams, 2014). In a Canadian study, falls were reported to occur most frequently at the back of the trailer, the truck step, and from transporting cargo resulting in a large number of sprains (43%), contusions (23.5%) and fractures (20%) (Jones & Switzer-McIntyre, 2003). A total of 352 commercial drivers (of 1036 cases) were injured incurring a cost of $5,313,901 (Jones & Switzer-McIntyre, 2003).

3.2.2.4 Fatigue Screening

One study developed a tool to screen for fatigue in bus drivers (Dorn et al. 2010). The screening tool consisted of ten components (each component having 3 to 13 items) which showed good to moderate test-retest reliability ranging from .68 to .86. However, only two of the components (i.e., evaluative coping and hazard monitoring components) were related crashes (i.e., records) and only one component (avoidance coping) was consistently associated with simulated bus driving.

3.2.2.5 Health Promotion

An observational study assessed 25 different work settings in North Carolina to better understand how the work environment influences physical and recreational activity of truckers (Apostolopoulos et al. 2012). Direct observations suggest that minimal opportunities are available for physical and recreational activities for truckers.
3.3 Review Articles

The database search yielded 10 review articles that covered topics related to exercise, sleep apnea/OSA, obesity and diabetes, workplace environment, and psychological stressors. Of the 10 articles, five were conducted in the USA, two in the UK, and one in Canada, China and Germany, respectively. Full details are shown in Appendix C.

3.3.1 Physical Inactivity

Taylor and Dorn (2005) performed a review examining the role of physical activity as a mediating variable (i.e., stress and psychological states, sleep, fatigue and alertness, health status) of crash risk in professional drivers. The findings support that exercise can improve driving performance and reduce crash risk by decreasing stress, psychological and physiological responses, improve sleep and alertness, reduce fatigue, improve cognitive functioning, and improve psychological and physical wellbeing.

3.3.2 Fatigue and Obstructive Sleep Apnea

Tregear et al. (2009) found that commercial drivers with obstructive sleep apnea (OSA) have higher crash rates (Odds ratio interval of 1.21-4.89) than those who do not have OSA which may be predicted by BMI, hypoxemia, oxygen saturation and possible daytime sleepiness. Kales and Straubel (2014) suggest that the simplest and most effective way to screen for OSA is using BMI cut-off points for obesity, supplemented by a questionnaire, documented health history by a physician and a full functional screen. Other methods to detect fatigue may include measuring driver states (i.e., eye and eyelid movements, blinking rates, direction of gaze), alone or in combination with a driving simulator (driving when fatigued on a simulator), and driver monitoring systems that provide real time feedback when driving (Wang et al. 2011).
3.3.3 Diabetes

Begg et al. (2003) revised the Canadian Diabetes Association’s Clinical and Scientific Section’s Position Statement on diabetes and driving by performing a review on crash risk in private and commercial drivers. Irrespective of insulin control, commercial drivers with type 1 and 2 diabetes had a 510% and 304% increased crash risk than the general population, respectively. After controlling for age and comorbidities, crash rates varied by type of commercial driver license. Straight truck drivers (Class III), but not articulated truck drivers (Class I), had a higher crash risk compared to the general population (statistics not provided). Consensus statements suggest that: 1) drivers with diabetes should routinely monitor blood glucose every four hours; 2) should not drive if blood glucose levels are above 4.0mmol/L; and 3) visit a physician twice per year and undergo an annual assessment (Begg et al. 2003).

3.3.4 Psychological

One study reviewed 13 articles on stress prevention and absenteeism from illness in bus drivers (Kompier et al. 2000). The studies reviewed were primarily from Germany and Holland (11 of 13 cases). Although the cases employed different methodologies (i.e., differing outcome variables) and interventions, six of seven studies found reduced absenteeism; 5 of 5 found improved cost savings from less absenteeism; seven of seven studies reported greater subjective health and five of five studies found increased work satisfaction. These findings suggest that stress interventions can benefit both companies and their employees.

3.3.5 Environment and Morbidity

Four studies reviewed health risks associated with morbidities in the workplace (Apostolopulos et al. 2010; 2011; 2012; Tse et al. 2006). Environmental and work place challenges include long work hours, fatigue, shift work, sleep deprivation, noise, vibration,
physical inactivity, unhealthy diet and exposure to diesel fumes, all which are risk factors for various medical conditions (Apostolopoulos et al. 2010). For example, stress increased the risk of psychiatric disorders; fatigue and shift work were related to obesity; sleep apnea was related to crashes; long workdays, vibration and postural fatigue were all related to musculoskeletal injuries; poor diet and physical inactivity were related to cardiovascular disorders and; diesel exposure was related to lung cancer. Obesity alone was related to several comorbidities and is moderated by multiple risk factors (i.e., exercise, diet, fatigue) (Apostolopoulos et al. 2012). Commercial drivers also have high rates of smoking, abuse of alcohol and unsafe sexual practices.

A review of bus drivers found similar risk factors including poor cabin ergonomics, shift work, and inflexible work hours (Tse et al. 2006). However, bus drivers also face unique problems (compared to short and long haul drivers) such as stress from traffic and violence from passengers. These risk factors can lead to the development of cardiovascular, musculoskeletal and psychological disorders, as well as absenteeism, turnover and accidents.

3.4 Reports

As shown in Appendix D, the grey literature search yielded 20 reports including four from Canada. From the reports, eight were survey or comparative and three were interventions, all pertaining to H&W, as well as driver fatigue, safety (performance) and turnover. Additionally, there were nine literature reviews on H&W, HIV and fatigue, employment and human factors.
3.4.1 Interventions

3.4.1.1 H&W

Based on the H&W concerns of 448 long-haul truck drivers, the Federal Motor Carrier Safety Administrators (2000) implemented an intervention (Getting’ in Gear) to create awareness and interest in H&W within the trucking industry. The intervention consisted of written and audio materials mailed directly to commercial drivers’ home, in addition to receiving optional personal coaching using the phone or email. After the intervention, commercial drivers reported more positive health and improvements in physical health (i.e., BMI, pulse, diastolic blood pressure, aerobic fitness, strength and flexibility). Although access to exercise clubs was provided as part of the intervention, the majority of participants exercised on their own (not at an exercise facility). The majority of participants (96%) reported the program improved awareness of health promotion activities (i.e., eating well) by providing access to their own personal health information.

3.4.1.2 Fatigue

Two reports funded by Transport Canada, pilot tested and assessed the feasibility of a comprehensive Fatigue Management Program (FMP) for CMV drivers that could be implemented across North America. After completion of these development and pilot testing phases, the North American Fatigue Management Program (NAFMP) was widely introduced thought the development of training manuals and a website (see: http://www.nafmp.com/en/). The NAFMP is a comprehensive approach for reducing driver related fatigued by providing education for drivers and employers, screening and treatment of sleep disorders, and scheduling of driver trips. Moscovitch et al. (2006) pilot tested the implementation of the NAFMP in three jurisdictions (Alberta, Quebec and Texas) examining corporate change, modification of
scheduling, fatigue management training, sleep apnea screening and treatment. The NAFMP intervention improved the number of hours slept and reduced fatigue. Additionally, 71% of drivers (25 of 35) had sleep apnea not previously diagnosed; 29% (10 of 35) whom underwent CPAP treatment. Sleep time improved by 73%, increasing from 3.9 hours to 6.8 hours per night, following CPAP treatment.

In the next phase, Smiley et al. (2009) assessed the feasibility of the NAFMP on fatigue, performance, sleep duration and mood in commercial drivers using an experimental pre-post design. 121 drivers (aged 24 to 64 years of age; held commercial license for one year) completed the baseline assessment, however, only 77 participants were assessed post-intervention. Following the intervention, participants had improved sleep quality (particularly on work days) and fewer reported critical events (i.e., dozing off) after controlling for distance driven. Participants also reported having more knowledge (i.e., education) and strategies to remain alert, although work schedules did not improve. Crash risk and road infractions, when controlling for distance driven, were reduced in Quebec but were not Alberta and California.

Balkin et al. (2000) compared sleep/wake cycles using wrist actigraphy over 20 days, as well as the effects of various sleep cycles (i.e., 3, 5, 7, and 9 hours of sleep) on alertness and performance (i.e., psychomotor tests; fitness; sleep latency) in short and long haul truck drivers. Almost 50% of long-haul drivers slept during their shifts (mainly sleeper-berth time) suggesting many drivers are partially sleep deprived. Conversely, short haul drivers were more likely to sleep the ideal number of hours over a single sleep cycle. Small changes in sleep patterns resulted in worse performance on the psychomotor vigilance test. Additionally, drivers who are sleep deprived (i.e., less than 3 hours of sleep per night) did not recover even after three consecutive nights of sleep (8 hours each night). The findings suggest that performance is not
only dependent on circadian rhythm, sleep period and/or duration, but also sleep history in the
prior three days.

3.4.2 Other Studies

3.4.2.1 H&W

Bigelow et al. (2012) conducted a pilot study to gather information about the perceptions
of the health, safety, and wellness issues in commercial drivers in Southwestern Ontario. In
phase I, surveys were developed using the input of various stakeholders (i.e., drivers and health
professionals). The findings indicated that respondents were aware of most of the major risk
factors for commercial drivers (i.e., long work hours, stress, fatigue). Slips, trips, and falls were
viewed as major causative factors in musculoskeletal disorders and pain (although age was not).
However, none of the respondents mentioned sleep apnea or illegal drug use as a concern.

A preliminary questionnaire was developed which was further adapted for commercial
drivers in Canada after an interview was conducted in four participants (Phase II). Subsequently,
pilot testing of the questionnaire was carried out with 107 commercial drivers at two truck stops
(Phase III). The results show that poor diet, stress, being overweight, and sleeping problems are
perceived as major concerns by commercial drivers. Additionally, respondents reported a high
rate of chest pain, shortness of breath, poor diet, as well as having high blood pressure and
cholesterol within the past 30 days. Cancer was not a particular concern expressed by drivers.

3.4.2.2 Fatigue

Elkington and Stevenson (2013) compared risk factors (i.e., health behaviors including
sleep) in 500 heavy truck drivers with and without police attended crashes in the preceding 3
years (from 2008-2011). Interviews were conducted and a breathing monitoring device given to
all participants for one night to assess for sleep apnea. Truck drivers who crashed were more likely to be less experienced, drink less coffee, and less likely to have worked 60 hours (although they took fewer breaks). Controls (non-crashers) were more experienced, drank more coffee, and worked longer hours but took more breaks. Most of the crashes occurred during peak traffic periods (from 9-11am; 2-4pm) with the majority occurring within the first hour (76%). Sleep apnea was found in 45% of drivers although only 4% had been previously diagnosed prior to the breathing monitoring system. In drivers, those who smoked regularly (more than one pack per day) had an increased crash risk.

3.4.2.3 Driver Performance and Safety

Fine et al. (2012) examined how health (i.e., sleep quantity and quality), cognitive load, driver distraction (i.e., no distraction, talking, texting and emailing), and performance on clinical tests (i.e., Useful Field of View) influenced simulated driving performance. Compared to the no distraction task, emailing and texting resulted in a two fold increase in violations (i.e., lane deviation). Emailing only resulted in an increased rate of crashes (5.5x) and lane deviations (3x), respectively. Meanwhile, texting resulted in a 3-fold increase in lane deviations. No associations emerged between health and cognition on simulated driving performance although there was a strong association between Epworth Sleepiness scores (measuring the likelihood of falling asleep) and the Useful Field of View test (measuring attention and speed of processing). Additionally, an hour increase in usual sleep time was associated with a 24% reduction in speeding (more than 15mph over the posted speed limit) and a 34% reduction in crashes.

One survey examined the perceptions of safety risks in bus 210 bus operators. Reported safety risks included, fatigue, stress, split shifts, time pressure, passenger distraction and negligence of other road users. Almost two thirds of respondents reported close calls (near
accidents) occur on a weekly basis, often being cut-off by other road users. Recommendations by the respondents include addressing scheduling practices and the need for greater public information to reduce negligent driving behaviours of the general public.

A study by Saccomanno et al. (2008), funded by Transport Canada, examined the safety (i.e., frequency and severity of crashes) implications of speed limiters (e.g., 80, 90, 100, 105, 110 km/hour) for large trucks (greater than 11,794kg) using driving simulation (computerized algorithms). This simulation, developed using crash data, was modeled with actual road segments (i.e., freeway). The use of speed limiters was primarily effective at 90 and 105 km/hour in uncongested traffic, however, the effectiveness decreased with increasing congestion. Additionally, speed limiters may be ineffective when drivers are required to merge and change lanes, or when using the on and off ramps of freeways.

Blanco et al. (2001) installed a data acquisition system (DAS) with sensors and video cameras over a four week period to examine naturalistic driving. In 97 commercial drivers, the DAS was installed for four weeks to determine the influence of the typical workday (driving and work hours, breaks) on driving safety (i.e., near misses, crashes). The primary findings show an increase in critical driving events (i.e., near misses, crashes, lane deviations) as driving duration increases. Participants had a higher risk of critical driving events in the 11th hour compared to the first and second hours of driving. Additionally, critical driving events are reduced 30-50% following a one-hour break. However, critical driving events are elevated when the combination of non-related and related driving activities went beyond 14 hours.

Van Dongen & Belenky (2010) examined the effectiveness of a 34 hours restart provision in worst and best case groups on cognitive and driving performance using a simulator. The best case groups (n=13) represented commercial drivers with daytime wakefulness that worked
throughout the day (and night-time sleep) while the worst case group (n=14) drove at night (with daytime sleep) during two 5-day work periods while transitioning back to a daytime schedule. In the best case group, cognitive performance remained the same before and after the 34 hour restart while the worst case group had impaired performance before the 34 hour restart, as well as worse simulated driving performance indicated by poorer lane positioning during conditions of night driving (predicted by the psychomotor vigilance test). There was also weak correspondence between objective measures of driving (i.e., simulator) and subjective tests of sleepiness and mood. Even though both groups had equal opportunity to sleep, the worst case group did not manage to sleep enough due to adverse circadian rhythms. The findings suggest a 34 hour restart period is not an effective intervention in helping drivers transition from a night to daytime shift.

3.4.2.4 Driver Retention and Turnover

Driver retention and turnover was examined using an online survey sent to various truck organizations in the US (Harrison & Pierce, 2009). Surveys were completed by 24 carrier companies representing approximately 10,500 commercial drivers. Of the 22 companies that reported turnover rates, 13 companies had rates at or below 30%, six between 31 and 75% and three greater than 95%. However, most companies reported that the current turnover rate was consistent with their ideal rate.

3.4.3 Reviews

3.4.3.1 H&W

Krueger et al. (2007) performed a literature review of studies related to H&W in commercial drivers (many of which are covered in this report). The most common health risks found were smoking, obesity/overweight, hypertension, lack of physical activity, fatigue, alcohol
and drug use. Additionally, cardiovascular and musculoskeletal disorders, stress and other mental health disorders, diabetes, hearing and vision impairments and sleep disorders, can all impair driving safety.

Phase 2 of Krueger et al. (2007) report summarized survey findings in managers and truck drivers. Maintaining vehicle ergonomics was the most important consideration for managers (86%), followed by promoting disability management programs (76%), providing drivers with benefits (67%), offering assistance to help drivers achieve a better work/life balance (52%), provide healthy foods (38%), and participating in H&W programs (38%). Truck drivers ranged in age from 22 to 57 (mean 32.8 years) and had an average of 8.14 years (range 1 to 36 years). Only 13% reported not being in good health. Sleep disorders and drug/alcohol abuse were rated as the two greatest concerns among truck drivers. Approximately 61% of truck drivers participate in H&W programs although only a quarter of respondents had access to fitness facilities (25%).

Phase 3 provided a review of interventions addressing H&W in commercial drivers. Interventions of five companies (i.e., Schneider National Inc; Trucks Inc; JB Hunt Inc; Waste Management Inc; and Greyhound Lines Inc) were profiled. All programs improved various aspects of H&W. Interventions consisted of sleep apnea screening, improvements in seat ergonomics, the use of H&W coaches, and yearly physical examinations. Full details and results are shown in Appendix D.

In 2010, the first International Conference on Commercial Driver Health and Wellness was held, summarized in Krueger et al. (2012) report. This report highlighted important steps needed for program implementation in the workplace (i.e., develop screening protocols, conduct a health appraisal, provide H&W programs most relevant to the needs of the employees) and
described cost-benefit/return-on-investment for various interventions. For example, several company interventions (i.e., Schneider National Inc, JB Hunt Inc) resulted in cost savings of millions of dollars. The company “JB Hunt Inc” saved between 1.6 and 4.1 million dollars per year after its intervention was implemented.

Similarly, Saltzman and Belzer (2007) also published a report summarizing conference presentations identifying risk factors related to H&W in commercial drivers. The primary findings showed that truck drivers are subjected to various chemical hazards such as skin reactions and chemical burns (from chromium and alkaline substances), headaches, nausea, dizziness (especially in gasoline tanker trucks), and lung cancer from inhaling diesel exhaust. Ergonomics risks were related to loading/unloading cargo and working in tight spaces that can lead to musculoskeletal injuries. Fatigue was considered a critical problem in commercial drivers which may result from medical conditions (i.e., sleep apnea) and/or work conditions (i.e., long work hours, stress, irregular schedules and shift work, comfortable sleeper berths). Other presentations included research on stress (i.e., pressure to stay on schedule, being away from friends and family), workplace violence (i.e., physical and verbal abuse) and driver compensation issues (i.e., employee turnover and crash risk).

Davis (2004) administered a survey to companies with an active H&W program for its employees. The survey was distributed to 33 companies; 14 surveys were returned. Each of the 14 companies had programs that focused on awareness, education and health behaviour change (i.e., exercise, nutrition, smoking cessation). However, many of these programs were not developed with employee input and many have not been systematically evaluated. Telephone interviews were also conducted with six companies, presented as case studies (see Appendix D). All six companies were aware of risk factors affected its employees although all took different
approaches to implementing their programs. However, a key component to the success of these programs is continuous and ongoing evaluation, providing an opportunity to refine and adjust the program according to the health behaviours and practices of the employees.

3.4.3.2 Sexual transmitted infections (STIs) and HIV/AIDS

The World Bank Group (2009) published a report on HIV/AIDS providing recommendations for developing and implementing interventions. Commercial drivers are identified as a vulnerable group susceptible to engaging in risky behavior with commercial sex workers, particularly those who work long hours and are away from home. Commercial drivers were found to lack awareness of HIV risk (i.e., methods of transmission) and/or may have misconceptions regarding safe sexual practices (i.e., condom use). The report suggests that STI and HIV interventions in the transportation sector should focus on promoting safe sexual practices (i.e., promoting condom use), treatment of transmitted infections, providing access to counseling, as well as reducing waiting time for long distance transport workers at border crossings (a key risk factor for sexual behavior and HIV transmission). Results from interventions are not described in this report.

3.4.3.3. Fatigue

The Australian National Transport Commission (2006) report provided details on a policy proposal to implement a fatigue management program. The program focused on managing fatigue by better balancing the demands for rest (i.e., greater fatigue recovery) while not compromising productivity. The report includes a description of fatigue management in various states. For example, Queensland’s program has shown a decrease in driver related fatigue over a span of 5 years from improving driver schedules and allowing more time for breaks, as well as
increased opportunities for education and support from management. Drivers were also less likely to report speeding, having difficulty concentrating or feeling tired.

The Federal Motor Carrier Safety Administration (2007) produced a systematic literature review and meta-analysis to determine risk factors associated with OSA, crash rates resulting from OSA, screening tools/tests to detect commercial drivers with OSA and associated treatments (i.e., length of treatment and effectiveness). From 17 articles (all rated moderate or low quality), the report concluded that CMV drivers with OSA have an increased crash risk (compared to those who do not have OSA) although actual rates were not determined. As for risk factors, no evidence based conclusions could be derived from 10 articles pertaining to risk factors related to crashes among CMV drivers with OSA. Additionally, three studies found that drivers with OSA may not be aware of being affected by daytime sleepiness.

The review concluded that no predictive model has been developed to accurately stratify drivers with OSA by disease severity (based on 43 studies) although a portable sleep monitor may be used at a relatively low cost. As an intervention, CPAP shows consistent positive results (with strong evidence) in reducing crash risk (even after one night of treatment). Cessation of CPAP results in poorer simulated driving performance and worsening symptoms of fatigue and OSA severity (may occur as soon as 24 hours from cessation of treatment). Meanwhile, other interventions (i.e., behaviour modification; dental appliances; medications; temperature-controlled radiofrequency tissue ablation; Uvulopalatopharyngoplasty) show mixed findings concerning crash risk (with weak or no evidence available).

### 3.4.3.4 Employment

Moffat et al. (2011) examined recruitment, retention and turnover of bus operators. A survey was sent to 75 transit agencies; 29 surveys were returned. The findings show that
managers are concerned about attracting and retaining quality applicants, and providing quality customer service. Moffat et al. (2011) suggests that companies should provide incentives (i.e., better pay and benefits), training and skill development opportunities, together with an appraisal of performance that go along increased opportunities and salary. Unfortunately, many transit operators are not routinely collecting or measuring data related to success factors of operators or selection ratios of operators (a measure of productivity). Only 30% of bus companies completed exit interviews (when employees leave the company) and 50% collected turnover statistics (used to inform selection and retention efforts of bus operators).

The Truckload Carriers Association (2000) conducted a survey to examine employment policies associated with commercial carriers. The survey data was then combined with a Recruiting Resource Center to ascertain a monetary value in earnings and costs. The average driver earns 30.5 cents per mile when starting a job, which increases to 33.0 cents per mile after 3 years. A driver will average 9,028 miles per month but will be unemployed for 4 months of the year (loss of $11,014.16). Additionally, a driver can expect to work 30 years with an average of 8 job changes. The average driver will be without medical coverage (average of $3,696.00 for uncovered medical expenses) and will lose eligibility to participate in the 401k for up to 84 months (loss of $115,000.00). Other sources of income loss may result from not being paid vacation time or not being considered for work contracts from a lack of seniority.

3.4.3.5 Human Factors

Thiffault (2011) performed a review examining the association between human factors and commercial vehicles (light and heavy vehicles), as well as the effectiveness of human factor interventions. Additionally, strategies were proposed for the development of interventions addressing commercial drivers within a Canadian context. Using the Canadian National Collision
Database (2003-2007), the causes of CMV crashes were caused by driver recognition (i.e., inattention from fatigue or distraction) and decision errors (i.e., risky driving behaviours) rather than performance errors or the use of drugs and alcohol.

To address these issues, Thiffault (2011) proposed various action items. For example, to reduce the amount of driver recognition errors from fatigue, more research is needed to understand the psychosocial determinants (i.e., theory of planned behaviour) that influence the need to continue driving when fatigued (i.e., meeting timelines; pay). Although fatigue management activities are part of initial training (acknowledged by 69% of motor carriers), organizations should implement the North American Fatigue Management Program (NAFMP) which consists of educational activities, scheduling guidelines, as well as OSA screening and treatment guidelines. Additional components may be added to the NAFMP including better sleep/recovery guidelines, fatigue monitoring and crash avoidance technologies, rest areas (and truck parking) and rumble strips to mitigate against crash risk.

Similarly, driver education should be a key component of any intervention targeting distracted driving in commercial drivers. Additionally, enforcements programs targeting commercial drivers use of cell phones/texting should be considered (currently being developed in the USA). The report also proposed several interventions (i.e., vehicles equipped with technology; policies limiting distracters; education) and countermeasures (i.e., use of telematic devices; fleet dispatcher communication devices; texting banned) that organizations/companies can employ (all requiring further research). The collection of data from organizations should also be promoted and shared between governments to determine legislative and regulatory policies on driver distraction.
Decision errors are primarily related to risky driving behaviours. Interventions should be incorporate both passive (i.e., crash avoidance technologies; vehicle infrastructure) and active driver-orientated approach (i.e., countermeasures). Several theory driven recommendations are also proposed including the psychosocial and personality approaches, driver assessment, behaviour modification, risk perception approach to better understand factors that influence risky driving behaviors. Additionally, other types of programs should be considered including training programs, promoting safety technologies, incentives, and programs targeting light vehicles/commercial drivers, as well as government-based initiatives to identify high risk drivers.

3.5 Conclusions

3.5.1 H&W

Studies show that commercial drivers have multiple risk factors (i.e., smoking, obesity, hypertension, poor diet, lack of exercise and sleep) that can lead to comorbidities (i.e., cardiovascular disorders) and adverse events (i.e., crashes and falls). A few Canadian studies (Angeles et al. 2013; Bigelow et al. 2012; Jones-Switzer & McIntyre, 2003) show that risk factors for chronic disease are highly prevalent in commercial drivers. For example, one study found that nearly one third of commercial driver smoked and approximately 50% were overweight and had a poor diet (Angeles et al. 2013). Bigelow et al. (2012) found high blood pressure and cholesterol, lack of exercise, being overweight and fatigued were also prevalent risk factors.

Obesity, in particular, is linked to high health care costs (Martin et al. 2009) and elevated crash risk (Anderson et al. 2012). However, obesity can be a mediating factor and it is unclear whether other factors (i.e., lack of exercise, poor diet, fatigue, sleep apnea) could contribute to the elevated health expenditures and crash risk. Additionally crash rates need to be interpreted
with caution. For example, Anderson’s study (2012) recruited only new hires that had minimal
driving experience which may have inflated crash rates (i.e., from making more mistakes leading
to crashes in the first two years). Two other studies found that absenteeism and job change is
related to crash risk (Staplin & Gish, 2005; Walhberg and Dorn, 2009) although it is not clear
what led to absenteeism or job change, and whether other factors may have influenced crash risk.
For example, Staplin & Gish (2005) included one predictor variable and did not account for the
influence of other mediating factors (i.e., age, health). Future studies are needed to identify what
specific factors are responsible for influencing insurance and claims, as well as driving
performance and crash risk in commercial drivers.

Besides sleep problems, smoking and lack of exercise, there were no common risk factors
among the studies. The lack of exercise is not surprising due to the lack of available exercise
facilities. To improve accessibility to exercise equipment and facilities, organizations should be
encouraged to develop facilities for their employees and provide information on health
promotion activities (Apostolopoulos et al. 2012).

Inconsistent findings among studies are likely due to sample composition and
geographical differences. For example, Layne’s study (2009) included a small convenience
sample (N=50) of equal men and women. Additionally, 84% were Caucasian similar to other
studies (Angeles et al. 2013; Apostolopoulos et al. 2013). Only Sieber et al. (2014) recruited a
larger percentage of African Americans (17%) and Hispanics (9%) which may reflect an
American demographic as African Americans and Hispanics represent 25% of all commercial
drivers. This may be one reason why prevalence rates of various risk factors differ between US
and Canadian studies. For example, African Americans are more likely to develop hypertension
and diabetes than Caucasians, which tend to be the majority of respondents in Canadian based studies.

Survey studies may have been also affected by selection bias as only interested participants may have enrolled, particularly if incentives are offered (Sieber et al. 2014; Angeles et al. 2013). Additionally, studies are limited by their cross sectional design and reliance on self-report measures (Layne et al. 2009; Angeles et al. 2013; Apostolopoulos et al. 2013; Elkington & Stevenson, 2013) which is subject to recall and social desirability bias. For example, BMI was calculated using self-reported height and weight which may not be entirely accurate (Anderson et al. 2012). Future studies are needed to prospectively examine whether and how continued exposure affects the influence of adverse outcomes (i.e., crash risk, workers compensation claims) in commercial drivers using objective and reliable measures.

Commercial drivers are one of five occupations that account for many driver-related long-term injury compensation claims in Canada (Etches & Mustard, 2007). In fact, Jones and Switzer-McIntyre (2003) show that nearly 25% of commercial drivers are injured by falls which often result in musculoskeletal injuries. Truckers, compared to other professions (waste, recycling) had the highest workers compensation costs due to falls from a high elevation (Smith & Williams, 2014). Indeed, falls occurring around the truck step was a primary concern for falls, as was transporting cargo and working near the back of the truck resulting in minor to severe injuries (Jones & Switzer-McIntyre, 2003). However, it is unknown what causes the falls (i.e., slip, step too steep) in commercial drivers. As medical costs due from falls are substantial, future studies need to identify specific fall related factors to improve the workplace environment. Prospective studies should include interviews to learn about falls and how to best implement workplace interventions to reduce fall risk.
A common finding across the survey studies was inadequate access to health care and insurance coverage. Approximately 32% and 38% of commercial drivers do not have insurance (Sieber et al. 2014; Apostolopoulos et al. 2013; Layne et al. 2009) and many would not access physician services while working on the road (Angeles et al. 2013). To improve satisfaction and access to health care, nurse stations should be implemented at truck stations, particularly in rural areas where health care services may be limited. Additionally, information postings, pamphlets are needed at truck stops, as well as organizations that employ commercial drivers to improve knowledge about health care services, as well as modifiable risk factors.

3.5.2 Interventions:

The BP Downshift program is tailored to commercial drivers to reduce cardiovascular risk factors. This intervention was employed with bus and utility truck drivers, however, with mixed results. In Harshman’s et al. (2008) study (using the same sample as Greene et al. 2009), blood pressure was better managed, particularly in those with a greater risk for cardiovascular events (i.e., diabetes, obesity) after the BP Downshift program. However, compared to Greene et al. (2009), Doyle et al. (2010) sample was older (49 versus 42.5 years), had a higher proportion of women (73% versus 0%) and African Americans (72% versus not reported), in addition to having a small sample (N= 120 versus N=499). It is possible the mixed findings are due to differences in sample size and composition. Future studies will need to address the heterogeneous driver population, including the assessment of the BP Downshift program in various commercial drivers (i.e., short versus long haul truck drivers; bus and transit operators).

Some studies show that various interventions are effective at improving health (Zavanela et al. 2012). For example, a resistance exercise program improved blood pressure, pain, endurance and flexibility compared to controls. However, the sample only included male bus
drivers who were unfit. It is likely that any type of activity would have improved health benefits in this group. There may also be substantial costs associated with developing a fitness facility for employees at the workplace. Another study examined the use of a simulator to predict fatigue (Moore-Ede et al. 2004). The authors found that the severity and frequency of accidents was reduced (Moore-Ede et al. 2004), however, to implement such a program across organizations would be costly (i.e., purchase of simulator) and would require staff/dispatches to be trained on detecting optimal states of fatigue.

Several studies examined health benefits before and after an intervention. However, none of the studies followed participants after the intervention to determine whether any healthy behaviour practices were maintained (i.e., Doyle et al. 2010; Harshman et al. 2008; Hwang et al. 2012; Gill & Wijk, 2004; Greene et al. 2009; Olson et al. 2009; Zavanela et al. 2012). Additionally, many did not include a comparison or control group (Doyle et al. 2010; Fine et al. 2012; Hwang et al. 2012; Greene et al. 2009; Harshman et al. 2008; Gill & Wijk, 2004), limiting the ability to determine whether the changes in health was of the intervention or other lifestyle factors. Instead of targeting commercial drivers, one study tailored an intervention to the staff at truck stops (Gill & Wijk, 2004). Observations and interviews determined that the intervention increased awareness of healthy foods, improved healthy cooking by the staff and provided more nutritious foods to commercial drivers. However, this intervention may not apply to bus or utility drivers as only long haul truck drivers typically visit truck stops. Nonetheless, more information is needed to determine whether this type of intervention (targeting program staff at truck stops) is cost effective.

Two Canadian studies found that approximately 70% of commercial drivers have sleep apnea (Moscovitch et al. 2006; Smiley et al. 2009). Treatment of sleep apnea (CPAP or BiPAP)
is immediately effective and can improve driving performance, and reduce fatigue and OSA severity (Federal Motor Carrier Safety Administration, 2007). For example, sleep time improved by 73% from 3.9 hours to 6.8 hours per night, following CPAP treatment (Moscovitch et al. 2006). However, effective screening is necessary to ensure treatment is sought. One study found that selective polysomnography was the most cost effective method for screening for OSA, provided treatment was sought (Gurubhagavatula et al. 2008). Meanwhile, another study found that commercial drivers with OSA treated with CPAP or BiPAP resulted in annual savings of $6000 from an increase in work productivity and a reduction of disability claims over a two year period compared to those who did not receive CPAP or BiPAP (Hoffman et al. 2008). As fatigue is prominent in commercial drivers, developing interventions and systems that alert a driver of impending fatigue may reduce crash risk. However, further research is needed before monitoring systems are implemented in practice as driver detection techniques are not sensitive enough to predict fatigue (Wang et al. 2011). Additionally, driver fatigue may be reduced by establishing work schedules and adapting HOS regulations that allow greater flexibility (e.g., taking into account strategic napping and circadian timing).

Other studies included a multi-component intervention. Hwang et al. (2012) included a physician, dietician, a nurse, a physical trainer and a therapist to guide an intervention on improving blood pressure control. Olson et al. (2009) included computer based programs, education materials, and motivations techniques for employees. While both interventions showed positive results (i.e., better diet, more physical activity), both studies are limited by self-report (bias and/or under-reporting of health issues). Additionally, the psychometric properties of some tools were not reported (may not be valid or reliable) and both studies did not include a control
group. Olson et al. (2009) also included competition as a motivation strategy which may not be effective for all organizations and employees.

Future studies need to employ longitudinal studies with appropriate control groups to test the impact of reducing physical and psychological stressors of the workforce. Additionally, discovering the role of moderators/mediators in the risk factor/morbidity relationship will further uncover how and where interventions can be applied. This is particularly important as risk factors can be different among bus and transit operators, as well as in short and long haul drivers. Interventions should also include multiple components that target several risk factors (and not solely one factor) to better understand which risk factors should be modified for a better health outcome, in addition to examining the cost savings. For example, a change in behaviour related to one risk factor can improve the outcomes of another. Physical activity, for instance, can lead to weight loss and better sleep, thus reducing crash risk (Apostolopoulos et al. 2012). The addition of cost effectiveness and benefit analysis will determine whether the interventions produce cost savings to the employer and the health care system.
4. Proposed National Epidemiological Study of Canadian CMV Drivers

4.1 Rationale and Objectives

As presented in the prior section, commercial drivers have high rates of morbidity (i.e., diabetes, obesity, hypertension, health disease, stroke, and musculoskeletal disorders) and injuries (i.e., vehicular accidents and falls). Thus, it is surprising that this high-risk population has not received much attention in Canada. Two recent cross-sectional studies (Angeles et al. 2013; Bigelow et al. 2012) provide some evidence that Canadian truck drivers are also (or similarly) at a higher risk of having poor health outcomes. Both of these studies, however, were confined to Southwestern Ontario and similar to most studies, only examined truck drivers. Few studies have examined bus drivers and none to our knowledge have looked at coach drivers (i.e., those who drive for Greyhound bus lines or charter companies).

Drivers of CMVs are a large and diverse population. The nature of their occupation not only places them at high risk for unhealthy lifestyles and related health problems, but also makes them a difficult population to study. Although small, cross-sectional studies provide a snapshot of H&W issues in CMV drivers, there is a need for large national epidemiological study to collect baseline data to better characterize H&W issues, as well as to develop potential solutions. Health and safety concerns regarding CMV drivers have stimulated programs of research in other countries (particularly in the U.S., Australia and Europe) that have included population-based epidemiological investigations to examine the extent of the problem and provide baseline data for targeted interventions. Similar studies are needed in Canada.

The primary objective of a Canadian national epidemiological study would be to determine the most prevalent risk factors in different CMV drivers (i.e., short and long-haul truck drivers; transit and coach operators) who work in different provinces (e.g., in highly
populated urban areas and remote northern areas) and work environments. Other important components of such a study include: an environmental scan to identify H&W programs and resources available to Canadian drivers in various sectors of the industry and different parts of the country; an examination of factors influencing the delivery and use of existing resources; the perceived needs of drivers and employers; as well as the relationships of driver wellness with organizational metrics such as workers’ compensation costs, productivity, and other economic measures.

Epidemiology is a science that studies the distribution, patterns, and determinants of health and disease conditions in particular populations. Many studies shown in Appendix B examining risk factors in truck drivers were epidemiological in nature. For instance, Sieber et al. (2014) reported findings from the US National Survey of Long-haul Truck Driver Health and Injury (LHTDS). The LHTDS collected interview and anthropometric data from 1670 long-haul drivers at 32 truck stops across the U.S. A three stage sampling procedure was used to generate an approximately representative national sample of long-haul drivers. The first stage of the sampling process was based on geographic regions and traffic flows to ensure drivers in high and low traffic flow areas were included. Truck stops were then selected based on probabilities proportional to the number of parking spaces at the truck stop. Finally, truck drivers entering the truck stops were randomly approached to participate (Sieber et al. 2014). The LHTDS was the only investigation we found in which the sample was representative of national population of CMV drivers.

Other US studies conducted prior to the LHTDS were based on small convenience samples or were representative of a more defined population. For instance, Spielholz et al. (2008) surveyed a representative sample of truck drivers and employers in the State of
Washington with respect to perceived risk of injury on the job. This study did not focus on H&W per se and thus was not included in our review. However, their sampling methodology merits description as this could be a viable model for future studies. To identify drivers working in the trucking industry, Spielholz and colleagues (2008) cross-referenced a database of commercial driver license (CDL) holders in the state of Washington using the government employer registry. A random sample of eligible CDL drivers was then mailed surveys, as were employers of trucking companies.

A number of other epidemiological studies of CMV drivers have reported successful recruitment techniques that inform the development of a nationwide study in Canada. For example, Angeles et al. (2013) identified 20 short-haul trucking companies through the Hamilton Chamber of Commerce and the Ontario Trucking Association. The research team worked with occupational health and safety personnel in each company to plan and organize the distribution of driver surveys. A total of 822 drivers in 13 companies received surveys, with a return rate of 49.4% (Angeles et al. 2013). Meanwhile, Apostolopoulos et al. (2013) actively recruited truck drivers to complete a questionnaire at truck stops and terminals in North Carolina with 316 drivers participating. Bigelow et al. (2012) had a low refusal rate in a study conducted at two truck stops in southern Ontario with drivers being provided vouchers for food products. Another study of truck drivers conducted to examine determinants of job satisfaction recruited long haul drivers at one truck stop adjacent of an Interstate highway in the mid-west region of the US (Johnson et al. 2011). Drivers were approached as they paid for fuel and the refusal rate was less than 5% with no drivers objecting to the use of a tape recorder. Over half the truck drivers in this study were owner operators with the remainder reporting driving for a company (Johnson et al. 2011).
Canadian CMV drivers experience challenges unique to the Canadian context, environment and geography. To conduct a Canadian study that is representative of CMV drivers, it is critical to include all types of commercial drivers across different regions. For example, long-haul drivers based in southern Ontario will likely travel more to U.S. destinations than drivers based in northern areas of Canada. This is reflected in recent data from Statistics Canada (2013) that reported 3,557,255 Canadian trucks crossed the US border. Additionally, 2,229,135 trucks returned to Canada crossing via Ontario. Weather, road, driving conditions, and facilities vary significantly between the two countries, as well as across Canada.

Table 4.1 shows the number of salaried truck drivers and owner operators in Canada by province within the truck transportation sector. Truck drivers are also employed in other industrial sectors such as manufacturing and construction. Therefore, the total number of truck drivers reported in Table 4.1 reflects employment in the “for-hire” trucking sector but overall the number of truck drivers in Canada is closer to 300,000 (Gill & Macdonald, 2013). To reduce costs, companies are using more owner operators in the US and Canada, with as many as 30% of truck drivers being owner operators (see Table 4.1). Working conditions for owner operators are generally poorer than for employees of a company and they suffer greater levels of psychological distress (Mayhew and Quinlan, 2006).
Table 4.1. Trucking Industry Employment Statistics by Province and Territory

<table>
<thead>
<tr>
<th></th>
<th>Salaried Truck Drivers</th>
<th>Owner Operators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>128,429</td>
<td>54,086</td>
</tr>
<tr>
<td>NL</td>
<td>848</td>
<td>141</td>
</tr>
<tr>
<td>PEI</td>
<td>494</td>
<td>44</td>
</tr>
<tr>
<td>NB</td>
<td>4,615</td>
<td>3,003</td>
</tr>
<tr>
<td>NS</td>
<td>2,199</td>
<td>713</td>
</tr>
<tr>
<td>QC</td>
<td>30,087</td>
<td>8,567</td>
</tr>
<tr>
<td>ON</td>
<td>44,030</td>
<td>18,417</td>
</tr>
<tr>
<td>MN</td>
<td>7,948</td>
<td>4,138</td>
</tr>
<tr>
<td>SK</td>
<td>6,719</td>
<td>2,053</td>
</tr>
<tr>
<td>AB</td>
<td>18,604</td>
<td>10,391</td>
</tr>
<tr>
<td>BC</td>
<td>12,777</td>
<td>6,509</td>
</tr>
<tr>
<td>YT</td>
<td>49</td>
<td>4</td>
</tr>
<tr>
<td>NWT</td>
<td>46</td>
<td>81</td>
</tr>
<tr>
<td>NU</td>
<td>14</td>
<td>24</td>
</tr>
</tbody>
</table>

Statistics Canada. Table 403-0011 - Trucking industry, employment statistics, by province and territory, annual (2010). CANSIM (database). (accessed: 2014-03-17). The survey covers all businesses located in Canada with at least one establishment classified to "Truck Transportation" according to the North American Industrial Classification System (484 - Truck Transportation (NAICS 2007)) provided that the annual revenue from the trucking establishments is $30,000 or more.

The demographics of those employed as bus drivers, subway and transit operators are significantly different than for truck drivers with the former group being younger and comprising a greater proportion of women (approximately 30%) (Service Canada, 2013). Although the distribution and total numbers of those employed as bus drivers across Canada is not readily available, the number of registered motor coaches, school and transit buses as of 2011 provides some indication of the overall prevalence of drivers (see Table 4.2).
Table 4.2. Bus and Urban Transit Industries Equipment Operated in Canada (2011)

<table>
<thead>
<tr>
<th>Total number of vehicles</th>
<th>67,027</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Coaches</td>
<td>5,397</td>
</tr>
<tr>
<td>School Buses</td>
<td>35,385</td>
</tr>
<tr>
<td>Urban Transit buses</td>
<td>17,796</td>
</tr>
<tr>
<td>Other Rolling stock</td>
<td>8,449</td>
</tr>
</tbody>
</table>

Statistics Canada. *Table 408-0010 - Canadian passenger bus and urban transit industries, equipment operated, by North American Industry Classification System (NAICS) and type of vehicle, annual (2011).* CANSIM (database). (accessed: 2014-03-17). These figures include vehicles that are used to generate revenue, and exclude vehicles that are owned by private organizations or companies that use the vehicles to transport people and goods for private purposes. This combines North American Industry Classification System, 2002 (NAICS) codes 485110, 485210, 485410, 485510, 485990, as well as bus activities in 487110 and other industries.

Given there are numerous options for conducting a national epidemiological study of CMV drivers in Canada, this section of the report outlines three different approaches that could be considered. The various approaches have specific advantages and disadvantages and it would be important that key stakeholders be active participants in the selection of the final design. Thus we also recommend that, regardless of the research design, that Research Advisory and Project Planning Committees be formed to engage stakeholders. Additionally, such little is known about the existing H&W resources/needs of CMV drivers and transportation companies in Canada it is recommended that an environmental scan be completed prior to finalizing the study design and protocol. For each of the three approaches presented in this report, the sampling procedures, suggested measurements and instruments, data analysis, and expected outcomes are described.
4.2 Approaches to Conducting an Epidemiological Study of Canadian CMV Drivers

Three approaches for an epidemiological study of Canadian CMV drivers are presented in this section. The first approach is a cluster sample, cross-sectional survey in which drivers in a random sample of transportation companies (tucking, bus and transit companies) would be recruited. The second approach is a mixed methods study in which CMV drivers would be interviewed at truck stops with a subsample invited to participate in clinical assessments. It should be noted that the target population for the second approach would be those CMV drivers who stop at truck or rest stops, thus bus and other CMV drivers would be under sampled. Additional data collection locations would need to be added in a much larger investigation to ensure the sample is representative of all CMV drivers. The third approach is a linked database study which would utilize health administrative data from a number of sources that would provide baseline data on the H&W of Canadian CMV drivers.

Common to all three approaches for an epidemiological study would be the formation of Research Advisory/Project Planning Committees and an environmental scan. Details of the Research Advisory/Project Planning Committees as well as the environmental scan are provided in Section 6 as these are preparatory activities that are best practice in conducting large epidemiological studies. Figure 4.1 provides an overall description of the three approaches and the function of preliminary work in setting up the Research Advisory/Project Planning Committees as well as the environmental scan. Details of the three approaches are provided in Sections 4.2.1 (Approach #1 Cluster sample survey), 4.2.2 (Approach # 2 Mixed Methods Study with a focus on truck transport drivers), and 4.2.3 (Approach #3 Linked Database study).
Figure 4.1. Overview of Approaches for Epidemiological Studies of CMV Drivers

**Formation of Research Advisory Committee and Project Planning Committee**

**Environmental Scan**

**Approach #1: Cluster Sample Survey (3 year study)**

**Sampling Transportation Companies and CMV Drivers (informed from results of Environmental Scan and Committee input)**

**Development of Questionnaires**
1. Long & short haul truck drivers
2. Bus and transit drivers
3. Trucking company management
4. Bus company management

**Data Analysis and Feedback**

**To engage key research collaborators and key stakeholders early on. Participatory research techniques**

**Work with Committees to collect information on all agencies and organizations impacting CMV drivers. Key informant interviews and document analysis methods**

**Develop sample frame of companies of CMV drivers in Canada**

**Stratified random sampling approach to select companies**

**Research team works with selected companies to administer driver surveys (census survey or random sample)**

**N=250 companies; Driver surveys completed by over 5,000 drivers**

**Stratified random sampling approach to select companies**

**Companies contacted first with management questionnaires returned; follow-up with companies to administer driver surveys**

**Research team works with selected companies to administer driver surveys (census survey or random sample)**

**Descriptive statistics for rates of conditions and risk factors; compare across CMV occupations and jurisdictions; factor analysis; path analysis; multilevel modelling.**

**Baseline data on CMV drivers; identify modifiable risk factors for chronic disease; links of CMV wellness to company performance; inform intervention research**
Approach #2: Mixed Methods Study – Initial Focus on Truck Drivers (2 year study)

Environmental Scan

Informs Data Collection Locations and Recruitment Protocols

12 truck stops at minimum and on two ferries (BC Ferries and Marine Atlantic transport the largest numbers of commercial vehicles in Canada); truck stop locations informed by CMV routes and volumes and from Environmental Scan

Development of Interview Questions and Clinical/Anthropometric Measurements

Interview questions developed using protocol described for Approach #1 for (1) Long & short haul truck drivers; (2) Bus and transit drivers
Clinical measures from past CMV driver studies

Data Analysis and Feedback

Descriptive statistics for rates of conditions and risk factors; compare across CMV occupations and jurisdictions.
Validity assessment of questionnaire/interviewer obtained self-reports of height/weight (BMI) and risk factors with objective data
Findings inform stakeholders and intervention researchers
Approach #3: Linked Database Investigation (14 months)

Selection of Databases
- Canadian Community Health Survey (CCHS), National Ambulatory Care Reporting System (NACRS), Canadian Mortality Database (CMDB), Discharge Abstract Database.
Databases linked to identify CMV drivers.
Potential to add provincial databases including workers compensation and transportation ministry data.

Selection of Key Variables (Environmental Scan informs selection)
- Literature reviews and past findings identify key H&W variables. Environmental Scan and Advisory/Planning Committee inform occupation and environmental variables (work characteristics and exposures).

Data Analysis and Feedback
- Descriptive statistics for rates of conditions and risk factors; compare across CMV occupations and jurisdictions. Extensive analyses to compare rates of conditions and risk factors to those in other occupations.
4.2.1 Approach # 1: Cluster Sample Survey of CMV Drivers and Employers

One approach for this national epidemiological study would be to survey CMV drivers and company representatives. Using a two-staged procedure (i.e. cluster sampling), the first stage would identify and randomize transportation companies. In the second stage, CMV drivers would be surveyed using a census approach or alternatively randomly selected within each selected company.

4.2.1.1 Company and Driver Surveys

The sampling pool would consist of all registered transportation companies in Canada with surveys administered to a stratified random sample of company representatives along with census surveys of drivers within the selected companies. Four separate surveys (comprising both validated scales and questionnaires) would be developed for each audience as follows: (1) long and short haul truck drivers: focusing on health problems, lifestyle behaviours (sleep, exercise, diet, smoking), fatigue, injury risks, perceptions of the safety climate of their company, psychosocial job factors, and barriers to adopting healthy behaviours; (2) bus drivers: focusing on similar health problems to truck drivers but modified to reflect the unique concerns, work environments and tasks of this driving population (e.g., stress, emotional labour); (3) truck company representatives focusing on existing driver H&W programs and incentives for participation, perceived importance of driver employee wellness, safety climate at the management level, and solutions and barriers to improving driver wellness; and (4) bus company representatives, focusing on the same issues as (3) but modifying the survey questions for appropriateness to this sector where needed.

The first stage of the sampling process would be to obtain a nationally representative sample of transportation (bus and truck transport) companies. Freight hauling companies within
each province/territory could be identified through a number of sources, including provincial trucking associations, the Canadian Trucking Alliance, workers’ compensation boards and transportation sector safety associations, as well as national directories (e.g., canadatransportation.com). Bus and transit companies in Canada, meanwhile, could be identified through national motor coach associations, municipal transit authorities, provincial/territorial workers’ compensation boards, transportation sector safety associations, as well as through business directories.

After assembling as representative a list as possible of all transportation companies in Canada, the sampling frame could be stratified according to: a) Type of vehicle and route (short haul/ long haul; intercity bus/transit/school transport); b) Company size (small, medium, large) as measured by the number of employees or number of vehicles; c) Region (province/territory) and location (proximity to major cities). Companies within each stratum would then be randomly selected and invited to participate in the study. Although further work is required to more precisely calculate sample size (i.e., information on variability of measures, numbers of companies in each strata, number of drivers per companies, etc.), we estimate sample size of approximately 250 companies are needed to reflect the diversity of the CMV industry in Canada. Companies that agree to participate would then be invited to complete the questionnaires designed for bus company or truck transport company representatives. Researchers will work with company representatives (ideally such representatives will be members of Joint Health and Safety Committees) to gain access to drivers to facilitate the administration of the (driver) surveys.
4.2.1.2 Development of Surveys and Data Collection (drivers and company representatives)

Investigators from the University of Waterloo and McMaster University have had success with self-administered truck driver questionnaires that include scales for diet, smoking, physical activities, other health behaviours, job characteristics, psychosocial factors as well as general health (Bigelow et al. 2012; Angeles et al. 2013). Additionally, scales used in the US National Survey of Long-Haul Truck Drivers have shown good reliability and validity and will be considered (Sieber et al. 2014). With respect to bus drivers, we would consider the work of other authors (i.e., Greiner et al. 1997; Krause et al. 2010; and Ragland et al. 1995; Tse et al. 2006) who have conducted survey studies on risk factors and health. Adapting items and scales from their studies to develop a bus driver survey within a Canadian context is a feasible approach. Other proposed measures are shown in Table 4.3.
Table 4.3. Measures appropriate for CMV drivers

<table>
<thead>
<tr>
<th>Concept</th>
<th>Questionnaires and Scales¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics and work characteristics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age, Sex, Education Level (CCHS, APHEO)</td>
</tr>
<tr>
<td></td>
<td>Method of compensation, Driving experience, Tenure with company,</td>
</tr>
<tr>
<td></td>
<td>Nights away from home; Passengers in cab; Goods transported, Bus/truck</td>
</tr>
<tr>
<td></td>
<td>type (Spielholz et al.; Greiner et al.; Johnson et al.; Sieber et al.)</td>
</tr>
<tr>
<td></td>
<td>Work hours, Work schedule, Points of delivery, Time pressure, driving</td>
</tr>
<tr>
<td></td>
<td>practices (Angeles et al.; Bigelow et al.; Greiner et al.; Sieber et al.)</td>
</tr>
<tr>
<td></td>
<td>Sources of health information (Brann et al.; HINTS)</td>
</tr>
<tr>
<td>Psychosocial exposures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self-Perceived Work Stress (CCHS, APHEO)</td>
</tr>
<tr>
<td></td>
<td>Self-Perceived Life Stress (CCHS, APHEO)</td>
</tr>
<tr>
<td></td>
<td>Cognitive demands, Quantitative demands, Emotional demands, Job control</td>
</tr>
<tr>
<td></td>
<td>(COPSOQ)</td>
</tr>
<tr>
<td></td>
<td>Fear of violence (Poulsen et al.)</td>
</tr>
<tr>
<td></td>
<td>Safety climate (Huang et al.)</td>
</tr>
<tr>
<td>Physical Exposures and health behaviours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leisure time physical activity (APHEO, van der Ploeg et al.)</td>
</tr>
<tr>
<td></td>
<td>Activities during breaks/at rest stops (Brann et al.)</td>
</tr>
<tr>
<td></td>
<td>Smoking, Alcohol (APHEO, CCHS)</td>
</tr>
<tr>
<td></td>
<td>Diet (Angeles et al.)</td>
</tr>
<tr>
<td></td>
<td>Musculoskeletal disorder risks (Bigelow et al.; Spielholz et al; Wells et al.)</td>
</tr>
<tr>
<td></td>
<td>Sleep quality (PSQI)</td>
</tr>
<tr>
<td></td>
<td>Concern over fatigue (WorkSafe BC)</td>
</tr>
<tr>
<td>Health Measures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overall health (CCHS)</td>
</tr>
<tr>
<td></td>
<td>Mental health (SF-36)</td>
</tr>
<tr>
<td></td>
<td>Quality of life (WHO)</td>
</tr>
<tr>
<td></td>
<td>Fatigue (Epworth Sleepiness Scale; Michielsen et al.)</td>
</tr>
<tr>
<td></td>
<td>Health complaints (Bigelow at al.; Sluiter et al.)</td>
</tr>
<tr>
<td></td>
<td>Need for recovery, Psychosomatic complaints (Sluiter et al.)</td>
</tr>
</tbody>
</table>

Employer questionnaires would be informed by previous trucking survey research and by the work of Spielholz and colleagues (2008). Their state-wide survey of transportation employers was completed by owners, top management, or other administrative staff and contained items on injury risks and other themes relevant to this proposed research. Additionally, questionnaire items pertaining to existing H&W programs, as well as facilitators and barriers to

¹ CCHS – Canadian Community Health Survey, APHEO – Association of Public Health Epidemiologists of Ontario, HINTS – US Health Information National Trends Survey, COPSOQ - Copenhagen Psychosocial Questionnaire, PSQI - Pittsburgh Sleep Quality Index
implementation will be informed by the work of Bigelow et al. (2009) who interviewed occupational health and safety professionals in the transportation sector on these topics.

Table 4.4. Scales appropriate for representatives from truck transport and bus companies

<table>
<thead>
<tr>
<th>Concept</th>
<th>Scales and descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respondent characteristics and company demographics</strong></td>
<td>Age, Sex, Education Level, Job, Role in company (CCHS, APHEO, Spielholz et al.)</td>
</tr>
<tr>
<td></td>
<td>Business activities, Number of vehicles, Number of employees, Hours per week company drivers, Hours per week non-company drivers, Unionization, (Spielholz et al.)</td>
</tr>
<tr>
<td></td>
<td>Financial performance, Safety Performance (Naveh and Marcus)</td>
</tr>
<tr>
<td><strong>Safety management and management systems</strong></td>
<td>Organizational policies and procedures (Cullen et al.; Ossmann et al.; Amick et al.; Spielholz et al.)</td>
</tr>
<tr>
<td></td>
<td>Ranking of safety and health concerns (Spielholz et al.)</td>
</tr>
<tr>
<td></td>
<td>Present programs addressing driver H&amp;W</td>
</tr>
<tr>
<td></td>
<td>Challenges to implementing driver H&amp;W programs</td>
</tr>
</tbody>
</table>

An appropriate method for contacting selected companies is by first mailing them the questionnaires, then contacting the companies by phone. This strategy was used successfully in Spielholz and colleagues (2008) work where they identified all trucking companies in the state of Washington (with over 5 FTE employees; N=926) and then mailed questionnaires to all the companies. After a phone follow-up, the overall response rate was 52%. Angeles et al. (2013), in a smaller and more focused investigation, identified trucking companies in the Hamilton area and contacted them by telephone. The refusal rate was low and 13 companies participated. Research staff then worked with health and safety leaders in the companies to distribute anonymous surveys to drivers.

Study investigators could work with companies who complete and return the questionnaire (those who complete the company truck or bus questionnaire). After the company representative completes the survey and provides consent for employee follow-up, the research
team, together with the company, could collaborate and determine the best an approach for administering surveys to CMV drivers.

An important aspect of the driver survey is ensuring minimal effort is required from company staff and with minimal disruption of regular work tasks. The research by Smiley et al. (2009) used PDAs to efficiently collect data on sleep, mood, workload and performance of drivers in a fatigue management intervention. Similarly, it is proposed in this approach that mobile devices such as smart phones, tablets or existing on-board computer systems could be utilized for administering the questionnaire to drivers. Numerous transportation companies, both in the bus and trucking subsectors, use onboard computer systems for a variety of purposes (e.g., logistics, routing, fuel efficiency, driver monitoring) and it is possible to integrate survey administration with these systems. For companies where integration with onboard computer systems is not possible the use of mobile devices, or on-line questionnaires could be explored. It is expected that most companies communicate with drivers by email so sending drivers a link to a web-based survey would likely be effective. FluidSurveys or another online survey software provider with data hosted on Canadian servers could be used for online and mobile device–based surveys.

4.2.1.3 Data analysis

For questionnaires completed by pen and paper, double data entry would be performed to reduce data entry errors. A database of responses would be developed with data from various data sources amalgamated. Companies and individuals would be assigned unique codes and no personal identifiers would be contained in the database. A paper file that contains the names of companies and individuals and their codes would be stored in a locked filing cabinet.
Statistical analysis would be performed using SAS 9.1 or SPSS 22. Descriptive statistics would be conducted first to profile the respondents and to determine the most prominent risk factors. Respondent demographics and prevalence of risk factors can be compared to the Canadian Community Health Survey (CCHS) to determine if they are different than the general Canadian population. Exploratory and confirmatory factor analysis would be used to group items that identify common themes and to test existing scales. Multivariate statistical analysis techniques would be used to examine associations between injuries, health conditions, health behaviours and risk factors. Multilevel analyses could be performed to assess company and subsector variables on health and injury outcomes in drivers.

4.2.1.4 Expected outcomes

The study would be the first to provide important baseline data on the occupational health, safety and wellness of Canadian CMV drivers. CMV drivers are an at risk population and understanding the range and diversity of adverse health conditions and their distribution in the population will assist regulatory agencies, health organizations, transportation companies, unions and occupational health professionals in addressing the problem. Drivers will benefit directly as findings would be provided directly to participants who then would be able to take action to reduce their risks. The population of drivers as a whole has the potential to be impacted through future research and interventions that are based on the evidence the study would provide.

Such a study would identify risk factors that are most strongly associated with medical conditions and poor health and safety outcomes for Canadian CMV drivers. Knowing these risk factors in relation to the context of the work environments of CMV drivers in Canada would help researchers develop interventions that will be effective. Through multilevel modeling, an understanding of the impacts of company-level factors in the relationships of potential risk
factors with H&W outcomes would be achievable. Associations between driver H&W with indicators of company performance would also be possible.

4.2.1.5 Budget considerations and timeframe

It would be feasible to complete the study over a three year period at a cost of approximately $500,000. The time required for recruiting large numbers of commercial drivers from transportation companies (in addition to first recruiting managers of transportation companies) would require substantial resources.

4.2.1.6 Partners and funding sources

Potential research partners for this project include: The Institute for Work & Health; Transport Canada; University of British Columbia, University of Northern BC; University of Waterloo; McMaster University; McGill University; Dalhousie University; Memorial University. Stakeholders include: Unifor; Teamsters Canada; the Owner-Operator's Business Association of Canada (OBAC); and the Canadian Trucking Alliance. Potential funding sources include: Canadian Institute of Health Research (CIHR); Association of Workers Compensation Boards; and the Provincial Workers Compensation Boards.

4.2.2 Approach #2: Mixed-Methods Study

The second approach would recruit CMV drivers at truck stops and/or other locations on their routes. Although more costly than administering surveys, this approach is advantageous as response rates would be higher due to face-to-face recruitment of drivers and would ensure that owner-operators are included in the study. Additionally, objective measurements of height, body weight, blood pressure and heart rate could be obtained from participants at truck stops allowing for the comparisons with self-report information on health problems and lifestyle practices obtained through questionnaires. The limitation of this approach is that only drivers who stop at
truckstops or rest areas and other data collection locations would be represented in the final sample (thus bus and transit drivers would be under sampled). More locations would need to be added (such as bus stations, schools (for school buses), and transit hubs) for a more comprehensive study.

4.2.2.1 Driver Interviews and Clinical Measurements

As nearly 30% of commercial truck drivers are owner operators, recruiting drivers from truck stops as well as other places they stop (i.e., weigh stations, rest areas, border crossings) has been effective. It is possible to use truck traffic volumes to identify appropriate locations to engage drivers. It is recommended that recruiting drivers at a minimum of 12 truck stops across the country and on the Vancouver Island truck ferry and the Marine Atlantic to the Isle of Newfoundland ferry would be appropriate. Managers of truck stops/ferry operators could be asked to provide space for drivers to participate in interviews. Drivers could be given a voucher for food or products sold at the data collection location after completion of the interview and clinical assessment. A sub-sample of drivers would be invited to participate in an anthropometric/clinical component of the study. Participants would have their height, weight, heart rate and blood pressure measured (see Table 4.5).

Although in the focus for this approach is on truck drivers, the approach could be expanded to include other CMV drivers. The completion of the environmental scan described in Section 6 is a critical first step that is necessary before details of appropriate data collection locations and procedures can be provided.
Table 4.5. Clinical and anthropometric measurements and interview questions

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Description</th>
</tr>
</thead>
</table>
| Blood pressure, heart rate, height, weight | Portable automatic blood pressure monitoring device (BP and HR)  
Standard procedures for height and body weight measurement |
| Interview schedule                  | Truck driver survey questions will be modified to be interviewer administered. |

4.2.2.2 Data analysis

Similar approaches for protecting the confidentiality of participants would need to be followed as described in section 4.2.1.3. Statistical analysis would be performed using SAS 9.1 or SPSS 22. Descriptive statistics would be conducted first to profile the respondents and to determine the most prominent risk factors. Exploratory and confirmatory factor analysis would be used to group items that identify common themes and to test existing scales.

4.2.2.3 Expected outcomes

The study would provide important baseline data on the occupational health, safety and wellness of Canadian truck drivers. The data would not be representative of all CMV drivers in Canada but would provide excellent baseline data on truck drivers who are a population known to be at high risk. Additionally, independent owner operators, who make up a large population of truck drivers would be well represented in the sample. These owner operators are a hard to reach population and likely experience high rates of morbidity as compared to other drivers.

As for Approach #1, this study would identify risk factors that are most strongly associated with medical conditions and poor health and safety outcomes for the drivers sampled. Knowing these risk factors is crucial information for developing interventions for this at risk population.
4.2.2.4 Budget considerations and timeframe

Collecting data at truck stops across various geographical regions in Canada, in collaboration with other universities and health organizations, could be completed with a budget of approximately $400,000 to $500,000 over a period of two years. It is noted that this budget would pertain to data collection occurring at two ferry terminals and 12 truck stops across Canada and the study could be expanded to ensure all CMV drivers would be represented in the sample. The completion of an environmental scan and collaboration with stakeholders would be effective in identifying the best locations and methods of data collection for recruiting short haul truck drivers, bus and other CMV drivers. The US National Survey of Long-Haul Truck Driver Health and Injury (LHTDS) involved the completion of 1300 interviews of drivers from 32 truck stops across the U.S. This study, although with more comprehensive clinical and sleep assessments than presented in Approach #2, had an overall budget of over $1.25 million USD. Thus, expanding the scope of Approach #2 to include other CMV drivers would raise the budget estimate to over $1,000,000.

4.2.2.5 Partners and funding sources

Potential research partners for this project include: Transport Canada; University of British Columbia; University of Northern BC; University of Alberta; University of Manitoba; University of Waterloo; McMaster University; McGill University; Dalhousie University; Memorial University. Stakeholders include: Unifor; Teamsters Canada; the Owner-Operator's Business Association of Canada (OBAC); Canadian Trucking Alliance, and the Canadian Trucking Human Resources Council. Potential funding sources include: Canadian Institute of Health Research (CIHR); Association of Workers Compensation Boards; Provincial Workers
Compensation Boards; Provincial Ministries of Health; and the Social Sciences and Humanities Research Council the (SSHRC).

4.2.3 Approach #3: Linked Databases

Statistics Canada collects health administrative data from a number of sources and also conducts national surveys that can be linked to study H&W of CMV drivers. Additionally, British Columbia and Manitoba routinely collect health data that also can be linked. This third approach for an epidemiological study focuses on Statistics Canada data sources as it provides the opportunity to examine drivers in all jurisdictions in Canada. The provincial data sources, although more limited in geographic coverage, do have advantages in terms of accessing more comprehensive data on occupational health in a timelier manner (less of a lag time between the time data is collected at the source until it is available to researchers).

The Statistics Canada datasets that are appropriate for the study are the Canadian Community Health Survey (CCHS), the National Ambulatory Care Reporting System (NACRS), the Discharge Abstract Database (DAD), the Canadian Mortality Database (CMDB) and the Historical Tax Summary File. The CCHS is a large, biennial, cross-sectional survey with over 130,000 respondents. CMV drivers can be identified by the following National Occupational Classification codes:

7511 Transport truck drivers
7512 Bus drivers, subway operators and other transit operators
7513 Taxi and limousine drivers and chauffeurs
7514 Delivery and courier service drivers

The CCHS collects information on a variety of health conditions (e.g., hypertension, diabetes, health disease, stroke, lung conditions, etc.), health behaviours (e.g., smoking, drinking,
physical activity, fruit and vegetable consumption, etc.) and general health (health history, mental health, sleep quality, stress).

Linking the CCCH files to the NACRS file provides data on day surgeries and visits to emergency departments and outpatient clinics. The DAD provides details of the treatments and conditions (diagnostics) of individuals receiving medical care (also details on resources/costs of treatments). The CMDB contains information on underlying cause of death and other demographic information.

4.2.3.1 Data analysis

All data analyses and linkages would be performed within a Statistics Canada Research Data Centre (e.g., South Western Ontario Research Data Centre, British Columbia Inter-university Research Data Centre). Statistical analysis would be performed using SAS 9.1 or SPSS 22. Univariate analysis with crosstabs would be used to generate descriptive statistics. A number of outcomes could be assessed including BMI, specific health conditions, level of physical activity, diet, and various measures of health (including death) and utilization of health services. Simple linear regression is recommended to examine work characteristics and the selected outcomes. Multivariable models could be developed to examine important occupational relationships with health outcomes while controlling for potential confounders.

4.2.3.2 Expected outcomes

The study would provide important information on the H&W of Canadian CMV drivers. It is hypothesized that CMV drivers are at increased risk of cardiovascular disease, stroke, hypertension, poor mental and physical health, and earlier mortality. Additionally, it is hypothesized that commercial drivers are more likely than other employed Canadians to smoke, participate less in sports and physical activities, have poorer diets, and have more exposures to
stress. Through the database linkages it would be possible to examine the health utilization of drivers compared to workers in other occupations. Additionally, the analyses would generate an understanding of the associations between driving and behavioural risk factors and the costs on health care services. Thus, the study would be the first to examine the prevalence of adverse health conditions in CMV drivers and also provide insight into the health care costs associated with the poor health of this segment of the Canadian population.

4.2.3.3 Budget considerations and timeframe

The timeframe for the project would be as follows: development of a proposal for submission to Statistics Canada (for data access) (month 1-2); data linkage (month 2-4); data analysis (month 4-10); report and manuscript preparation (month 10-14). The budget for the project is estimated at $200,000.

4.2.3.4 Partners and funding sources

Statistics Canada would have interest in this research and there is the potential for collaboration with scientists within their Health Analytics Division. Additionally, scientists from Transport Canada, the University of Northern BC, University of Waterloo, the Institute for Work & Health, and McMaster University may have an interest in collaborating. Other stakeholders with an interest may be Unifor, Teamsters Canada, the Owner-Operator's Business Association of Canada (OBAC), and the Canadian Trucking Alliance. Funding from the Canadian Institutes of Health Research may be a possibility. Potential funding sources include: (CIHR) Canadian Institute of Health Research; Association of Workers Compensation Boards; Provincial Workers Compensation Boards; Provincial Ministries of Health; and the Social Sciences and Humanities Research Council the (SSHRC).
5. Potential H&W Interventions for Canadian CMV Drivers

5.1 Relevance and justification for additional interventions

CMV drivers face disproportionally high risks of occupational fatalities and injuries (i.e., crashes, falls) and are more likely to be diagnosed with cardiovascular and musculoskeletal disorders than workers in other occupations. While drivers face occupational risks, which may be inherent to the job, these risks can be exacerbated by poor health amongst many drivers. The poorer health of commercial drivers, especially long-haul drivers is largely a result of demanding and transitory work environments that are not supportive of regular physical activity, good nutrition, quality sleep, or access to health information and regular or preventative health care. The links between driver health, demanding work schedules, lifestyle practices, and work-related injuries are well established. Given these linkages, interventions that address both health promotion and occupational health and safety are of utmost importance in the commercial driver population.

The proposed national epidemiology study is greatly needed to provide accurate estimates of risk factors and health conditions of CMV drivers in Canada. Due to differences in the driver population, road design, driving routes, environmental conditions and health behaviours as well as the sparsity of studies on the health of Canadian CMV drivers, it is difficult to draw conclusions on rates and types of illness and injury in comparison to drivers in the U.S. or other countries. As CMV drivers make up the most prevalent occupation for Canadian males, (e.g., there were over 304,000 truck drivers in Canada in 2006 (Gill & Macdonald, 2013)), interventions that reduce chronic disease risk factors and associated injuries have great potential for improving the health of this significant portion of our population.
Due to the paucity of research in this area, little information exists on direct cost savings stemming from interventions that would result in a reduction in the burden of illness and injury in CMV drivers. However the economic and health benefits could be estimated from empirical models projecting declines in smoking, obesity, workers compensation claims, and motor vehicle collisions after a hypothetical CMV driver H&W intervention.

Lightwood and Glantz (1997) determined the short-term economic benefits of a 7-year smoking intervention resulted in a 1% per year reduction in smoking rates in California. This study showed that a 1% reduction in smoking rates would reduce the number of deaths from acute myocardial infarction and stroke (~13,000 deaths), resulting in savings of $3.2 billion in medical costs. More importantly, the transition from smoker to non-smoker reduced health care costs from acute conditions by $47 in the first year and $853 during the next 7 years.

One intervention that has shown success targeting cardiovascular risk factors in commercial drivers is The BP Downshift Program. This program resulted in cost savings of $500 per driver (Green et al. 2009). Economic projections similar to the work of Lightwood and Glantz (1997) could be made for CMV drivers based on expected impacts of a new Canadian intervention and the burden of specific chronic diseases in Canada (see PHAC & CIHI, 2011).

Fatigue is a major cause of accidents resulting in substantial medical and insurance costs. The U.S. Department of Transportation reported that fatigue is responsible for an excess of $12 billion per year in total costs (Downey, 2000). Moore-Ede et al. (2004) estimated that implementing the Circadian Alertness Simulator (CAS) tool could reduce the frequency and severity of crashes by improving employee schedules. Through the use of CAS in a trucking company with 500 power units, the number of accidents from inattention was reduced by 81% resulting in a reduction of costs from $1,187,699 to $226,627 per year. With more than 67,000
buses and 829,000 trucks over 4.5 tons operating in Canada (Statistics Canada, 2009) and as more than 50% of commercial drivers report suffering from fatigue (Apostolopoulos et al. 2012), addressing the issue of driver fatigue needs to be a priority.

Approximately 70% of commercial drivers in Canada have sleep apnea (Moscovitch et al. 2006; Smiley et al. 2009). Hoffman et al. suggest that for each driver treated for sleep apnea (i.e., CPAP or BiPAP), there was a yearly cost savings of $6000 from increased work productivity and fewer disability claims (Hoffman et al. 2008). Thus, reducing the number of fatigue related crashes, through interventions such as the CAS tool or treatments for sleep apnea, could result in tremendous cost savings to transportation companies, workers compensation agencies, the health system, and the Canadian economy as a whole.

Besides vehicular crashes, commercial drivers also have high rates of falls and musculoskeletal disorders. Approximately 25% of all commercial drivers report falling resulting in substantial worker compensation costs (Jones & Switzer-McIntyre, 2003). For example, falls from non-moving vehicles (a common injury in CMV drivers) resulted in a cost of over $5,000,000 (Jones & Switzer-McIntyre, 2003). Compared to other occupations, commercial drivers (particularly truck drivers) have the highest number of lost time claims (Smith & Williams, 2014). Thus, interventions are needed to reduce the number of work-related fall injuries, musculoskeletal disorders and associated workers compensation claims.

In conclusion, there is a dire need for more intervention studies on the H&W of CMV drivers in Canada. Although transportation companies are aware of the risk factors associated with the trucking industry (Bigelow et al. 2012), employers are concerned with the aging driver workforce resulting in an anticipated shortage of 25,000 to 33,000 drivers by 2020 (Gill & Macdonald 2013), as well as the constant and ongoing challenge of recruiting and retaining
quality drivers (Moffat et al. 2011). These challenges require companies to maintain the health of their employees and call for the need for further studies to determine the most cost effective interventions on H&W. While prior studies have generally examined interventions tailored to a specific risk factor (i.e., obesity, fatigue), multi-component interventions are needed that address comorbid risk factors and environmental demands in commercial drivers simultaneously.

5.2 Format of an intervention based on findings from an epidemiology study

Findings from the epidemiological study of CMV drivers across Canada will identify injury and chronic disease risk factors in this highly vulnerable population. The transportation environment in Canada has been largely unstudied and the epidemiology study would uncover new insights into the occupational hazards and barriers to H&W that these drivers face. Knowing the risk factors and the context of the drivers’ environment that modifies those factors is crucially important information for the design of interventions. Options for 2 interventions are presented in this section. The first option is an intervention focusing on new drivers that incorporates H&W into existing driver training which has traditionally focused on injury and crash prevention. The second option is for the implementation of a comprehensive health promotion program into selected transportation companies with an evaluation of both health and economic impacts.

5.2.1 Option 1 – Integrating H&W into driver training

Integrating the prevention of injury, illness with employee wellness is considered a very effective approach for improving employee health, wellness and productivity. Training of CMV drivers has traditionally focused on driving skills and the prevention of injury with little attention paid to driver H&W. Including a wellness component in driver training and providing supports
to drivers when they begin work with transportation companies has the potential to have a major impact on the health of the CMV driver population in Canada.

A recent report from the Canadian Trucking Alliance’s Blue Ribbon Task Force on the Driver Shortage (CTA, 2012) has recommended that driver training should be mandatory and that driver wellness be a key priority for the industry. One of the systemic barriers to recruiting new drivers is related to perception that driving is seen as an unskilled occupation with a generally poor quality of life. An intervention that marries driver training and H&W is timely and fits with the recommendations to address the shortage of truck drivers which is seen as one of the industry’s greatest long term challenges. An intervention study is proposed below.

The potential project would develop and test an integrated health promotion-occupational health intervention that could be provided to drivers as they undertake commercial driver training at a major training institute such as First Student Canada (school bus), Greyhound Canada (intercity bus) or the Humber Institute of Technology & Advanced Learning’s Transportation Training Centre (transport truck). The project would involve integrating safety, H&W intervention components into existing driver training offered at driver training schools. Most truck and bus driving schools offer a combination of classroom and in-vehicle training that provides the theory and driving skills required for individuals to safely operate trucks or buses.

In phase 1 of this proposed intervention, concept mapping is recommended to first identify existing content on health, safety and wellness within the current driver training programs. Concept mapping is a technique for organizing and representing knowledge in a visual manner that identifies key concepts and the relationships between them. Researchers could also work with driver trainers within the appropriate industry sector (e.g., SafetyDriven and the Infrastructure Health & Safety Association (trucking), and Motor Coach Canada) to develop
concept maps based on the tacit knowledge of transportation health and safety experts. The final step in the concept mapping approach to curriculum development would be identifying gaps in the existing driver training and working with instructors in integrating new knowledge and skills development into the curriculum. Content on topics such as MSD injury prevention, fatigue management, and overall employee H&W would be developed and integrated into the existing driver training curriculum. An evaluation of the new content within the driver training program could be conducted after its initial implementation.

In addition to overall course content changes, the research could include the development and pilot testing of a driver health, safety and wellness coaching intervention. A selected number of driver trainees would be invited to participate in this arm of the study in which they would receive both the health, safety and wellness content within the curriculum along with individualized coaching tailored to their specific needs and work environments. Drivers who volunteer for the wellness coaching intervention would undergo a health, safety and wellness assessment and a program would be designed to best suit their needs. A telephone consultation component of the program would reinforce safety skills and good lifestyle behaviors over a one-year period. This would help drivers achieve their personal goals and overcome barriers they face in their own work environments.

5.2.2 Option 2 – Exercise, diet, smoking cessation, and fatigue intervention to improve health and prevent crashes

Option 1 would be an intervention targeting new CMV drivers but there is also a need to impact the health of existing drivers. Option 2, described below would be an intervention that has four primary intervention components – exercise, diet, smoking cessation, and fatigue management.
Improving the H&W of CMV drivers in Canada by focusing on body weight has the potential for numerous benefits in addition to reducing the chronic disease burden in this population. H&W is linked to collision risk with less obese drivers and those without sleep apnea having lower risk. For example, Anderson et al. (2012) found that obesity in new truck drivers was associated with an increased risk of future crashes. Findings from Weigand et al. (2009) support the link between obesity and fatigue as in their naturalistic driving study obese truck drivers were between 1.22 and 1.69 times more likely to drive while fatigued.

A survey of truck drivers found that the two most common approaches for coping with fatigue were exercise and healthy eating (Brann et al. 2011). Focusing an intervention on exercise and fatigue also makes sense as both health behaviours are important for preventing obesity, which is highly prevalent in CMV drivers. It is interesting that Sieber et al. (2014) found that although two-thirds of long-haul truck drivers in a U.S. national survey were obese, there was a lack of correlation between physical activity and obesity. This finding suggests that health promotion activities need to include both exercise and diet components in order to reduce obesity rates in truck drivers.

The prevalence of smoking is high in most CMV driving occupations, especially long-haul truck drivers (Angeles et al. 2013; Sieber et al. 2014), and along with obesity is a leading cause of premature mortality. Thus, an important component of a H&W intervention is smoking cessation. Smoking has a complex relationship with obesity with current smokers often having a lower body mass index than never or former smokers (Kaufman et al. 2012). Thus, effort needs to be made to ensure that smokers who are attempting to quit smoking are encouraged to adopt behavior patterns that control or reduce body weight (Ng et al. in press).
A health promotion intervention for CMV drivers that focuses on exercise, diet, and smoking cessation as well as fatigue prevention is suggested. As transportation companies are operating on tight margins there is interest within the industry in intervention research that includes cost-benefit or cost-effective analyses. The proposed intervention would be conducted in several Canadian transportation companies and would include an economic evaluation. The details of the proposed intervention are below.

5.2.3 Developing the intervention

The literature review identified a number of intervention studies with individual components that would be appropriate for the proposed intervention. For example, Gill and Wijk (2004) implemented a program targeting staff about healthy food choices (and menu changes) at a large truck stop. Through direct observation and interviews, staff changed their food preparation routines, which resulted in healthier eating practices in commercial drivers, as well as a reduction in time preparation for menu items (cost savings in goods and labour – a benefit to truck stop operators). The application of Circadian Alertness Simulator by managers and dispatchers was shown to be effective in reducing the amount of time drivers were required to perform in a fatigue state (Moore-Ede et al. 2004). The North American Fatigue Management Program has a wealth of resources that are available online that are suggested for integration within the proposed intervention (Moscovitch et al. 2006). The cardiovascular disease risk factor intervention reported by Hwang et al. (2012) provided smoking cessation education, nicotine patches when required, as well as requiring smokers to sign a contract saying they would quit smoking. The Gear up for Health program is also informative as its focus was both on smoking cessation and weight management in truck drivers (Sorensen et al. 2009).
Understanding the risks and needs of Canadian CMV drivers and transportation companies is important to incorporate into the design of the intervention. The proposed epidemiological study, in particular Approach 1 – the Cluster Sample Survey, would gather relevant information from both management of transport companies and drivers. Both management and drivers would have been asked what programs are available and what they would recommend for improving driver H&W. This information on existing programs, resources and needs would be useful in tailoring the proposed intervention to ensure it would be effective.

5.2.4 Recruiting companies

The proposed epidemiological study would provide relevant information to aid in the selection of transportation companies for the intervention. Drivers within the industry sector with the most elevated health risks would be ideal as a target population. Given the intensity of the intervention it would be suggested that only a small number of companies be invited to participate.

5.2.5 Recommendations for study designs

Ideally an intervention study should incorporate pre and post testing as well as a control group. It is extremely challenging to include a control group when the planned intervention involves multi-level components (i.e., changes targeted at the company level, in the work environment, and at the individual level). If a control group is not possible, a pretest, posttest design would be recommended; in this situation it could be possible to utilize findings from Approach 1 of the proposed epidemiology study to obtain baseline H&W data for comparable companies (ideally researchers could conduct a follow-up epidemiology study in the same manner as Approach 1 so as to have sufficient data for a pretest posttest nonequivalent control group design).
Measures recommended in this proposed intervention study include those discussed in the proposed epidemiology study. Additionally, objective measures of driver fatigue should be considered such as video-based measures of eyelid closure. To conduct economic analysis, administrative data including hours of work, work absences (and reasons), driver turnover, grievances, recruitment costs, training costs, NLT injuries, LT injuries, claim costs, workers compensation premiums, replacement worker costs, driving incidents, driving violations, work accommodation requests and costs, and applicable productivity data (e.g., late deliveries) should be collected. Costs related to implementation of the intervention should also be obtained.
6. Conclusions and Recommendations

CMV drivers are widely considered a vulnerable population with unacceptably high risks of injury, morbidity and mortality. Based on our review of the literature, further research is needed to characterize the work environment and lifestyle practices (particularly sleep, diet and exercise) of CMV drivers in Canada as well as to understand the interactions between various risk factors and the health and well-being of drivers. Obtaining baseline information, including national prevalence rates of health issues, is vitally important for public health, regulatory organizations, and industry to coordinate prevention efforts. This report presents a number of options for collecting national epidemiological and other important data on Canadian CMV drivers. Given the short time-line for this project, it was impossible to fully develop study designs, including precise sampling calculations, definitive protocols or exact timelines and associated budgets.

Equally important, we did not have time to consult key stakeholders. The involvement of key stakeholders in the planning process (i.e., a participatory approach) is essential for ensuring buy-in for research studies (national survey, in-depth examination and/or linked databases) and ultimately for developing and implementing effective, efficient, feasible and acceptable H&W programs. We also need to know what is currently being done by various CMV sectors in different parts of the country, as well as the perceived need and demand (on the part of both transportation companies and drivers themselves) for additional H&W programs and services. Thus one of our recommendations for moving forward is to establish a Research Advisory Committee that includes representation of key stakeholder groups. Although not exhaustive, Appendix E lists the government bodies, as well as industry associations and not for profit
organizations in Canada who we believe have a vested interest in the safety, productivity and health and well-being of commercial vehicle drivers.

Our review of the peer reviewed and grey literature indicated that little research has focused on the health of Canadian CMV drivers. Through preliminary analyses of a number of Statistics Canada databases we also found that it is extremely difficult to obtain statistics on specific occupational categories of CMV drivers (such as long- versus short- haul truck drivers, or school, public transit versus coach bus drivers). Other investigators have overcome this challenge by linking databases from different organizations (Etches & Mustard, 2007; Spielholz et al. 2008) and one of the study options outlined in Section 4 focuses on linked datasets. Given CMV drivers are understudied and their specific occupational groups are not well represented in health databases, a second recommendation for moving forward is to conduct an environmental scan. The environmental scan would identify all information sources that are necessary to effectively design and conduct the epidemiology study (i.e., number/types of drivers visiting specific truck stops; approaches for sampling transit and intercity bus drivers etc.).

6.1 Recommendation 1: Establish Research Advisory Committee/Project Planning Committees

In addition to the research team at the University of Waterloo, a number of universities and research organizations in Canada have scientists with expertise in methodologies and substantive areas that are relevant to a national epidemiology study of CMV drivers. For example, faculty members at the University of British Columbia have experience with PopBC, one of the richest data resources in the world for population health research. Researchers at the University of Northern British Columbia, meanwhile, bring a unique perspective with their focus on health issues in the northern parts of the country. Researchers from École Polytechnique de
Montréal have extensive expertise in the measurement of driver fatigue. Scientists from the Institute for Work & Health in Toronto, McMaster University, and Dalhousie University all are potential collaborators with interest and expertise that would add value to the research. Scientists from academia, government and industry who have interest and expertise in CMV driver H&W would be ideal for the Research Advisory Committee.

The experience and opinions of managers of carriers of various sizes, their drivers, as well as owner/operators are essential in planning research studies (from the early design phase to the dissemination of findings), as well as planning feasible and desired H&W programs. As Paulsen et al. (2007) found, those actually doing the job may have different experiences than employers who spend little time driving. Stakeholders that represent the interest of both bus and truck transportation companies, as well as drivers themselves, would be key members of the committee. The associations described in Appendix E (e.g., the Canadian Trucking Alliance, Motor Coach Canada, the Owner-Operator Business Association of Canada (OBAC), the Teamsters Canada, and the Private Motor Truck Council of Canada) provide excellent starting points for recruiting representatives for the Project Planning Committee.

In an effort to address the complexity of concerns facing CMV drivers, other members of these committees would include representatives from various health and regulatory agencies, Transport Canada, and the safe workplace health associations (e.g., SafetyDriven). However, it is important that both the Research Advisory and Project Planning Committees be kept relatively small (maximum 10 to 12 people). Thus, there would likely have to be a core group of individuals who are the project leads and serve on both committees and act as facilitators and liaisons between the two groups.
6.2 Recommendation 2. Conduct an Environmental Scan

As CMV drivers in Canada are a diverse and understudied group, an environmental scan is recommended to characterize their work arrangements, work processes and H&W needs. Information for the environmental scan will be obtained from existing resources (websites and databases), as well as interviews with key stakeholders (as described in Appendix E). The scan will inform recruitment procedures and sample size calculation for the national epidemiology study, as well as more in-depth studies involving accessing drivers at truck and bus terminals (e.g., Greyhound Line) and rest stops. The environmental scan will also be used to identify existing H&W programs and services in various sectors across the country.

6.3 Conclusion

The formation of Research Advisory/Planning Committees and the completion of an environmental scan are the logical next steps for developing proposals for funding agencies. Through the use of teleconferencing and webinars, the costs of bringing key stakeholders together would be substantially less than face-to-face meetings. We believe that both these steps could be accomplished within four to six months at a total cost of $40K to $50K. The main deliverables would be an environmental scan and a detailed research proposal for an epidemiology study of CMV drivers in Canada that reflects the needs of key stakeholders.
7. References


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Public Health Agency of Canada (PHAC) & Canadian Institute for Health Information (CIHI) (2011). *Obesity in Canada, PHAC and CIHI, Ottawa, ON*


Service Canada (2014). *Job Futures Quebec. Bus Drivers and Subway and Other Transit Operators.* Government of Canada


## Appendix A: Summary of Published Intervention Studies

<table>
<thead>
<tr>
<th>Article</th>
<th>Sample</th>
<th>Design/Protocol</th>
<th>Measures</th>
<th>Key Results</th>
<th>Conclusions / Implications</th>
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<tbody>
<tr>
<td>Hwang et al (2012)</td>
<td>N=248 Mean age = 56.2 97% Male</td>
<td>Tailored to middle-age and advanced-age bus drivers, the health promotion program consisted of exercise, diet, temperance, and smoking cessation education; to reduce cardiovascular disease risk factors and was administered for 6 months. Educational sessions: disease control, exercise, dietary, temperance and smoking cessation, laugh therapy, sleeping control 2 times/month for 6 months. Participants given a 'control diary' to keep track</td>
<td>- Blood pressure, cholesterol, BMI  - Alcohol consumption, smoking habits, physical activity, and dietary habits  - Job stress: Korean Occupational Stress Score</td>
<td>After the program, health behaviours, such as physical activity, dietary habits, smoking habits, and alcohol consumption, and health status indicators, such as blood pressure, had significantly improved (p&lt;0.05).</td>
<td>Findings suggest that a tailored health promotion program for middle-aged and advanced-age bus drivers was effective.</td>
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<td>Zavenala et al (2012)</td>
<td>N=96 Training group = 48 Control group = 48 100% Male Bus Drivers</td>
<td>Examined the effects of a workplace-based resistance training intervention on different health-, fitness-, and work-related measures in bus drivers. 2-phase RCT consisting of a 24-week interventional period and a 12-week follow-up period. Training group: 3 sessions/week weeks 0-8, 4 sessions/week weeks 9-24. Control group: no training</td>
<td>Body composition, blood pressure, pain incidence, muscular endurance, and flexibility before and after the 24-week period. Work absenteeism during and after 12-week follow-up period.</td>
<td>Significant (p&lt;0.05) reduction in BP and pain incidence, along with improvements in muscle endurance and flexibility were seen after 24 weeks in the Training group (no changes in these parameters in the control group) Reduction in worker absenteeism rate in the training (vs. control) group during both the interventional and follow-up periods (p&lt;0.05).</td>
<td>Long-term resistance training programs can provide multiple health and fitness benefits for workers classified as being sedentary and untrained, the positive effects of which may also transfer to a reduction in worker absenteeism.</td>
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<td>Doyle et al (2010)</td>
<td>N=208 Follow-up data: n=120 Mean Age = 49</td>
<td>Impact of a hypertension awareness and educational program (BP DownShift) was evaluated. Intervention: 4 educational mailings, BP measurements Hypertension awareness Management practices</td>
<td>- 97% satisfaction with the program Systolic &amp; Diastolic BP were lower at follow up (average: 9/4mm/Hg) - Improvement in overall self-reported</td>
<td>Implementation of a hypertension education, self-management, and awareness program was associated with</td>
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<tr>
<td>Study</td>
<td>Participants</td>
<td>Intervention</td>
<td>Outcome Measures</td>
<td>Results</td>
<td>Conclusion</td>
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<td>Pressure Control Among School Bus Drivers with Hypertension, USA (2010)</td>
<td>73% Female, 72% Black</td>
<td>Installation of BP machines at all terminals, access to free dietician consultations and gym memberships. Pre/post measurements after 9-months of intervention</td>
<td>Health status - Higher proportion of drivers reported: home BP monitoring, regular exercise, following a healthy diet - 93% made changes in BP management</td>
<td>An improvement in BP control, which may positively impact commercial driver's license recertification as well as improve employee health.</td>
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<tr>
<td>Hoffman et al. (2010)</td>
<td>N=248, Study: n=156, Control: n=92, Mean Age: 45, 99% Male</td>
<td>Retrospective, pre/post claims-based comparison analysis was performed. Health plan and disability costs, disability claimant rates and missed workdays were compared for the 12 months 24 months after CPAP or BiPAP obstructive sleep apnea treatment.</td>
<td>Health plan costs - Health Plan costs decreased $2,727 first year post-treatment (p=0.002), and $3,086 second year post-treatment (p=0.008). 2-year savings of $528 on short-term disability costs 4.4 fewer lost workdays first year post-treatment and 2.5 fewer days in second year post-treatment</td>
<td>Effective treatment of obstructive sleep apnea in drivers is associated with lower health care and disability costs and fewer missed workdays.</td>
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<td>Greene et al. (2009)</td>
<td>N=499, Mean Age=42.5, 100% Male</td>
<td>Developed an economic simulation model to evaluate the 2-year impact of the BP DownShift Program on direct and indirect costs associated with changes in hypertension Intervention: resources to help them understand and manage hypertension, verbal counselling, tools for employer to promote hypertension awareness and participation in the program.</td>
<td>Clinical outcomes (BP, SBP, DBP, BP medication use, predicted CHD events, predicted stroke events) Work productivity and economic outcomes (lost time, cost due to lost time, costs of certification, hypertension treatment costs)</td>
<td>Results showed a 16.3% (more than $540,000) reduction in costs for a sample of 499 CDL employees over 2 years. 2-year cost savings of $1084 per CDL employee, or $542 per CDL employee annually</td>
<td>Found that a management and health promotion program resulted in significantly improved control of hypertension and that the improved health benefits led to a significant reduction in employer-borne costs over a 2-year period.</td>
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<tr>
<td>Authors</td>
<td>Study Title</td>
<td>Study Design</td>
<td>Intervention</td>
<td>Findings</td>
<td>Notes</td>
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| Mackie & Moore      | (2009) “Fit for the road”: Log truck driver health and well-being NEW ZEALAND | Questionnaire: N=225, Mean Age= 43.8  
Intervention: N=45 drivers, and a control group (no details) | Twofold project:  
1) Questionnaire to identify health and fitness issue of drivers to provide recommendations for intervention  
2) Develop and implement pilot intervention - Fit for the Road: year-long with monthly themes (nutrition, quit smoking, wellness), mail-outs and activities (e.g., food diary analysis) | Demographics, obesity, mental illness, hearing problems, hour of sleep per night, injuries, relationships  
Driver's overweight compared to population  
High reported incidence of mental illness  
Widespread hearing problems  
10-20% of drivers reported problems with sleep, sleepiness or fatigue  
17% reported slips, trips and falls from or around truck | Study indicated a number of health and wellness issues affecting log truck drivers, leading to development of Fit for the Road. Outcome evaluation will occur in the future.  
Intervention description and baseline measures taken, no reported post-intervention findings. |
| Olson et.al         | (2009) A New Health Promotion Model for Lone Workers: Results of the Safety & Health Involvement For Truckers (SHIFT) Pilot Study USA | Participants recruited from four trucking companies  
Intervention: N=29  
Mean age= 48  
Mean BMI = 39  
79% Male | Pre/post test design (no control).  
6-month intervention  
SHIFT intervention: Safety & Health Involvement for Truckers  
Intervention: Weight loss and safe driving competition with incentives. Supported by computer based training, behavioural self-monitoring (BSM), motivational interviewing, SHIFT program website | Health assessment, Body weight and prevention behaviour (i.e. diet, exercise, and safety), Psychosocial measures include overall self-rating of health state and self-efficacy  
Significant weight loss after intervention (p=0.005), on average 7.8 lbs.  
Decrease in Percent calories (p=0.01), sugary drinks (p=0.01), sugary snacks (p=0.03), fast food frequency (p=0.03), waist circumference (p=0.01) and waist-to-hip (p=0.08) | Results suggest the new interventional model (SHIFT) is more engaging and effective with truck drivers than prior educational interventions. |
| Harshman et.al      | (2008) Impact of a Hypertension Management/Health Promotion Program on Commercial Driver’s License Employees of a large electric utility company located in the south eastern USA | N=501  
100% male  
Mean age=42.5  
Participants recruited from a large electric utility company located in the south eastern | Study to determine whether a hypertension management and health promotion program (BP DownShift) designed for commercial drivers improved blood pressure (BP) outcomes among drivers.  
Intervention: Employees were continuously provided educational materials explaining the program  
Data retrieved from Department of Transportation (DOT) Medical Examination Reports.  
- Demographics (age, gender, CDL class)  
- Employee-reported medical history  
- Results of the physical exam | After the program, significantly fewer employees had uncontrolled hypertension according to the Department of Transportation hypertension guidelines (17.2% versus 26.1%, p<0.01).  
Program significantly improved the percentage of employees with controlled BP from 73.9% to 82.8% | An education program improved control of BP among commercial drivers, improving their health and safety, and reducing the number at high risk of medical disqualification. |
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Description</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Insured Utility Company USA</td>
<td>United States</td>
<td>Importance of BP control in lowering their cardiovascular risk and maintaining their CDL certification; also received treatment information and record-keeping tools</td>
<td>Evaluation (including assessments of BP and of height and weight used to calculate BMI). (p&lt;0.01).</td>
</tr>
<tr>
<td>Gurubhagavatula et al. (2008) Estimated cost of crashes in commercial drivers supports screening and treatment of obstructive sleep apnea USA</td>
<td>N=406 High-risk OSA: n=247 Lower-risk OSA: n=159 Randomly selected Mean Age=45.4 Mean BMI=29.9</td>
<td>Cost analysis of three methods for identifying sleep apnea syndrome: (1) in-lab polysomnography; (2) selective in-lab polysomnography for high-risk drivers, where high risk is first identified by body mass index, age and gender, (3) not screening.</td>
<td>No Screening cost = $689/driver Screening using polysomnography is not cost-effective = $920/driver Selective polysomnography, using a combination of BMI, age and gender to determine who should undergo polysomnography IS cost effective = $358/driver Findings indicate that strategies that reduce reliance on in-laboratory polysomnography may be more cost-effective than not screening, and that treatment acceptance may need to be a condition of employment for affected drivers.</td>
</tr>
<tr>
<td>Poulsen et al. (2007) Using action research to improve health and the work environment for 3500 municipal bus drivers DENMARK</td>
<td>Baseline exposure to risk factors and disease patterns: N=2677 Mean Age=45 68% Male</td>
<td>Project purpose was to improve the health and well-being of 3500 Copenhagen bus drivers - HealthyBus By the end of the study over 200 interventions had been implemented. Article described the approach of combining epidemiological results and qualitative methodologies in developing effective interventions - Epidemiological data from questionnaire studies - In-depth qualitative interviews, focus groups and observations - Systematic activity plans for implementation of and follow-up on interventions. - Logbooks on relevant activities at the workplaces - project employees’ diaries of personal observations</td>
<td>After 3-years HealthyBus interventions have made improvements in health-related parameters and widespread reductions in exposure to harmful factors. 45% of the bus drivers said that the work environment had improved Able to reduce stress by more than one-third for 3500 bus drivers HealthyBus project outlined effective methodology for research on how to make changes in the work environment.</td>
</tr>
<tr>
<td>Gill &amp; Wijk (2004)</td>
<td>Case study of a healthy eating intervention for Swedish lorry drivers</td>
<td>SWEDEN</td>
<td>n=60 (drivers) Mean Age=41</td>
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<td>Moore-Ede et al. (2004)</td>
<td>Circadian Alertness Simulator for Fatigue Risk Assessment in Transportation: Application to Reduce Frequency and Severity of Truck Accidents USA</td>
<td>Participants from three trucking operations in USA. Different sets of participants for different stages of project.</td>
<td>Circadian Alertness Simulator (CAS) is a practical tool for assessing the risk of diminished alertness at work. CAS fatigue score is calculated: documented work schedules of employees, sleep and alertness patterns A risk-informed, performance-based safety program in a 500 power-unit trucking fleet, where dispatchers and managers were held accountable for minimizing driver CAS fatigue risk scores</td>
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<tr>
<td>Author(s)</td>
<td>Year</td>
<td>Country</td>
<td>Sample Size</td>
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| Kashima  | 2003 | USA     | N=109       | 98% Male Average BMI=30  
ChevronTexaco implemented a medical fitness for duty program consisting of 1) physical examination  
2) education (on safe body mechanics), and 3) physical fitness.  
(Functional Capacity Evaluations, FCE)  
Article also describes the follow-up program for drivers found to be at risk for a back injury.  
Key outcome is the Fitness for Duty categorization  
First year of the program, 109 FCE's were completed by trained clinicians, and 88% of candidates were found “able to work without restrictions,” whereas 6% were found “able to work with caution.”  
The program has allowed ChevronTexaco to take a proactive step toward reducing back injuries in the truck driver workforce.  
Intervention description and baseline measures taken, no reported post-intervention findings. |
| Bunn et al. | 2001 | USA     | Employee base of International Truck and Engine Corporation consists of approximately 14,000 employees in the United States, 4000 employees in Canada and Mexico  
Health and Productivity Management model includes the measurement, analysis, and management of the individual component programs affecting employee safety, health, and productivity  
Monthly reports/analyses are sent to senior management, and annual goals are set with the board of directors.  
Incidence frequency rate  
Lost time case rate  
Workers’ compensation costs  
Performance measures  
- Comprehensive corporate wellness effort has had a significant impact in reducing both direct health care cost and improving productivity, measured as absenteeism.  
-Workers’ compensation and disability program interventions have led to a significant reductions in financial liability.  
- Overall, an integrated health, safety, and productivity program (HSP) was reported to show at least a twofold return on investment  
The integration of an HSP program and application of health and productivity management principles can improve quality, improve health, and reduce a company’s total costs. |
## Appendix B: Characteristics of Other (Non – Intervention) Published Studies

<table>
<thead>
<tr>
<th>Article</th>
<th>Sample</th>
<th>Design / Protocol</th>
<th>Measures</th>
<th>Key Results</th>
<th>Conclusions / Implications</th>
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</thead>
<tbody>
<tr>
<td>Sieber et.al (2014)</td>
<td>- 1,670 participated - 1,265 personal interviews - 405 non-respondent interviews - 94% male - Avg. age 48 - 74% white, 17% black, 7% other</td>
<td>National Institute for Occupational Safety and Health (NIOSH) initiated the National Survey of Long-Haul Truck Driver Health and Injury (LHTDS). 3-stage sampling process 1) limited-access highway segments were stratified by geographic region and truck traffic volume 2) individual truck stops were selected 3) truck drivers entering truck stops</td>
<td>- work environment, - work history and driving practices - health conditions and risk factors - health insurance cover - sleep and demographics. - height and weight</td>
<td>Chronic disease risk factors present among LHTD: hypertension, high cholesterol, obesity, smoking, physical inactivity, and sleep duration The high prevalence of obesity and smoking, prevalence of self-reported health conditions, and low utilization of health resources by truck drivers are primary findings from the survey. Study suggests a need for targeted interventions to meet the health needs of LHTD and surveillance through repeated data collections to track progress in meeting these health needs</td>
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<td>Smith &amp; Williams (2014)</td>
<td>10,171 Workers’ compensation State Fund and Self- Insured claims with dates of injury from 2005 to 2010</td>
<td>Workers’ compensation compensable State Fund and Self- Insured claims with dates of injury from 2005 to 2010 Washington State Department of Labor and Industries workers’ compensation data system</td>
<td>Claimant data extracted: age at date of injury, gender, marital status, number of dependents, length of employment, health insurance benefits, occupation, self- reported height and weight, injury nature, body part, source, event or exposure. For all State Fund claims, time loss days, total costs and medical costs were also obtained</td>
<td>Medical and non-medical costs for Trucking Industry State Fund compensable claims for this period totalled over $295 million dollars and accounted for 1.4 million days of time loss. The most common claim type across was non-traumatic musculoskeletal disorders of the neck, back and upper extremities, (34–49% of claims) General Freight Trucking had higher median time-loss and medical costs as well as time loss days.</td>
<td>Not all occupations within trucking are suffering from the same injuries and not all occupations across sectors have similar risks. With limited resources for health and safety activities it is important to identify what injuries are happening in which occupations in order to better target prevention efforts.</td>
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<tr>
<td>Angeles et.al (2013)</td>
<td>CANADA</td>
<td>- 406 respondents from 822 distributed surveys (49.4% response) - 96% male - 48.5% were age 50 or older</td>
<td>Cross-sectional study was conducted among short haul truck drivers employed by 13 trucking companies based in Southwestern Ontario (mostly from Hamilton) 2 focus groups with managers and health and safety committee members and 2 with truck drivers to identify what should be included in the survey</td>
<td>- Dietary Guidelines from the Behavioural Risk Factor Surveillance System - International Physical Activity Questionnaire - Job Content Questionnaire - Stress Satisfaction - General health, sleep, tobacco use and demographics - Health care utilization</td>
<td>Smoking and poor diet were 1.5 and 3 times higher among truck drivers</td>
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<tr>
<td>Apostolopoulos et.al (2013)</td>
<td>USA</td>
<td>N=316 truckers Mean Age = 44.2 100% male (females excluded) Randomly selected truckers were recruited from truckstops and trucking terminals in central North Carolina</td>
<td>Healthy Trucker Survey: A small-scale cross-sectional study was designed to assess connections between the trucking work environment and U.S. truck drivers’ physical health, their access to healthcare services and medical treatment, as well as participation in health promotion programs</td>
<td>82 questions on demographics, work history, workplace conditions, physical health and wellness, mental health, healthcare access, and medical treatment history</td>
<td>Despite 75% reporting good health: - 83.4% were overweight/obese - 57.9% had sleeping disturbances - 56.3% fatigue - 42.3% musculoskeletal disorders - 40% cardiovascular disease concerns - 33% had no health insurance - 70% had no regular healthcare visits - 24.4% could not afford insurance - Exercise facilities were unavailable in over 70% of trucking worksites - 70% of drivers did not exercise regularly.</td>
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</table>
**Anderson et al. (2012)**  
Obesity is associated with the future risk of heavy truck crashes among newly recruited commercial drivers  
USA  

| N=744 new truck drivers  
90% male  
86% Caucasian  
New truckers from a large, high-turnover trucking firm were recruited during training | Intake data was collected during the first two weeks of instructional training at a school operated by the cooperating trucking firm. Drivers were then followed prospectively on the job using the firm’s operational data for two years, or until employment separation. | BMI  
Miles Driven  
Job Type  
Number of Crashes  
Crash Rate (per 100,000 miles) | Compared to normal BMI (18.5 < BMI < 25) the risk ratio (RR) for all crashes was significantly higher for drivers in the combined obesity Classes II and III: RR = 1.55 (95% CI 1.24–1.94) | Prospective study establishes an association between obesity and increased crash risk among a group of commercial drivers operating heavy freight vehicles on the public highways. |

| **Apostolopoulos et al. (2012)** | Active Living in the Trucking Sector: Environmental Barriers and Health Promotion Strategies  
USA | Baseline assessment of 25 work settings  
- 8 truck stops  
- 8 trucking terminals  
- 7 warehouses  
- 2 highway rest areas  
North-Carolina | Healthy Trucking Worksites Audit Instrument (HEATWAI) was designed to assess the health-promotive characteristics of trucking work settings.  
Observation to measure corporate, social, and built-environment attributes of trucking worksites that positively influence food choices/eating behaviours and physical/recreational activities of truckers | 250-item HEATWAI Environment Subscales:  
- Active-living (65 items)  
- Health Supportive Social (15 items)  
- Health Supportive Community (24 items)  
- Health information (11 items)  
- Healthy Food (128 items)  
Aggregate score /100% | 90–100% = fully supportive  
75–89.9% = mostly supportive  
50–74.9% partially supportive  
35–49.9% scarcely supportive  
<35% not at all supportive  
Trucking Terminals = 16.8%  
Truck Stops = 21.1%  
Warehouses = 11.6%  
Highway Rest Areas = 35.3%  
All work settings = 17.5% | Study places the highly underserved population of truckers firmly within the discourse of worksite health promotion, and calls for comprehensive multistakeholder wellness strategies. |
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Study Title</th>
<th>Country</th>
<th>Sample Size</th>
<th>Mean Age</th>
<th>Gender</th>
<th>Methodology</th>
<th>Results</th>
<th>Implications</th>
</tr>
</thead>
</table>
| Dorn et al.      | 2010    | Development and validation of a self-report measure of bus driver behaviour | UK      | Study 1: N=315; Mean Age=46.3, 94% Male  
Study 2: N=557; Mean age=46.5, 93% Male  
Study 3: N=71, Mean Age=36.0, 87% Male |          |         |         | Paper reports on three studies to develop and validate a self-report measure of bus driver behaviour | Study 1) Driver behaviour components, driver coping components  
Study 2) Bus Crash Involvement  
Study 3) Celeration behaviour in a simulator | The instrument can be used by bus companies for driver stress and fatigue management training to identify at-risk bus driver behaviour. Training to reduce the tendency to engage in avoidance coping strategies, improve evaluative coping strategies and hazard monitoring when under stress may improve bus driver safety. |
| Layne et al.     | 2009    | Health and Gender Comparisons in the Long-Haul Trucking Industry           | USA     | N=50; 50% Male (mean age: 50)  
50% Female (mean age: 47) |          |         |         | Survey to determine whether health conditions and health care access differ between male and female long-haul truck drivers. Surveys were conducted at truck stops in 3 rural Ohio areas for a 1-month period in summer of 2005. | Health care Access  
Work Experience  
Health care and health status  
Demographic information | Both male and female truck drivers suffer from and are at an increased risk for numerous health problems, as well as experience limited access to health care services. |
| Martin et al.    | 2009    | The Impact of Overweight and Obesity on the Direct Medical Costs of Truck Drivers | USA     | N=2950; Mean age=45.2  
Mean BMI=32  
69% Caucasian  
Excluded if BMI < 18.5 |          |         |         | Purpose of the study was to quantify health care costs of truckers across categories of normal weight, overweight, and obese. Health care claims data from a transportation logistics company were obtained from 2004 to 2005 and were merged with body mass index measures | BMI  
Health care costs  
Comorbidities (e.g., hypertension, diabetes, and hyperlipidemia) | Unadjusted trimmed total health care costs for overweight subjects ($1613) and obese subjects ($1792) were significantly higher than for normal weight subjects ($1012; p<0.05).  
Obese and overweight subjects had on average, $591 (p=0.031) and $383 (p=0.188) higher total trimmed health care cost than normal weight subjects | Individuals in the overweight and obese weight categories have substantially higher health care costs compared with those in the normal weight category. |
<table>
<thead>
<tr>
<th>Study</th>
<th>Methodology</th>
<th>Primary:</th>
<th>Secondary:</th>
<th>Findings/Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorensen et al (2009)</td>
<td>Cross-sectional survey to examine the relationships between the work environment and amount smoked, intention to quit, and participation in a health promotion intervention</td>
<td>Primary: tobacco use, intentions to quit, and program participation</td>
<td>Secondary: job satisfaction, job strain, adequate sleep</td>
<td>Gear Up for Health Study was designed to test an intervention to promote tobacco use cessation and weight management in truck drivers. Intervention not described. Overall, 41% used some form of tobacco. Despite high job satisfaction (88%), 30% of respondents reported high levels of job strain. Intention to quit smoking was associated with program participation. Heavier smoking was associated with inadequate sleep. Study provides an in-depth examination of the relationship of work experiences and job conditions to tobacco use patterns and willingness to participate in a health promotion program among motor freight workers.</td>
</tr>
<tr>
<td>Wahlberg, A. &amp; Dorn, L. (2009)</td>
<td>Bus driver absence from work was analyzed in association with crash records data retrieved from the employer</td>
<td>Days of absence</td>
<td>Number of crashes</td>
<td>The use of absence records for the identification of at risk drivers would seem to be a simple and useful method for companies with major fleets. Shows the importance of promoting employee health and well being at work as a potential method of reducing the cost of absenteeism and crashes in company vehicles.</td>
</tr>
<tr>
<td>Staplin &amp; Gish (2005)</td>
<td>Study analyzed the Motor Carrier Management Information System (MCMIS) database to develop estimates of the increased risk of crash involvement experienced by commercial drivers who change jobs frequently</td>
<td>Number of jobs per year</td>
<td>Number of Crashes</td>
<td>These findings may be of potential significance to commercial fleet managers charged with recruitment and driver selection.</td>
</tr>
<tr>
<td>Jones &amp; Switzer-McIntyre (2003)</td>
<td>Falls from trucks: A descriptive study based on a workers compensation database</td>
<td>Canada</td>
<td>352 of 1056 claims met the study criteria</td>
<td>Data extracted from the Province of Ontario, Workplace Safety &amp; Insurance Board (WSIB) database for the year 1997. All claims reviewed were falls from a non-moving vehicle.</td>
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| Majority between 30-45 years old | 99% male |
Appendix C: Summary of Review Articles

<table>
<thead>
<tr>
<th>Article</th>
<th>Rationale / Description</th>
<th>Search Process / Criteria</th>
<th>Focus</th>
<th>Key Findings</th>
<th>Conclusion / Implications</th>
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</thead>
<tbody>
<tr>
<td>Kales &amp; Straubel (2014) Obstructive Sleep Apnea in North American Commercial Drivers USA</td>
<td>Review to identify risk factors of Obstructive Sleep Apnea (OSA); consequences of OSA for transportation workers; and management of OSA risk in the transportation industry (screening, diagnosis, risk reduction, cost-benefit)</td>
<td>No details on Review Process</td>
<td>Risk factors for OSA (obesity, age, male sex, ethnicity) Consequences of OSA for workers (crash risk) Screening strategies (ESS, somni-stage questionnaire, PVT, BMI) Diagnosis (PSG, monitors) Risk Reduction (CPAP, wellness programs)</td>
<td>- OSA associated with increased crash risk - common in commercial drivers, but under diagnosed and undertreated - several effective screening strategies exist - treatment of OSA (CPAP) reduces crash risk - Limited cost-benefit data</td>
<td>Identifying commercial drivers with OSA and having them effectively treated should decrease crash-related fatalities and injuries</td>
</tr>
<tr>
<td>Apostolopoulos et.al (2012) Environmental determinants of obesity-associated morbidity risks for truckers USA</td>
<td>Paper presented a critical review of multidisciplinary literature, an analysis of the role of the transportation environment in trucker obesity, a conceptual framework for addressing connections between the transportation environment and trucker obesity, and considerations for promising interventions in the transportation environment.</td>
<td>N=120 articles Retrieved from PubMed Central and TRANSPORT Keywords and medical subjects were selected to represent the outcomes and exposures of interest No stated exclusion criteria</td>
<td>Long work hours Shiftwork Sleep deprivation Sedentary lifestyle Occupational stressors Lack of physical activity Unhealthy diets</td>
<td>The numerous benefits of worksite wellness programs include improved morale, reduced turnover, increased potential for recruitment, reduced absenteeism, containment of health-care costs, and overall improved trucker health status.</td>
<td>Review outlines the need for the development, implementation and evaluation of interventions to mitigate trucker obesity</td>
</tr>
<tr>
<td>Authors and Title</td>
<td>Overview</td>
<td>Methods</td>
<td>Key Findings</td>
<td>Remarks</td>
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<td>Apostolopoulos et al. (2011)</td>
<td>Psychosocial environment of commercial driving: morbidities, hazards, and productivity of truck and bus drivers USA</td>
<td>Chapter applies several theoretical perspectives of stress (Person Environment Fit Model, the Effort Reward Imbalance Model, Demand-Control Model) to explain how the psychosocial environment of commercial drivers may negatively impact health. Chapter concludes with an overview of promising intervention strategies to improve the work environment for drivers.</td>
<td>Book Chapter</td>
<td>Theoretical perspectives; commercial driving work environment, mental health problems, other co-morbidities; accidents and crashes; diminished work performance; preventive interventions</td>
<td>Benefits of worksite wellness programs include improved morale, reduced turnover, increased recruitment, decreased healthcare costs, improved trucker health status and improved productivity. As the global economy supports deregulation and increased competition from new labour markets, commercial drivers may experience even more job strain. Therefore it is imperative to enact primary prevention measures to ensure the health of commercial drivers and in turn maintain the safety of the public.</td>
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<tr>
<td>Wang et al. (2011)</td>
<td>Driver Fatigue Detection Technology in Active Safety Systems CHINA</td>
<td>Paper presents a comprehensive review of driver fatigue detection technologies</td>
<td>No details on review process or criteria</td>
<td>Driver state: eye state, mouth shape, head position Driver performance: lane tracking, tracking distance between vehicles PERCLOS, faceLAB, SMI InSight, AWAKE</td>
<td>If drivers learn to rely on the technology then the failure of warning may be a catastrophe for drivers. If the driver believes that the device is misleading them it will be ignored totally, even if an unsafe fatigue is detected.</td>
</tr>
<tr>
<td>Apostolopoulos et al. (2010)</td>
<td>Worksite-Induced Morbidities among Truck Drivers in the United States USA</td>
<td>Examined the relationships between transportation environment and trucker morbidities</td>
<td>120 articles and reports identified from PubMed Central, PsycINFO, and TRASPORT databases. Key words were selected to represent outcomes and exposures of interest</td>
<td>Psychological and psychiatric disorders Detriments resulting from disrupted biological cycles Musculoskeletal disorders Cancer and respiratory morbidities</td>
<td>- Health- compromising situations for Truckers: long work hours and fatigue; shift work and sleep deprivation; postural fatigue and exposure to noise or vibration; exposure to diesel fumes; sedentary lifestyle and unhealthful diet - Documented Morbidities for Truckers: musculoskeletal disorders; CVD; accidents; fatigue; disrupted</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Methods</td>
<td>Findings</td>
<td>Notes</td>
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<td>Treager et al (2009)</td>
<td>Primary objective: are individuals with obstructive sleep apnea (OSA) at an increased risk for a motor vehicle crash when compared to comparable individuals who do not have the disorder? Secondary objective: what factors are associated with an increased motor vehicle crash risk among individuals with OSA.</td>
<td>Systematic Review (MEDLINE, PubMed, EMBASE, PsycINFO, CINAHL, TRIS, and Cochrane library) were searched (2009) Evaluated the quality of each study: quality, quantity, robustness, and consistency of the body of evidence, and tested for publication bias.</td>
<td>Individuals with OSA are clearly at increased risk for crash. Mean crash-rate ratio associated with OSA is likely to fall within the range of 1.21 to 4.89. Characteristics that may predict crash in drivers with OSA: BMI, apnea plus hypopnoea index, oxygen saturation, and possibly daytime sleepiness.</td>
<td>Untreated sleep apnea is a significant contributor to motor vehicle crashes.</td>
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<td>Tse, Flin, &amp; Mearns (2006)</td>
<td>Review paper consolidates the key research on the occupational health of urban bus drivers since the 1950s</td>
<td>N=27 articles Combination of search terms including 'bus driver', 'occupational stress', 'well-being', 'health' and 'professional drivers', several electronic databases (PsychARTICLES, PsychINFO, PubMed, ScienceDirect, Swetswise and Web of Science) were searched</td>
<td>Physical health (CHD, gastrointestinal, musculoskeletal, fatigue) Psychological (PTSD) Behavioural (alcohol/drug Organisational (absenteeism, turnover, accidents)</td>
<td>Bus driver ill health will have consequences for organisational performance in terms of employee absence, labour turnover and accidents. Stressors for bus drivers include poor cabin ergonomics, rotating shift patterns and inflexible running times. Studies reviewed indicate a necessity for bus operators to improve workplace practices to reduce job stressors and ameliorate the work environment of bus drivers.</td>
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<td>Reference</td>
<td>Methodology</td>
<td>Findings</td>
<td>Conclusions</td>
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| **Taylor & Dorn (2005)**  
Stress, Fatigue, Health, and Risk of Road Traffic Accidents among Professional Drivers: The Contribution of Physical Inactivity  
UK | Chapter provides an overview, within an evidence-based framework, of the impact of human factors on driver performance and risk of accidents and then examines how physical (in)activity may moderate and mediate these relationships. | Several ways in which increased physical activity may improve driving performance and potentially reduce accident risk: stress and psychological and physiological responses; enhanced sleep and alertness, reduced fatigue, and improved cognitive functioning; and enhanced psychological and physical health status | Intervention studies are needed to examine the effects of chronic exercise on driver performance in natural and controlled settings |
| **Begg et.al (2003)**  
Canadian Diabetes Association’s Clinical Practice Guidelines for Diabetes and Commercial Driving  
CANADA | To revise and expand the 1991 Canadian Diabetes Association’s (CDA’s) Clinical & Scientific Section (C&SS) Position Statement on Diabetes and Commercial Driving | Severe hypoglycemia led to 0.0402 and 0.0239 additional crashes per driver per year in subjects with type 1 and type 2 diabetes using insulin, respectively  
Risk of a crash decreased from 6.1 to 3.7 and from 4.1 to 2.7 in insulin-treated people with type 1 and type 2 diabetes, respectively | Truck drivers with diabetes may be at an increased risk for highway accidents compared to private drivers |

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<tr>
<th>Methodology</th>
<th>Findings</th>
<th>Conclusions</th>
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</table>
| Preparation of the guidelines was based on literature searches on PubMed®, including MEDLINE®, references from book chapters and consensus from the C&SS of the CDA | Number of reaction while driving (per person/year)  
Hours driving with mild hypoglycemia per year  
Crashes per nondiabetic  
Additional crashes per insulin-using driver per year | | |
Kompier et. al (2000)  
Stress prevention in Bus Drivers: Evaluation of 13 Natural Experiments  

| Germany | Selected, compared and analyzed 'natural experiments' (interventions/programs) with respect to the prevention of occupational stress and sickness absenteeism among bus drivers. | 13 cases met eligibility criteria  
8 cases - Germany  
3 cases - Netherlands  
Cases identified through networking and literature study; no further details | Changes in company-registered sickness absenteeism  
Work disability  
Stress markers  
Subjective health status  
Work satisfaction  
Program Satisfaction  
Perceived workload  
Cost-benefit analysis | Substantial variation between cases. Some key case outcomes:  
Case 10: intervention reduced occupational stress  
Several cases found decreases in sickness absenteeism  
Several cases were successful financially (see Case 12 for most detailed cost-benefit analysis) | Two factors deemed important for program implementation: 1) participatory approach with employees and middle management 2) sustained commitment from top management.  
Successful when stress prevention combines adequate intervention with proper implementation. |
### Appendix D: Summary of Reports

#### Intervention Studies

<table>
<thead>
<tr>
<th>Authors (year) Title Location</th>
<th>Sample</th>
<th>Design/Protocol</th>
<th>Measures</th>
<th>Key Results</th>
<th>Conclusions / Implications</th>
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<tr>
<td><strong>Smiley et.al (2009)</strong> Effects of a Fatigue Management Program on Fatigue in the Commercial Motor Carrier Industry CANADA</td>
<td>Worked with 3 motor companies in AB, QC &amp; California 121 drivers pretest; 92 screened for sleep disorders; 77 all phases Final sample: Quebec (n=29, 96% male, mean age=45.6); Alberta (n=23, 100% male, mean age=48.2); California (n=25, 96% male, mean age=47.2).</td>
<td>Goal to assess the feasibility of a company-wide approach to fatigue management and its impact on drivers’ fatigue, performance, sleep duration and mood, as well as on company performance measures, scheduling policies and practices. Fatigue Management Program (FMP) involved: 1) educational sessions for drivers, some managers, trainers and dispatchers; 2) sleep disorder diagnosis and treatment; and 3) interaction with dispatchers and management. Baseline (8-10 days) to establish levels of fatigue, sleep and performance via PDA and actigraph. In-home evaluation for sleep disorders and further physician diagnosis and treatment. Post-FMP data collection after 1) at least one month post diagnosis with sleep apnea and start of treatment, AND 2) two weeks after the last education session.</td>
<td>Pre-post measures: Sleep-wake log, actigraphy, mood/fatigue assessment, workload assessment (end of day), critical incidents (end of day), factors contributing to fatigue (end of day), PVT. Corporate measures on a range of safety, health, and operational variables, depending availability. Alertness Management Strategies Evaluation (AMSE) questionnaire. Focus groups or individual interviews were used to obtain information about dispatcher scheduling practices and challenges.</td>
<td>71.3% of drivers found to have sleep apnea (31.9% moderate to severe) 7.6% improvement post FMP in subjective sleep quality (greatest effect on duty days) Regardless of sleep disorders, found a significant increase in total sleep Significant decrease in proportion reporting at least one critical event (i.e., nod off or close call) from 45.5% pre to 28.6% post; and reduction in critical events per km for two sites with distance data Questionnaire results showed significant improvements in four areas (education, alertness strategies, healthy sleep, organization) Corporate measures over 3 months indicated improved performance: significantly fewer road infractions and accidents; trend for reduced absent days per km (Québec site only). Changes at the Alberta and California sites were not significant.</td>
<td>Study demonstrates the feasibility of implementing a comprehensive FMP program, using a company-based approach within the CMV industry. Findings suggest a beneficial impact of comprehensive FMPs on drivers’ well-being and behaviour, as well as on corporate health and safety. One element that did not change was night driving as there were no FMP activities focusing on changing this practice (i.e., scheduling). Other factors (e.g., organization of duty days; dispatching) also need to be considered in future FMPs.</td>
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<tr>
<td>Source</td>
<td>Description</td>
<td>Details</td>
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<td>Moscovitch et al. (2006)</td>
<td>Development of a NA Fatigue Management Program for Commercial Motor Carriers</td>
<td>Phase II: Development of Materials &amp; Procedures CANADA Driving questionnaire completed by 89 drivers (73 from Alberta, 8 from Quebec and 8 from Texas) N=45 recruited for FMP pilot study (98% men, age 47.6±10.1; average BMI 29; mean 22.4 yrs experience as truck driver) Of the 45: 29 AB, 8 from QC, 8 from Texas. Pilot Study (Phase II) to develop and refine comprehensive FMP (educational modules, operational tools, and step-wise sleep disorder screening and treatment) in actual operating environment. General data on sleep and fatigue via questionnaire (N=89). Enroute component (29 Alberta drivers wore actigraphs). Two rounds pre and post FMP. Staged approach: 35 drivers completed sleep disorder assessment &amp; treatment (27 of who examined in sleep lab). Feedback on educational modules in Alberta and Quebec. Pre/post quiz of the Texas drivers on the Driver Core session. Driving questionnaire. Multiple subjective measures of sleepiness, fatigue, sleep duration and quality (ESS), and objective measures: actigraphy and vigilance performance (Performance Vigilance Test – PV) Drivers exhibited less sleep and greater fatigue than general population Drivers experienced 44% fewer lapses in vigilance following FMP. Reduction in driver fatigue between 38% and 50% pre- and post-FMP 71% had some degree of sleep apnea, with 56% rated as mild, 28% rated as moderate, and 16% rated as severe. 29% had a condition serious enough to warrant medical intervention. Drivers treated for sleep apnea increased observed sleep time by 73% (3.9 hours of sleep to 6.8 hours) Treatment by CPAP or dental device showed a 73% increase in sleep time post intervention (3.9 to 6.8 hrs/ night) Findings provide preliminary support that the proposed FMP (after a number of recommended changes) will be effective when systematically examined in the next phase. Several recommendations provided (such as having experienced FM trainers, ordering of modules, and improved communication between all stakeholders).</td>
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<td>US Dept of Transport (2000)</td>
<td>Design, Development, and Evaluation of Truck and Bus Driver Wellness Programs USA</td>
<td>N=128 drivers at baseline; 54 (42%) completed 4 month follow-up assessments (evaluation) Tech Brief describes the development of Gettin’ in Gear based on literature, survey of 448 experienced drivers, and input from drivers and personnel(participatory approach). Employees received information (written and audio and video) on healthy eating, relationships, benefits of exercise, stress management. Also contact and support over 4 months. Some companies offered snacks and free gym memberships. Questionnaire on work environment and health beliefs Blood pressure and heart rate readings Blood glucose and cholesterol levels Flexibility, strength, and aerobic fitness tests The 54 who completed follow-up rated the program highly overall. Tended to use the audio tapes more than written materials. Most did not use fitness clubs; exercised on own. Self-reported improvements in diet and exercise. 96% of participants responded that the program had helped them Significant improvements for 2 of the 10 physical measures: aerobic fitness ($p&lt;0.01$) and strength ($p=0.04$). Recommended a promotional campaign to make information on Gettin’ in Gear available to the trucking industry. Consider a ‘train the trainer’ approach as well as training fleet managers or safety directors to conduct the fitness assessments. Blood work would still need to be done by health professionals.</td>
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<tr>
<td>Authors (year)</td>
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<td>Elkington &amp; Stevenson (2013)</td>
<td>N=1047 530 cases and 517 controls (59 and 58% response rates). Mean Age=44 99% Male</td>
<td>Case control study to explore the size, direction and interaction of the risk factors for long distance heavy vehicle crashes. Cases were drivers of heavy vehicles (≥ 12 tonnes) who had a police attended crash between December 2008 and May 2011 on a long distance trip (200+ km from base) Controls were drivers who had not had a police attended crash in the previous 12 months. Drivers of passenger coaches were excluded Data for controls were collected from 25 truck stops on major trucking routes over 66 interviewing days Data were collected via a 40 minute interview, and an at-home breathing monitoring device (Flow Wizard &amp; nasal cannula)</td>
<td>Driving schedules, payment schedules, crash history, fatigue management, health and lifestyle factors, medical conditions, sleep and sleep health, vehicle and load related factors</td>
<td>Higher proportion of cases (22.5%) than controls (14.7%) involved in a crash past 5 year period (OR=1.67, p=0.002). Significantly lower proportion of cases (66.9%) than controls (72.5%) had training in managing driver fatigue (p=0.049); and consuming caffeine (22% vs 49%) Heavy cigarette smoking showed significant association with crash risk (OR=0.49, p&lt;0.001). Significantly fewer cases than controls (15.9% vs 22.8%; p&lt;0.01) reported not sufficient sleep Caffeine consumption was associated with a decreased crash risk Drivers with less than 10 years driving experience were found to have more than three times the risk of crashing Very high proportion of obese (50%), and cigarette smokers (54%) 45% had sleep apnea, only 4% had previously been diagnosed</td>
<td>Approaches to facilitate frequent breaks while driving, including the provision of suitably equipped rest stops along the major trucking routes and attention to safer schedules and safety features of heavy vehicle, needs to be further explored.</td>
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Strathman, Kwon & Callas (2013)  
Bus Operator Perceptions of Safety Risks  
USA  

<table>
<thead>
<tr>
<th>Operator Characteristics</th>
<th>N=210 operators</th>
<th>31.7% Part-time</th>
<th>68.3% Full-time</th>
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</thead>
</table>

Report presents the results of a survey of TriMet bus operators addressing safety risks in their assigned work. Surveyed risk factors were organized into five categories: vehicle design and condition; route layout; operating conditions; fatigue; and stress.

Risk factors were identified for each category, and operators were asked to rank the factors in order of importance.

Final section of the survey asked operators to suggest changes in TriMet’s standard operating procedures that they thought would improve safety.

Respondent ranking of risk factors within each of the five categories, and overall ranking of categories.

Frequency of 'close-calls'

Suggestions for improvement

Greatest perceived safety risk for: Vehicle Design condition = blind spots from pillars, posts and mirror (1.27) Route Layout = Left or right turns (2.02) Operating Conditions = narrow travel lanes (2.21) Fatigue = Working long splits (1.78) Stress = disruptive passengers (2.31)

(Ranked perceived safety risk for each; 1=greatest risk)

Overall: stress (2.16), fatigue (2.17), operating class (2.74), vehicle design and condition (3.64), route layout (3.85).

45.3% of operators said they experience a 'close-call' everyday.

Most frequent suggestion: 28.6% said better schedules (more time for recovery and layover).

Operator perceptions of safety risk and suggestions for improvements in safety should serve as a complement rather than a substitute for detailed analyses of safety incidents.

Fine et.al (2012)  
Impact of Distraction and Health on Commercial Driving Performance  
USA  

<table>
<thead>
<tr>
<th>Participant Characteristic</th>
<th>N=55</th>
<th>Mean Age=40.5</th>
<th>98% Male</th>
<th>56% White</th>
<th>36% African-American</th>
<th>Mean BMI=32.8</th>
<th>Recruited from Alabama-based trucking companies</th>
</tr>
</thead>
</table>

Study examined the interaction of the cognitive and technological aspects of distracted driving as well as physical health among commercial drivers.

Participants completed cognitive testing and drove an 88-mile simulated trip while engaging in one of four secondary tasks (no secondary task, cell phone conversation, texting interaction, and email interaction) in a commercial truck driving simulator (L-3 Communications TranSimTM truck driving simulator).

Evaluated the impact of visual and cognitive distraction

Visual and cognitive distraction

Sleep (ESS)

Medication use

Medical conditions

Age

Cognition (tests by Useful Field of Vision (UFOV), and Psychomotor Vigilance Test (PVT))

Driving performance

Compared to the condition with no secondary task, significant increase in violations overall for the emailing (RR 1.97, 95% CI 1.76-2.19) and texting (RR 1.90, 95% CI 1.68-2.14), specifically the collision rate (RR 5.48, 95% CI 1.45-20.68), and lane deviation rate (RR 2.89, 95% CI 2.39-3.49), while a 42% reduction in the rate of eye glances off the road was observed (RR 0.58, 95% CI 0.42-0.78)

35% decrease in the rate of drivers riding the clutch was observed during the texting condition (RR 0.65, 95%)

Association of increased sleep time with significant reductions in risky driving behaviors, space management and speeding, provides justification for the development and consistent implementation of sleep and fatigue management programs for use with current commercial drivers and commercial driver trainees.

Findings suggest need for additional restrictions to include restricting the use of...
### Table

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Study Title</th>
<th>Participants</th>
<th>Methodology</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Blanco et al. (2011)</td>
<td>The Impact of Driving, Non-Driver Work, and Rest Breaks on Driving Performance in Commercial Motor Vehicle Operations USA</td>
<td>N=97 Mean age=44 94% Male 4 for-hire trucking companies participated in the study Data collected between November 2005 and March 2007</td>
<td>Naturalistic-data-collection approach: 9 trucks were fitted with unobtrusive data-collection equipment consisting of a data acquisition system (DAS), sensors to measure driver performance, and video cameras that recorded the driver’s face, steering wheel, and three views outside of the truck. Each driver drove an instrumented truck for 4-weeks, totalling 735,000 miles</td>
<td>Cognitive distraction, sleep, medication use, medical conditions, age, and cognition on driving performance CI 0.45-0.94) Significant decrease in driving speed for cell phone compared to no secondary task (54.97 vs. 56.65mph, p=0.0398) One-hour increase in sleep associated with 24% reduction in the rate of speeding 15+ over speed limit (RR 0.76, 95% CI 0.76, 0.59-0.99) and a 34% decrease in the collision rate (RR 0.66, 95% CI 0.48-0.91)</td>
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<tr>
<td><strong>Van Dongen &amp; Belenky (2010)</strong></td>
<td><strong>Objective of this Phase I research project was to determine the recuperative effectiveness of the current 34-hour restart provision in the hours-of-service (HOS) regulations.</strong></td>
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<td><strong>Investigation into Motor Carrier Practices to Achieve Optimal Commercial Motor Vehicle Driver Performance: Phase I</strong></td>
<td><strong>&quot;worst-case&quot; (night shifts followed by transition to day shifts over 34-hour restart) – &quot;best-case&quot; (day shifts throughout) between-groups comparison of two 5-day (14-hour/day) work periods separated by a 34-hour restart period.</strong></td>
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<td><strong>USA</strong></td>
<td><strong>Performance on a variety of neurobehavioral tasks and on a high-fidelity driving simulator to evaluate whether the 34-hour restart period was effective at maintaining performance in both conditions.</strong></td>
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<td><strong>N=27</strong></td>
<td><strong>Psychomotor vigilance test (PVT); Karolinska Sleepiness Scale (KSS); visual analog scale of mood (VASM); Positive Affect Negative Affect Schedule (PANAS); digit symbol substitution task (DSST); performance and effort rating scales (PERF and EFFR); cardinal direction decision task (CDDT).</strong></td>
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<td><strong>&quot;worst-case&quot; group: n=14, 7 male, mean age=27.5</strong></td>
<td><strong>&quot;worst-case&quot; average PVT performance in the 5-day work period after the 34-hour restart was impaired relative to performance in the 5-day work period before the 34-hour restart. &quot;best case&quot; performance did not change (F=20.06, p&lt;0.001).</strong></td>
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<td><strong>&quot;best-case&quot; group: n=13, 6 male, mean age=27.0</strong></td>
<td><strong>Subjects in the &quot;worst-case&quot; condition displayed a progressive increase in lane deviation over the hours of the night, which was accompanied by an increase of up to 1 percent in fuel use.</strong></td>
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<td><strong>The study findings highlight the importance of considering circadian effects on sleep and performance in HOS regulations.</strong></td>
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<td><strong>Driver fatigue could be reduced by establishing work schedules and adapting HOS regulations that allow greater flexibility (e.g., taking into account strategic napping and circadian timing).</strong></td>
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<tr>
<th><strong>Harrison &amp; Pierce (2009)</strong></th>
<th><strong>Purpose was to review carrier turnover and retention; evaluate the nature of turnover and retention and define the problem by critically examining published results from evaluations; survey trucking industry representatives to identify current turnover and retention problems, concerns, and solution strategies.</strong></th>
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<tr>
<td><strong>Examining Driver Turnover and Retention in the Trucking Industry</strong></td>
<td><strong>Literature review and survey.</strong></td>
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<tr>
<td><strong>USA</strong></td>
<td><strong>Transportation survey was comprised of 5 items to indicate company size and</strong></td>
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<td><strong>N=24 responding carrier companies, representing 10,500 drivers.</strong></td>
<td><strong>Primary &amp; Secondary sources: 1) published results from evaluations and analyses of the trucking industry; 2) publicly available proprietary reports, trade publications, and government documents; 3) U.S. Department of Transportation, U.S. Department of Labor, and U.S. Census Bureau databases; 4) responses</strong></td>
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<tr>
<td><strong>Very poor response rate (not disclosed, 405 surveys were mailed and 1000+ were available online)</strong></td>
<td><strong>13 firms had turnover at or below 30%</strong></td>
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<td><strong>6 firms reported turnover between 31% and 75%</strong></td>
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<td><strong>3 companies had turnover rates of 95% or higher</strong></td>
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<td><strong>9 firms said acceptable turnover rates would be 10 percent or lower</strong></td>
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<td><strong>7 firms said 20 percent to 50 percent would be acceptable</strong></td>
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<p>|  | <strong>As no trucking company has successfully demonstrated that the costs associated with attacking turnover can be offset by profits gained from increased retention, the assumption could be made that the level of turnover and retention is appropriate for the prevailing business climate in the motor carrier industry.</strong> |</p>
<table>
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<tr>
<th>Authors</th>
<th>Study Title</th>
<th>Methodology</th>
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<tr>
<td>Saccomanno et al (2008)</td>
<td>Safety Implications of Mandated Truck Speed Limiters on Canadian Highways</td>
<td>CANADA Simulation runs were performed on the simulation platform VISSIM (Version 4.3) to investigate safety implications of truck speed limiters. Aim of this study was to assess the safety implications of mandating speed limiters for large trucks (weight &gt; 11,794 kg) for different maximum speeds including the 105 km/h threshold suggested by the recent Ontario and Quebec legislation. Used a microscopic traffic simulation model that provided accurate “real time” estimates of safety performance (or crash potential) and assessed how this was affected by different speed control strategies applied to different highway geometries and traffic scenarios.</td>
<td>Safety performance: critical vehicle speeds, deceleration profiles Crash Potential Index (CPI): probability that a following vehicle deceleration rate needed to avoid a crash with a lead vehicle (or DRAC) exceeds the maximum available vehicle deceleration rate (or MADR) Introduction of speed limiters set at 105 km/h increases safety in the uncongested region of traffic flow for all geometric configurations, especially in the straight segment. If maximum speed is set at 110 km/h the safety gains with the introduction of mandatory limiters become less prominent Maximum safety gains were obtained when the maximum control speed was set at 90 km/h for uncongested traffic volumes As volume and percentage trucks are increased the safety gains associated with mandatory limiters set at 105 km/h become less pronounced Speed limiters set at 105 km/h (commensurate with Ontario and Quebec regulations) increases safety in uncongested traffic for all geometric configurations.</td>
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<td>Balkin et al (2000)</td>
<td>Effects of Sleep Schedules On Commercial Motor Vehicle Driver Performance</td>
<td>USA Field Study: N=50, aged 21 to 65, n=25 were short-haul truckers who, and n=25 were long haul truckers Laboratory Study N=66, 16 females with a mean age Project was comprised of two studies—a field study and a laboratory study. Field study was designed to assess the sleep/wake schedules of CMV drivers in a naturalistic and minimally intrusive manner. Wrist actigraphy was used to objectively measure the timing and duration of sleep periods over a 20-day period. Drivers were also given Field: Objective data from actigraphy and subjective information on sleep times, sleep latency, arousals during sleep, alertness upon awakening, napping (number and duration), and self-reported caffeine, alcohol, and drug use. Lab: sleep dose-dependent Field: found that both long- and short-haul drivers averaged approximately 7.5 hours of sleep per night. Long-haul drivers obtained almost half of their daily sleep during work-shift hours (mainly sleeper-berth time), which suggests that they spend a significant portion of the work shift in a state of partial sleep deprivation. Laboratory: Findings suggest</td>
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of 43, and 50 males with a mean age of 35. Sleep logs.

Laboratory: to determine the effects of four sleep/wake schedules on alertness and performance, and to develop an algorithmic model to predict performance on the basis of prior sleep parameters. Subjects spent 14.5 days in the laboratory: 3 days of training/baseline performance with 8 hours time in bed (TIB); followed by 7 consecutive days of performance testing during which subjects were allowed either 3, 5, 7, or 9 hours TIB each night.

Lab: psychomotor tasks [Walter Reed Performance Assessment Battery (PAB), the Psychomotor Vigilance Task (PVT)] and physiological measures [oculomotor measures from Fitness Impairment Tester (FIT) device, vital signs, and the sleep latency test (SLT)]. Sleep/wake state was measured and recorded 24 hours per day with portable EEG recorders.

differences in subsequent daytime performance were evident (and quantifiable) for several measures. Even a relatively small reduction in average nighttime sleep duration resulted in measurably decremented performance (PVT). Decrements were maintained across the entire 7 consecutive days of sleep restriction, suggesting that there was no compensatory or adaptive response to even this mild degree of sleep loss. Of the various performance measures, the PVT was deemed optimal as there no apparent learning effect and the measure was sensitive.

Lab: psychomotor tasks [Walter Reed Performance Assessment Battery (PAB), the Psychomotor Vigilance Task (PVT)] and physiological measures [oculomotor measures from Fitness Impairment Tester (FIT) device, vital signs, and the sleep latency test (SLT)]. Sleep/wake state was measured and recorded 24 hours per day with portable EEG recorders.

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That the extant level of daytime alertness and performance capacity is a function not only of an individual's circadian rhythm, time since the last sleep period, and duration of the last sleep period, but is also a function of his/her sleep history, extending back for at least several days.

---


**USA**

**N=140**

Respondents categorized by Carrier Size: A) 1 - 50 trucks, B) 51 - 200 trucks, C) 201+ trucks.

Objective was to determine the cost of turnover to the drivers themselves, not the Carriers.

TCA and Highway Bound created a questionnaire which was faxed to all TCA members.

Merged the study with Recruiting Resource Center data to create a realistic cost to an average driver over a 30 year period.

Earnings per mile
Miles per month
Job Changes
Unemployment time
Medical coverage
401k participation

Earn 30.5 cents/mile at a new job, whereas earn 33 cents/mile after 3 year with a company. Average driver changes jobs 8 times during a 30-year career. Job changes associated with 4 months of unemployment over a career.

Reduction in earnings: $11,014.16
Cost of uncovered medical expenses: $3,696.00
401k potential lost: $115,000. Total associated costs with turnover: $129,710.16.

Also: loss of miles due to seniority, loss of paid vacation time, not being considered for dedicated run, non-driving position due to lack of seniority.

In a typical driving career, job switching is currently costing the driver in excess of 5 cents on every mile driven.
Mean Age=50.5  
98% Male  
Years of experience = 18.4 years; 9.5 years with current employer  
Recruited from two truck stops in Southwestern Ontario | To determine the feasibility of conducting a national survey to gather information on health and wellness of commercial drivers.  
Phase I: Survey development (n=12)  
Phase II: Survey refinement (n=4)  
Phase III: pilot testing (N=107) | Prevalence and risk factors for health conditions  
Risk factors for crashes and occupational injury  
Barriers to achieving improved health, safety and well-being | 63% drove irregular routes and long distances; 17% were long-haul drivers with regular routes.  
Symptoms reported in last 30 days included: headache (44%), heartburn (30%), leg cramps (30%), ease to anger (30%), colds or flu (19%), depression (19%), frequent urination (16%), anxiety (16%), chest pain (12%), and shortness of breath (15%).  
Respondents were diagnosed with high blood pressure (22%), high blood cholesterol (15%), diabetes (14%), hearing loss (10%), heart attack (7%) and sleep apnea (7%).  
Conditions of most concern among respondents were poor diet; lack of exercise, stress, being overweight and sleeping problems. Conditions of least concern to respondents were sexually transmitted infections, use of illegal drugs and cancer from diesel exhaust.  
Over 50% reported exposure to diesel exhaust always or often; 21% reported always or often consuming 5 or more fruits and vegetables per day; Almost 50% reported poor work/life balance | Support for a truck driver survey. Collaboration and partnerships with key stakeholders are needed to develop and implement a provincial or national survey in commercial drivers. Health and safety professionals believe data on driver health, safety, and wellness can be useful in prevention efforts in a Canadian context. |
**Authors (year)**  | **Rationale / Description**  | **Search Process / Criteria**  | **Key Findings**  | **Conclusions**  
--- | --- | --- | --- | ---  
Krueger  | 2010 conference focused on commercial truck and bus driver health and wellness issues. Goals were to (a) review research that identifies health and wellness (H&W) issues for commercial drivers; (b) examine the magnitude of these issues; (c) identify countermeasures and current practices addressing these issues; (d) explore and document the effectiveness of such countermeasures and current practices; and (e) identify research gaps in this field.  | N/A Summary of conference proceedings  | Key findings on H&W interventions: Place significant value on employees, make a company assessment of employee H&W status beginning with a health risk appraisal (HRA); establish H&W program elements most relevant to your worker population’s needs; educate all levels of the company about the importance of corporate H&W programs; before hiring, consider preplacement physicals and H&W screening and use job placement to avoid problems; encourage participation by employee family members in corporate programs; target particular health issues with intervention programs; incentivize employee participation in H&W initiatives (e.g., rewards, insurance discounts, fitness membership reimbursement) and create group competition; measure outcomes, track progress, and monitor individual and group successes and failures  | Conference presentations and discussions made it clear that personal health, wellness, and fitness are critically important for truck drivers and bus and motor coach operators for themselves and for their families  
**USA**  | Another topic was cost-benefit and return-on-investments (ROI) analyses that might apply to small and large commercial trucks and bus carriers.  |  | Key ROI findings: J.B. Hunt’s preemployment screening, job safety placement, and Better Health for Life (BHFL) program reduced preventable claim costs by approximately $550 per participant and resulted in a positive ROI in the first 12 months of the company’s H&W program, net program savings of between $1.6 and $4.1 million; Schneider National’s comprehensive program to evaluate and treat drivers for sleep apnea, health care savings were in excess of $500 per enrolled driver per month. Outside of trucking, an automotive parts manufacturer with 15,000 employees reported an ROI of 4.95 to 1 for their H&W program, gross savings totaling almost $2 million; Pfiffner described data indicating that medical costs for overweight and obese truckers are up 44% more than those for truckers with more normal weight; Baicker reported that medical costs fall by about $3.27 for every dollar spent on wellness programs and in addition that absenteeism costs fall by about $2.73 for every dollar spent.  | Highly sought-after financial ROIs were not the only positive outcomes of adopting employee H&W programs in the commercial driver work force. Healthier drivers can lead to improved morale, lower driver turnover, reduced medical and worker’s compensation costs, and increased roadway safety by decreased accident risk  |
| World Bank (2009) Transport against HIV/AIDS: synthesis of experience and best practice guidelines | Paper aims to provide guidance to World Bank transport and health staff on entry points for mitigating HIV’s impact on the transport sector while providing resources and recommendations for designing and implementing interventions. Reviews interventions and approaches undertaken by the World Bank’s transport group, drawing attention to the role and resources of partner agencies, trade unions and key stakeholders. No details on the review process. Monitoring and surveillance studies of truck drivers’ behaviour and knowledge about HIV showed that drivers tend to have poor AIDS awareness and misconceptions about condom use and HIV transmission modes. Evidence on the direct impact of HIV on transport’s productivity shows that the disease can significantly compromise the effectiveness and reliability of the sector, with the capacity to further strain health systems and national economies. Use of alcohol or drugs can add substantially to the risk of engaging in casual unprotected sexual relations and is a contributing behavioural risk factor to the spread of the HIV/AIDS epidemic. Sector interventions must be linked to the various local health services delivery mechanisms, including local implementation units such as NGOs that are most effective for providing HIV services. HIV interventions in the transport sector should focus on promoting safe sex behaviour. Interventions should include the provision of training on HIV/AIDS risks that encourage behaviour change, particularly condom use, the treatment of sexually transmitted infections, and the referral of transport workers and vulnerable groups to Voluntary Counselling and Treatment (VCT) services. Good practices include: road-side clinics and wellness centers for truckers, health passports and targeted communication materials. Level and type of interventions best suited to meet a specific country prevalence rate and risks associated with a particular type of transport project should be assessed. Effective interventions should address issues that can lead transport workers to engage in risky behaviour, such as working long hours without taking enough time to rest; poor facilities for recreation and rest; and lack of appropriate health services and other benefits. Lessons learned are (i) strategies must be crafted to meet the specific needs of the country in accordance with the local culture and unique epidemic situations; (ii) coordination with the health sector and the national AIDS authority is necessary for effective program design; and (iii) involving stakeholders from local communities is key to program success. Permanent resources for HIV prevention would be needed from client countries’ budgets to sustain the achievements made in some countries and at regional levels. |
## Purpose of this evidence report

The purpose of this evidence report is to address 7 key questions posed by the FMCSA:

1. Are individuals with obstructive sleep apnea (OSA) at an increased risk for a motor vehicle crash when compared to comparable individuals who do not have the disorder?
2. What disease-related factors are associated with an increased motor vehicle crash risk among individuals with OSA?
3. Are individuals with OSA unaware of the presence of the factors that appear to be associated with an increased motor vehicle crash risk?
4. Are there screening/diagnostic tests available that identify those individuals with OSA who are at an increased risk for a motor vehicle crash?
5. Which treatments have been shown to effectively reduce crash risk among individuals with OSA?
6. What is the length of time required following an effective treatment for to reach a degree of improvement for safe driving?
7. How soon, following cessation of treatment will individuals demonstrate reduced driver safety?

## Evidence for Key Questions

### 1) Are individuals with OSA at an increased risk for a motor vehicle crash when compared to their counterparts who do not have the disorder?

- **Findings:**
  - 17 articles; CMV drivers with OSA are at an increased risk for a crash when compared to their counterparts who do not have the disorder. Drivers diagnosed with apnea (ESS score ≥11) were found to be at an increased risk for motor vehicle crash (odds ratio (OR) = 1.3, 95% 1.00-1.69).

### 2) What disease-related factors are associated with an increased motor vehicle crash risk among individuals with OSA?

- **Findings:**
  - 10 articles; Four factors (daytime sleepiness (ESS), severity of disordered respiration during sleep (AHI or RDI), blood SaO2 levels, and BMI) have been shown to be associated with crash risk among the general driver population. However, no evidence-based conclusion pertaining to the risk factors for crash among CMV drivers with OSA can be drawn at the present time.

### 3) Are individuals with OSA unaware of the presence of the factors that appear to be associated with an increased motor vehicle crash risk?

- **Findings:**
  - 3 articles; Individuals with OSA may not be aware of the extent to which they are affected by daytime sleepiness.

### 4) Are there screening/diagnostic tests available that identify those individuals with OSA who are at an increased risk for a motor vehicle crash?

- **Findings:**
  - 43 articles; Compared to reference standard for diagnosing the severity of OSA, in-lab, technician-attended polysomnography (PSG). Portable sleep monitoring systems, though not as accurate as the current reference standard, do offer an alternative method by which the severity of OSA may be assessed in a large number of individuals at a relatively low cost. However, not clear whether currently available portable sleep monitoring systems are accurate enough to be considered as acceptable alternatives to the current reference standard.

### 5) Which treatments have been shown to effectively reduce crash risk among individuals with moderate-to-severe OSA?

- **Findings:**
  - Continuous positive airway pressure (CPAP) reduces crash risk among individuals with moderate-to-severe OSA.

### 6) What is the length of time required following an effective treatment for to reach a degree of improvement for safe driving?

- **Findings:**
  - The impact that CPAP has on crash-risk reduction among individuals with OSA can be seen after as little as one night of treatment. Exactly how many nights of treatment are required until CPAP exerts its maximum benefit is not known, but evidence suggests that this point has been reached prior to two weeks.

### 7) How soon, following cessation of treatment will individuals demonstrate reduced driver safety?

- **Findings:**
  - Cessation of CPAP leads to a decrease in simulated driving ability and increases in both OSA severity and daytime sleepiness. This deterioration may occur as soon as 24 hours following cessation of treatment.
<table>
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<tr>
<th>Krueger et al. (2007)</th>
<th>Synthesis 15: Health and Wellness Programs for Commercial Drivers USA</th>
<th>Five objectives for synthesis: 1) to review the literature on truck and bus driver health issues, highlighting the chief health risks facing commercial drivers 2) to present an analytical review of literature associating crash causation with functional impairments 3) to describe elements of employee health and wellness programs that could apply to transportation industry 4) to conduct a survey of trucking, bus, and motorcoach companies who already have implemented employee health and wellness programs 5) to report several case studies of successful employee health and wellness programs</th>
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<td><strong>Review</strong> contained: (a) journal articles; (b) occupational health and health promotion journals; (c) truck, bus/motorcoach industry trade literature; (d) corporate and human resources (HR) literature; as well as wellness magazines and websites of providers.</td>
<td><strong>Review findings:</strong> more than 50% of commercial drivers are regular smokers. Many are obese, lack proper physical exercise, tend to develop chronic diseases such as diabetes at relatively early ages; half of driver injuries involving lost workdays are attributable to sprains, often caused by overexertion such as lifting heavy objects; sleep disorders, sleep loss, sleepiness, and driver fatigue from long and irregular work hours increase risks of operational errors, unsafe driving, injuries, and deaths; worker fatigue in the United States carried overall estimated costs of more than $136 billion per year in health-related lost productivity—$101 million more than for workers without fatigue; there is a direct dose-dependent relationship between BMI and driver crash-likelihood; regular exercising drivers at a company’s onsite fitness center achieved higher job performance ratings, stayed longer with the company, had lower medical and prescription claim expenses, and had lower absenteeism rates than those who did not exercise; WHO listed the risks of experiencing low back pain by drivers of buses, trucks and tractors at a risk score ranging from 1.83 to 5.49 relative to a baseline risk of 1.0 for office clerical workers; WHO listed the risks of experiencing low back pain by drivers of buses, trucks and tractors at a risk score ranging from 1.83 to 5.49 relative to a baseline risk of 1.0 for office clerical workers.</td>
<td>The work done in this synthesis leads the research team to believe that employing healthier drivers can possibly increase highway safety by decreasing accident risk. Employers who implement health and wellness programs for their drivers may find that such programs lead to improved employee morale, lower driver turnover, reduced medical and workers’ compensation costs, and improved profits</td>
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<td><strong>Surveys:</strong> (1) 24 managers of H&amp;W programs; (2) 23 truck and bus drivers involved in a program. Surveys distributed via fax, email and posted on ATRI’s website. No details on number distributed (response rate).</td>
<td>Effective H&amp;W programs should include: commitment from senior management; clear statement of philosophy, purpose, and goals; needs assessment; strong program leadership; accessible and convenient for employees; supportive environment.</td>
<td>Survey Findings: Manager survey (n=24) - Unhealthy diet (mean = 2.2) and obesity (mean = 2.3) were the two main concerns; reasons for starting a H&amp;W program included reducing health care costs (84%), to reduce occupational injury (84%), to enhance productivity (84%), to reduce accidents (74%), to reduce absenteeism (68%), to improve driver retention (63%) and morale (58%); approximate budgets ranged from $150 to $500,000, with a mean of $96,340.</td>
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<td>Case studies: identified through interactions with the companies</td>
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drug/alcohol abuse as the two greatest health risk factors for commercial drivers (opposite of managers); 76% indicated that participation has either remained constant or increased by some degree; respondents estimated a 61.2% participation rate

**Case Study Findings:**

1. **Schneider National:** reports that its health and wellness initiatives have had a positive impact on the company’s bottom line; treatment of 339 OSA drivers with CPAP for 1 year, led to $538 per driver per month health care savings among the cohort and a 55% greater retention rate among participating drivers than the fleet as a whole; investing in a system that works with existing cab and seat ergonomics improved driver discomfort complaints by 47%.

2. **Trucks Inc.:** company safety officials have completed the Gettin’ in Gear training course to educate drivers on health, wellness, and safety issues; annually checks drivers’ blood work to identify risk factors such as high cholesterol and to check prostate-specific antigen (PSA) levels, as well as provides exercise equipment for drivers, available 24 hr/day at company facilities; early diagnosis of health issues has saved Trucks, Inc., more than $250,000 in medical insurance costs and identified two cancer cases, five pre-heart attack conditions, and numerous pre-diabetic conditions; personnel turnover rate at Trucks, Inc., is under 30%, compared with industry averages in the truckload sector of more than 100%.

3. **JB Hunt:** drivers who are determined to have health risks such as hypertension and diabetes are connected with a health coach; reduction in the number of workers’ compensation claims and costs, a reduction of claims due to serious musculoskeletal injuries, a reduction in workers’ compensation claims within 90 days of hire, a reduction in accident rates, and a decrease in driver turnover.

4. **Waste Management Inc.:** human capital management (HCM) approach to addressing its health and disability challenges and achieving cost savings through focused programs and policy changes; health and wellness programs including diagnosing and treating sleep apnea, driver safety, managing obesity and blood pressure, lunch-and-learn educational programs, and first aid training; reported savings well over $100 million in just the few years since implementing new HCM program
Greyhound Lines Inc: program for drivers to design a personalized action plan under the employee’s doctor’s guidance; access to a personal, experienced registered nurse to call for guidance and support; discounts on fitness club memberships, weight management programs, massage therapy, chiropractic care, and two different smoking cessation options; 24-hour health information line.

| Saltzman & Belzer (2007) | April 2003 conference on the occupational safety and health of commercial motor vehicle drivers. The report is a review of conference proceedings and summary of contributor findings. | Diesel exhaust has been linked to lung cancer and allergic inflammation, and exposure can be substantial at loading docks and truck stops. Ergonomic risks vary widely and can include loading and unloading heavy cargo, awkward postures, and working in tight spaces. Fatigue is a critical problem for drivers and the trucking industry. One study reported that drivers slept an average of only 4.78 hours per day, while those who worked on a steady night schedule averaged only 3.83 hours of sleep per day. Moderate levels of sleep deprivation (17-24 hours of wakefulness) can cause neurobehavioral impairment equivalent to a blood alcohol level (BAC) of 0.05 to 0.10. 25% of long-distance truck drivers reported falling asleep at the wheel in the past year, while 47% reported having fallen asleep at the wheel sometime during their driving career. Driver fatigue was a factor in 6% to 49% of the highway truck crashes. 47% of truckers lacked a regular health care provider. 56% found it difficult to make a healthcare appointment due to work schedule, and 62% said they had failed to seek out needed health care when on the road working. Pressure to stay on schedule even when road conditions are bad or they are fatigued can strain drivers’ nerves. Driver compensation is inversely associated with both employee turnover and crash risk. J.B. Hunt: 10% higher base mileage rate was | A research agenda addressing the most pressing issues should be developed in consultation with truck drivers, trucking companies, government agencies, and other interested parties. Such an agenda would provide direction to the safety and health community and ensure that concerns are addressed in a coordinated manner. |
| National Transport Commission (2006) | Advanced fatigue management (AFM) option is the third tier of the multi option approach to heavy vehicle driver fatigue. Report discusses the fatigue information that has been used in developing the AFM option policy proposal. Review of Fatigue Management Practices in the Australian Transport Industry | No details on the Review process. | Under flexible fatigue management regimes, the available data shows that a range of work practices are possible. The critical issue is to ensure that fatigue precursors are well managed. In the design of schedules, providing continuous rest opportunities for sleep to manage the fatigue risk is paramount. |
| Davis (2004) | Synthesis provides a glimpse into the health and wellness issues faced by transit operators, impact on productivity and programs that transit agencies have implemented. The synthesis surveyed transit agency experience with employee | Extensive literature review: health risk factors common to transit operators, regulatory mandates related to operator qualifications, specific health conditions, health and wellness interventions, and health and wellness | Increasing documentation of the positive impacts of quality worksite health and wellness programs has motivated more and more employers to adopt such programs. Program benefits include reduced use of the health care system, lower rates of |
| TRCP Synthesis 52: Transit Operator Health and Wellness Programs | | Review Findings: Lack of physical activity, obesity, unhealthful diet, uncontrolled diabetes, and uncontrolled hypertension all rank close to the top of the list of these costly risk factors. Survey Findings (n=14 responding agencies): evidence of proactive models of organizations seeking to improve operator physical and psychological health and well-being; activities include health education, exercise, stress management, employee assistance, nutrition, smoking cessation, maintaining mental health, cardiovascular disease prevention, and disease management programs; variation in allocation of resources towards (1) awareness | |
health and wellness programs. program successes in the transit industry

A questionnaire was developed and distributed to 33 transit agencies (14 responses)

6 cases were selected from 14 to discuss in detail

activities (2) education (3) behaviour changes

Case Study Findings: Pierce Transit: health and wellness program activities at PT are part of a corporate strategy of high involvement by employees; 60% awareness, 20% education, 20% behaviour change; Health express program budget $2,000 - $4,000; employees who walked at least 25 mi, or ran or biked 50 mi, were eligible for a certificate recognizing their participation; 16-week Weight Watchers at Work program; smoking cessation reimbursement program; on-site fitness area. MetroLINK: Wise Living program was helpful in reversing the trend of escalating health insurance premiums; of 52 participants, 50% lost weight and collectively, the group lost 500 lbs; twice-weekly training sessions focused on body fat and weight loss strategies. Central Florida Regional Transportation Authority: LYNX wellness program; agency converted a former loading dock at one of the bus operating facilities, a 30- by 40-ft space, into the current wellness center; 33% awareness, 33% education, 33% behaviour change; includes wellness counselling, fitness testing, heart rate monitors, fitness training, blood pressure monitoring, body fat measurement and weight loss advising, showers and lockers, health fairs; 44% increase in annual participation; 75% to 80% of bus operators who started LYNX continue it long term. Orange County Transportation Authority: H&W program with budget of $220,500; 70% awareness, 20% education, 10% behaviours change; employee needs assessment survey; health screenings; Lunch while Learning education classes; back education classes; wellness library; on-site fitness facilities; incentives (shoes and wheels club, smoking cessation reimbursement, weight loss reimbursement, wellness champion of the quarter); annual health fair; evaluation recommend the program more towards a results-oriented approach. Utah Transit Authority: H&W program budget of $200,00; managers also actively promote participation in health and wellness activities; take care of yourself book; vitality magazine; healthy UTA incentive program (smoking cessation contract, weight loss contract); fitness factories; nutritional analysis and weight management; annual health fair; injury rehabilitation; resource library; sports program; most

injuries, absenteeism, and turnover, as well as increased productivity, elevated employee morale, and enhanced loyalty
A significant program result was that more than one-half of participants at risk for tobacco use had quit smoking. *Regional Transportation District:* two complementary components: health promotion ($240,000 budget) and on-the-job injury rehabilitation ($142,239 budget); Hooked on Health includes employee recreational tournaments, blood drives, health fairs, blood pressure testing/monitoring on-site, preparation for department of transportation/commercial driver’s license physical, blood lipid testing, blood composition analysis, health education program, bike program, post-occupational injury rehabilitation; reduced workers’ compensation claims by nearly 50% over 3 years, representing a cost reduction of about $5.5 million.

<p>| Moffat et al. (2001) TCRP Synthesis 40: A Challenged Employment System: Hiring; Training, Performance Evaluation, and Retention of Bus Drivers | USA | The synthesis is intended to provide a snapshot of public transit bus operator practices, focusing on hiring, training, performance evaluation, and retention. | Synthesis prepared using data from 1) the literature on transit and related periodicals and web-sites, and 2) a survey in 2000. Survey (71 items) sent to a random sample of 75 transit agencies. 29 responses received from 7 large, 9 medium and 13 small agencies. | <strong>Review Findings:</strong> New Jersey Transit reports a 2-day reduction in training time, cost reductions of $37/hour and annual overall training savings of $375,000 using simulated versus real-world driving. In addition, they've found a substantial decrease in accident rates; training simulators have the potential to reduce costs and improve effectiveness of training; US Department of Labour put the cost of replacing an employee in the $3,000 to $7,000 range, not including training; studies suggest that when salary and benefits are equal, employees gravitate to workplaces where they feel valued; <strong>Survey Findings:</strong> 24% indicated that they were concerned about the job conditions of bus operators; 41% have a recruitment package, 71% have a standard recruitment advertisement, 78% have a job posting/announcement, 56% have a mission/vision statement; 81% use an employee referral program, 31% said their referral program was one of their most successful programs; internet recruiting is used by 62% of agencies; 69% use a selection test as part of their bus operator selection process; 62% use a structured interview process, 59% have two or more interviewers present during interviews; 18% do not train for customer support, interpersonal interaction with peers and staff; 36% require drivers to participate in annual refresher training; 41% use formal evaluation for discipline or termination, 32% for advancement, 27% for reward or recognition. | Does not appear from this review that transit agencies are routinely pursuing methods of quantification and measurement as part of decision-making. There are opportunities for agencies to realign their hiring, training, development, and retention efforts so that they work in an integrated fashion. |
| recognition, and 17% for pay increase decisions; average turnover across all agencies was 10.9%; 11% have set specific retention goals; 67% conduct exit interviews and 30% use the exit interview data to inform their retention planning |</p>
<table>
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<tr>
<th>Article</th>
<th>Description</th>
<th>Key Findings and Recommendations</th>
<th>Government-level Recommendations</th>
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<td>Thiffault (2011)</td>
<td>Phase I: What are the problems and what should be done? Extensive literature review as well as an examination of a subset of data stemming from the Canadian National Collision Database (NCDB) relative to CMV related crashes during the 2003-2007 time period.</td>
<td><strong>Recognition</strong>: errors mainly relate to inattention as it is caused either by fatigue (hypovigilance) or distraction; prevention of recognition errors therefore involves mitigating the effects of the factors that contribute to fatigue and distraction. <strong>Fatigue</strong>: HOS regulations are necessary but not sufficient to address fatigue in the motor carrier industry, they need to be complemented by various initiatives to generate a comprehensive and efficient fatigue management approach. HOS rules should be enforced with tamper-proof equipment such as Electronic On-Board Recorders. Drivers tend to resist and try to fight fatigue with effort - ineffective and very risky. Suggested study investigating the psychological determinants of the decision to keep driving while experiencing fatigue be conducted, supported by the Theory of Planned Behaviour (TPB). Pay structure is most likely a significant determinant of the decision to keep driving while drowsy. 69% of carriers acknowledge that fatigue is part of their driver training activities; Phase III suggests several areas that should be covered in both training and testing. <strong>North American Fatigue Management Program (NAFMP)</strong>: recommended that governments and industry stakeholders vigorously promote the voluntary adoption of the web-based program by motor carriers of all sizes. NAFMP includes education components for drivers, dispatchers, company management, family members etc, OSA screening and treatment guidelines, procedures and tools, scheduling guidelines and tools as well as recommendations with regards to the use of fatigue monitoring technologies. <strong>Crash Avoidance Technologies</strong>: electronic stability control (ESC), forward collision warning systems (FCWS), lane-departure warning systems (LDWS) and blind-spot cameras can be beneficial for safety, it is recommended that their utilization be promoted in the motor carrier industry. Government-issued incentives like the ones given in the U.S. to help carriers to equip their fleets should be considered. <strong>Obstructive Sleep Apnea</strong>: no immediate action items are suggested, aside from promoting the NAFMP, monitoring what the U.S. does and waiting for the deliverables of CCMTA’s OSA working group.</td>
<td>Options for government-based initiatives: In Canada, like in the US, it is mainly up to carriers to come up with driver improvement initiatives aimed at high-risk drivers. Therefore governments could help the industry in this endeavour by providing expertise, scientifically developed and validated programs as well as incentives. Another possibility is to develop, in parallel, a government-based approach like the one currently being implemented in Quebec: high-risk drivers meeting various negative safety performance thresholds need to meet with the government in order to be evaluated. Remedial interventions will then be prescribed on the basis of the results of this evaluation. Options for government-based driver-oriented interventions are not intended to replace the carrier-based framework currently in place, but rather to complement and...</td>
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Phase II: What are we doing now? On-line surveys from 56 motor carriers from 6 provinces, 6 representatives of industry associations(e.g., petroleum, public transit, motor and tour coach operators) and provincial CRA representatives (from all jurisdictions expect ON and NU). (to identify strategies currently in place to address recognition, decision, performance and non-performance errors. | **Phase III**: gap analysis based findings of phases I and II. | | |

Canada
and buses. Should also be used to address the use of distractors, including hand-held cell phones and texting. Several recommendations made for carrier-based interventions to mitigate distracted driving. *Theory driven recommendations to address risky driving:* suggested to use the TPB to evaluate the determinants of various risky driving behaviours for CMV drivers in Canada, and develop a validated test battery that could be used by training schools at entry level, by carriers in the context of driver improvement programs, and in the context of a government-based intervention scheme. *Driver Assessment:* should be multidimensional, including personality dimensions attitudes, risk-perception and actual driving style or driving performance data. *Behaviour Modification:* need to develop specific means to alter the attitudes, beliefs, subjective norms, risk perception, etc., of sensation seekers and aggressive drivers, and the TPB offers interesting potential in this respect. Hazard perception training programs should be included in both entry-level training and driver improvement programs.  

*Training, testing, licensing:* need to address driving style, rather than focusing only on driving skills in driver education. Training elements should be developed to alter drivers’ behavioural, normative and control beliefs with regards to specific high-risk driving behaviours. Driver training could also be used to promote a positive health-enhancing lifestyle that would positively impact on CMV drivers’ health as well as their safety on the roads.  

*Safety Culture:* Safety Management System (SMS) approach represents a strong strategy to improve carriers’ safety culture and to impact on numerous predictors of risky driving at the individual level.  

*Incentives:* as reported in phase II, 71 % of the carriers who completed the survey acknowledged the use of some sort of safety incentives. Trucking and bus industry should therefore use incentive programs to its advantage in terms of increased safety, enhanced profitability, better company morale, greater productivity, reduction in personnel turnover.  

*Safety Technologies:* less than 10% of carriers currently report using FCWS, LDWS and RSC due to the cost. Use of low cost Driving Behaviour Management Systems (DBMS) that record parameters of driver behaviour when a critical safety situation occurs is a good opportunity to implement interventions to coach drivers with regards to their safety performance potentially improve it. Such an approach could have the advantage of (1) ensuring a greater uniformity in driver-based interventions, (2) ensuring that driver-based interventions are scientifically sound and (3) ensuring that these interventions are monitored, and evaluated.
## Appendix E. Key Stakeholders

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<th>Government Departments and Agencies</th>
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<td><strong>Transport Canada</strong></td>
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<tr>
<td><strong>Ontario Ministry of Transportation (and equivalent provincial bodies)</strong></td>
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<td><strong>Canadian Centre for Occupational Health and Safety (CCOHS)</strong></td>
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<td><strong>Provincial Workers’ Compensation Boards</strong></td>
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<td><strong>Canadian Council of Motor Transport Administrators (CCMTA)</strong></td>
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<td><strong>Employment and Social Development Canada (ESDC)</strong></td>
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<td><strong>Provincial Health Units and Health Authorities</strong></td>
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<td>Infrastructure Health and Safety Association (IHSA) and similar provincial bodies (e.g., SafetyDriven)</td>
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<tr>
<td><strong>Industry Associations/Non Profit Organizations</strong></td>
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<tr>
<td><strong>Ontario Trucking Association (and similar provincial organizations)</strong></td>
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<td><strong>Private Motor Truck Council of Canada (PMTC)</strong></td>
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<td><strong>Toronto Trucking Association (TTA)</strong></td>
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<td><strong>Canadian Trucking Alliance (CTA)</strong></td>
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<td><strong>Motor Coach Canada (MCC)</strong></td>
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<td><strong>Owner-Operator's Business Association of Canada (OBAC)</strong></td>
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<td><strong>Canadian Trucking Human Resources Council (CTHRC)</strong></td>
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<td><strong>Truckstop Canada</strong></td>
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<td><strong>Unifor</strong></td>
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<td><strong>Teamsters Canada</strong></td>
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<td><strong>Canadian Transportation Research Forum (CTRF)</strong></td>
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