Factors Associated with Depressive Symptoms in Long-haul Truck Drivers:

A Cross-sectional Study

by

Nyasha Makuto

A thesis

Presented to Lakehead University

In fulfillment of the

thesis requirement for the degree of

Master of Health Sciences

With specialization in Epidemiology

Thunder Bay, Ontario, Canada, 2020

Author's Declaration

I, Nyasha Makuto, hereby declare that I am the sole author of this thesis. This is a true copy of the final thesis, after any required revisions from my supervisor, committee and external examiner revisions. I understand that this thesis may be offered both as a hard copy and electronically to the public.

Acknowledgements

I'd like to thank my supervisor, Dr. Vicki Kristman, for her help in guiding and supervising me on my project throughout its development. Dr. Kristman has provided me with innumerable knowledge on how to properly design an epidemiological study. Her patience, care, and interest in ensuring that my project was a success was invaluable to me.

I would also like to thank Dr. Phil Bigelow and Dr. Michel Bédard for their support, patience, and critique of my thesis throughout its development. Their critique has always been very kind and constructive on my documents for revision. They were also very thoughtful and encouraging of me during my thesis-related defenses.

I'd like to thank all my professors in the Master of Health Science program for their kindness and knowledge at Lakehead University. I'd like to thank the Research Team of Dr. Kristman for providing me with much constructive feedback and fun memories in my program.

I'd like to thank my friends and family for providing me with much support throughout my time as a student and as a researcher. Finally, I'd like to also give a special thanks to Kim, Larry, Patrick, and Kevin Price for trying their best to use their connections and make this project a success; I'd like to thank Joanne Ritchie, Michelle Roberts, Joe Boucher, David Benjatschek from WowTrucks, Alana Pickrell from Dougall Media and Brandon Walker from Lakehead Communications as well in helping to promote the study.

Table of Contents

List of Tables

List of Abbreviations

CAD: Canadian dollar

CDME: Commercial Driver Medical Examination

CES-D: Center for Epidemiological Studies Depression Scale

CES-D-10: Center for Epidemiological Studies Depression Scale, 10-item

CI: Confidence Interval

HoS: Hours of Service

MHD: Mental health disorder

MSE: Mean squared error

NIOSH: National Institute for Occupational Safety and Health

OR: Odds Ratio

SAD: Seasonal affective disorder

SD: Standard Deviation

SDS: Self-rating Depression Scale

U.S./U.S.A.: United States/United States of America

Chapter 1: Introduction

Many North Americans are affected by mental health disorders (MHD) each year [1,2]. One of the most common MHDs is major depression [1,2]. Major depression has many costs for the individual and the economy [3–5]. Those with depression are more likely to experience difficulties sleeping, chronic fatigue, poor physical health, and are at risk of committing suicide when compared to non-depressed individuals [1,6,7]. The overall risk of mortality is higher among those with depression than those without [5]. On the economic level, depression is associated with an increased number of missed days at work (absenteeism) and poor productivity at work (presenteeism) [5]. Depression is estimated to cost the U.S. economy $36.6 billion per year in lost worker productivity [5].

Certain occupations put individuals at greater risk for depression than others. One of these occupations includes long-haul truck drivers. The risk of depression in trucking is higher when compared to at least 19 other occupational types [1,2,8–11]. Long-haul truck driving involves delivering freight to distant locations [12,13]. Truckers are usually on the road for several days at a time [14]. Many also drive overnight and are often alone during their shifts and their work breaks [14,15]. They also experience tight delivery timeliness and are often paid based on how far they drive, or how much freight they can deliver [13,16]. The working conditions of long-haul truckers can result in feels of social isolation and can lead to poor sleep and fatigue [14,15,17]. Many truckers have also reported that they experience stress due to tight and unrealistic delivery deadlines, poor road conditions, and violence at work [16].

Very few studies have examined possible risk factors for depression in long-haul truckers, despite the fact that there are several variables which may explain why they have a higher risk of depression than those working in other occupations. In addition, to the best of our

knowledge, no study to date has yet examined whether driving duration could be positively associated with depression, even though longer durations of driving could increase the risk of a trucker being exposed to the hazards and stressors of their work. Quantifying both of these associations represent gaps in the current literature.

This thesis consisted of an online, cross-sectional study with Canadian and U.S. long-haul truck drivers. These drivers were voluntarily recruited to participate in an online survey. The survey measured various possible risk factors of depression which could be related to themselves (e.g., demographics) or their working environment. The objectives of this thesis were threefold: first, to determine which variables could be associated with depression in long-haul truck drivers; second, to specifically determine the association between driving duration and depression while controlling for other extraneous factors; and third, to determine whether a trucker's country of work (either Canada, the U.S., or across both countries) could moderate the association between driving duration and depression. We looked at country of work as an effect modifier due to two possible differences between the working conditions of truckers in Canada and the U.S. One difference is that truckers in Canada may be exposed to fewer hours of sunlight and more challenging road conditions (i.e., ice, freezing rain, snow; poor road conditions could lead to higher job stress) more frequently than truckers in the U.S. [18,19]. A second difference is that Canada is mostly uninhabited when compared to the U.S., which could increase a Canadian trucker's risk of feeling socially isolated [20]. Prolonged exposure to these conditions (with increased driving duration) could lead to those who drive in Canada having a greater risk of depression relative to those who drive in the U.S. The sparser population of Canada could also result in fewer truck stops in this country, which could lead to greater fatigue and more unmet needs at work [21]. Poor job satisfaction is a risk factor of depression [22].

1.1. *References*

1. Public Health Agency of Canada. What is depression? [Internet]. 2009 [cited 2019 Jul 4]. Available from: https://www.canada.ca/en/public-health/services/chronic-diseases/mental-illness/what-depression.html

2. Centers for Disease Control and Prevention. Current depression among adults --- United States, 2006 and 2008. U.S. Department of Health and Human Services. 2010 Oct 1;59(38):1229–35.

3. Chiu M, Lebenbaum M, Cheng J, de Oliveira C, Kurdyak P. The direct healthcare costs associated with psychological distress and major depression: a population-based cohort study in Ontario, Canada. PLoS One. 2017;12(9):e0184268.

4. Greenberg PE, Fournier A-A, Sisitsky T, Pike CT, Kessler RC. The economic burden of adults with major depressive disorder in the United States (2005 and 2010). J Clin Psychiatry. 2015 Feb;76(2):155–62.

5. Bodden DHM, Stikkelbroek Y, Dirksen CD. Societal burden of adolescent depression, an overview and cost-of-illness study. J Affect Disord. 2018 Dec;241:256–62.

6. Mental Health Commission of Canada. Making the case for investing in mental health in Canada [Internet]. 2013. Available from: https://www.mentalhealthcommission.ca/sites/default/files/2016-06/Investing_in_Mental_Health_FINAL_Version_ENG.pdf

7. Hawes NJ, Wiggins AT, Reed DB, Hardin-Fanning F. Poor sleep quality is associated with obesity and depression in farmers. Public Health Nurs. 2019 May;36(3):270–5.

8. Fan ZJ, Bonauto DK, Foley MP, Anderson NJ, Yragui NL, Silverstein BA. Occupation and the prevalence of current depression and frequent mental distress, Washington Behavioral Risk Factor Surveillance System 2006 and 2008. Am J Ind Med. 2012 Oct;55(10):893–903.

9. Brody DJ, Pratt LA, Hughes JP. Prevalence of depression among adults aged 20 and over: United States, 2013–2016 [Internet]. Centers for Disease Control and Prevention; 2018. Available from: https://www.cdc.gov/nchs/data/databriefs/db303.pdf

10. Weinberger AH, Gbedemah M, Martinez AM, Nash D, Galea S, Goodwin RD. Trends in depression prevalence in the USA from 2005 to 2015: widening disparities in vulnerable groups. Psychol Med. 2018 Jun;48(8):1308–15.

11. Pilon D, Joshi K, Sheehan JJ, Zichlin ML, Zuckerman P, Lefebvre P, et al. Burden of treatment-resistant depression in Medicare: a retrospective claims database analysis. PLoS One [Internet]. 2019 Oct 10 [cited 2020 Sep 12];14(10). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6786597/

12. Martins AJ, Martini LA, Moreno CRC. Prudent diet is associated with low sleepiness among short-haul truck drivers. Nutrition. 2019;63(Complete):61–8.

13. Statistics Canada. Perspectives on labour and income: on the road again [Internet]. 2006 [cited 2019 May 11]. Available from: https://www150.statcan.gc.ca/n1/pub/75-001-x/10106/9061-eng.htm

14. Jensen A, Dahl S. Truck drivers Hours-of-Service regulations and occupational health. Work. 2009;33(3):363–8.

15. Mitler MM, Miller JC, Lipsitz JJ, Walsh JK, Wylie CD. The sleep of long-haul truck drivers. N Engl J Med. 1997 Sep 11;337(11):755–61.

16. Shattell M, Apostolopoulos Y, Sönmez S, Griffin M. Occupational stressors and the mental health of truckers. Issues Ment Health Nurs. 2010 Aug;31(9):561–8.

17. Apostolopoulos Y, Sönmez S, Hege A, Lemke M. Work strain, social isolation and mental health of long-haul truckers. Occup Ther Ment Health. 2016 Jan 2;32(1):50–69.

18. de Jong S, Auping WL, Oosterveld WT, Usanov A, Abdalla M, van de Bovenkamp A. The geopolitical impact of climate mitigation policies [Internet]. The Hague Centre for Strategic Studies; 2017. Available from: https://hcss.nl/sites/default/files/files/reports/HCSS_Energytransition.pdf

19. Ministry of Transportation. Winter driving: be prepared, be safe! [Internet]. Government of Ontario; n.d. Available from: http://www.mto.gov.on.ca/english/ontario-511/pdfs/winter-safe-driving.pdf

20. Statistics Canada. Canadian demographics at a glance: provinces and regions [Internet]. n.d. [cited 2020 Jun 22]. Available from: https://www150.statcan.gc.ca/n1/pub/91-003-x/2007001/4129908-eng.htm

21. Smart Trucking. A quick guide to the state of truck driving in Canada [Internet]. 2019 [cited 2020 Jul 1]. Available from: https://www.smart-trucking.com/truck-driving-in-canada/

22. Nakata A. Long working hours, job satisfaction, and depressive symptoms: a community-based cross-sectional study among Japanese employees in small- and medium-scale businesses. Oncotarget. 2017 May 23;8(32):53041–52.

Chapter 2: Background

More than 310,000 individuals worked as long-haul truck drivers in Canada, in 2011 [1]. In the United States (U.S.), over 3.5 million individuals worked as long-haul truck drivers in 2016 [2]. Long-haul trucking is one of the largest occupations in both Canada and the U.S. [1,2].

Long-haul truck driving consists of delivering large cargo, or freight, over distances which typically require travel over a day or more [3]. These driving shifts are often long, erratic and sometimes involve driving overnight for days at a time [4]. Long-haul truckers differ from short haul truckers in that the latter typically work a fixed daytime schedule (e.g., Monday to Friday from 9:00am to 5:00pm), drive over shorter distances and typically return home each day [4]. Examples of short haul truckers include mail and courier delivery drivers [4].

There are two types of long-haul truckers in Canada and the U.S.: *company* truck drivers who work for a company and whose truck is owned and maintained by the company (also referred to as employee, or wage-earning truck drivers); or *owner-operator*s who own and maintain their own truck, and either 1) drive it themselves as a for-hire long-haul truck driver, or 2) has full control of their truck, but is under a lease arrangement for a contracted period of time to a motor carrier [5–7]. Owner-operators are also known as self-employed truckers [3]. Tasks that a self-employed truck driver may do could include: signing their own contracts and negotiating their rate of pay, choosing their own loads and routes, or even hiring other drivers for their truck [3,6]. Leased drivers operate under the authority of the motor carrier in which they are leased to [7]. A study in 2004 found that out of all long-haul truck drivers in Canada, approximately 66% were company drivers, 29% were owner-operators and 5% were paid by a personnel agency [3]. A personnel agency is a temporary employment agency for work [3].

Canadian long-haul truckers typically drive domestically (picking up and delivering loads within Canada) or internationally (picking up a load in Canada and delivering it to the U.S., or picking up a load in the U.S. and delivering it to Canada) [3,8,9]. Canadian truckers must follow U.S. commercial driving laws upon crossing the U.S. border [9]. Likewise, U.S. truckers must follow Canadian driving laws upon entering Canada [9]. Although most Canadian truckers haul freight in the U.S. and vice-versa when working internationally, it is worth mentioning that it is possible, legally, for Canadian and U.S. truckers to deliver freight to Mexico (where they would be required to follow Mexican driving laws). However, freight deliveries into Mexico are rarely done by Canadian and U.S. truckers [10]. Instead, freight for Mexico is typically dropped off at the Mexican border, where it is loaded and delivered by truck drivers in Mexico [10]. Additionally, Canadian and U.S. truckers are required to complete a special program by the government of Mexico—that is only available in Spanish—if they want to drive in Mexico [11].

There is expected be a shortage of truck drivers in the upcoming years, due to the growth of the industry as well as the aging population of long-haul truckers [1,2]. This shortage has translated to ample job opportunities in both countries as well as a massive shift in the demographics of the trucking industry [12,13]. In 2016, 17.8% of Canada's truck drivers were of South Asian descent—most of whom were immigrants—as compared to 1.8% in the late 1990s [13]. In 2017, 20.2% of U.S. truckers were Hispanic, as compared to 17.8% in 2003 [12]. The proportion of females in trucking has been on the rise as well [14]. In particular, women made up 4% of the U.S. trucking population in 1978 and 12% in 2006 [14,15].

2.1. *Working Conditions of the Long-haul Truck Driver*

2.1.1. Work Hours and Durations of Driving

Though long-haul truck drivers are mostly driving while on the job, other non-driving work—such as paperwork or maintenance checks—may also take place [3,16]. Work hours may also consist of doing repairs on one's own truck (if the trucker is self-employed); physical labour such as loading and unloading shipments; staking, tarping or securing loads; waiting at loading docks or in traffic; filling out logbooks and other paperwork; or taking calls from dispatchers (as is similar in other occupations, such that a warehouse stocker may not *only* be stocking shelves during work, or a bus driver may not *only* be driving, but also responsible for other tasks during their work time) [3,5,17,18].

The Labour Force Survey of 2004 reported that Canadian long-haul truck drivers averaged 44.4 to 50.0 hours of work (both driving- and non-driving-related) per week [19]. However, Statistics Canada has indicated that these values were likely underestimates, given that these values were based on truckers' logbooks [3]. Logbooks are used in trucking to record work hours. However, truckers regularly omit some of their work hours in logbooks (such as by only writing down *driving* hours instead of *working* hours, the former of which, is one of the most common methods of remuneration in trucking) in order to maximize their income while giving the semblance that they are working within their legal limits [3,16]. Indeed, research by Belman, Monaco and Brooks (2004), the U.S. Department of Transportation, and the National Institute for Occupational Safety and Health found that U.S. long-haul truck drivers averaged 60 to 65.0 work hours per week between 1997 and 2010 [20–24]. These data suggest that the findings of the Canadian Labour Force Survey are indeed inaccurate, particularly because the U.S. has lower weekly legal limits on work hours (60) than Canada (70) [25–27].

Federal laws state that Canadian truck drivers may work for a maximum of 14 hours in one day and drive for a maximum of 13 hours per day [25,26,28]. Weekly, there is a strict working limit of 70 working hours per week for Canadian truckers (or, alternatively, a limit of 120 work hours over two weeks, with no limit on *weekly* working hours, but with a requirement to take at least 24 hours off after working for 70 hours in a row, at any point in time, during the two weeks) [25,26,28]. Long-haul trucking, however, strongly incentivizes its workers to drive for as much as possible, due to "just in time" delivery requirements (items which are delivered only at the exact time they are needed), unrealistic delivery deadlines, wages that are typically paid by the distance travelled, and companies offering bonuses—sometimes making up 5 to 7% of a truck drivers' salary—based on various achievements. Rewards may be given for meeting a monthly mileage threshold set by the company, crossing the Canada-U.S. border a certain number of times, and working on holidays [3,20,29–31]. Indeed, research on U.S. long-haul truck drivers has found that these individuals regularly work 90 to 100 hours per week, instead of their national limit of 60 work hours per week [20]. One study in 2010 had found that up to 20% of U.S. truckers worked for over 75 hours per week while a second study in 2015 had found that most U.S. truckers were, on average, working for 11 hours and 55 minutes each day [20,32]. In addition, in terms of driving hours, one study in 2003 had found that approximately 40% of U.S. truckers were driving for ten or more hours each day [2]. Thus, there is a significant body of literature which suggests that many U.S. truckers—and likely Canadian ones—are driving for lengths of time which either exceed, or approximate, their weekly legal limits.

Note that ten hours of driving followed by eight hours off-duty (with the ten hours of driving only allowed within a 16-hour "driving window", upon arrival at work) was the daily driving limit for U.S. truckers in 2003 [16,27]. Since 2004—and as of still presently—the new

driving limit for U.S. truck drivers is 11 hours of driving followed by ten hours off-duty (with the 11 hours of driving only allowed within a 14-hour "driving window", upon arriving to work) [16,27]. Thus, the U.S. has lower driving limits for long-haul truckers who drive in their country than Canada.

Also note that the U.S. has no daily work limits for long-haul truck drivers [16]. Thus, non-driving work can be done even after exceeding daily driving limits as well as after exceeding the daily 14-hour "driving window" [27]. However, the total number of work hours each week cannot exceed 60 hours [27]. Also note that in the U.S., the maximum working hours each week (60) could also technically refer to the maximum driving hours each week (60), because "all" of a driver's written work hours each day could be devoted strictly to driving (so long as this daily driving time does not exceed 11 hours each day, based on the 2004-and still currently active- rules). Finally, it should be pointed out that U.S. companies remunerate their long-haul truck drivers similarly to Canadian ones, in that U.S. truckers are also often paid by the distance or load [20].

2.1.2. Violence

A qualitative study by Shattell, Apostolopoulos, Sönmez and Griffin (2010) found that 5.1% of U.S. long-haul truck drivers have been a victim of assault at least once, 5.1% of the drivers have been arrested or incarcerated at least once, and 3.4% of the drivers have seen violence or a fatal crash at some point on the job [18]. Truck drivers have reported dealing with road rage, racism and discrimination on the job [18,33]. Stress due to the threat of being robbed, hijacked or physically assaulted at work has also been reported [18,33]. Finally, truck drivers have expressed personal safety concerns when parked at truck stops or shipping warehouses

[18,33]. Warehouses, in particular, have been reported as a source of anxiety in trucking, due to the buildings often being found in remote, high-crime areas and decrepit neighbourhoods [18].

2.1.3. Social Isolation

Social isolation refers to an objective and subjective lack of social contact with others [34]. Social isolation occurs when there is an inadequacy in the quality and quantity of social relations at the individual, group and community level [34]. Long-haul truck drivers are vulnerable to social isolation as they are generally alone while working and alone during rest periods [35]. They may also be away from friends and family for weeks at a time, and their long, erratic work schedules can make it difficult to maintain an adequate number of strong social relationships [3,16,33,36]. People who live alone, or are divorced, widowed or single are particularly vulnerable to social isolation [37]. Shattell et al. (2010) have found that the majority of U.S. long-haul truck drivers (64.4%) are either separated, divorced, single or widowed [37].

Some grey literature has indicated that some truckers may be able to bring along a pet, or co-drive (share their driving with a partner) who is a friend, spouse, or family member [38]. However, this depends on the individual company [38]. Unfortunately, the percentage of truckers who drive with a co-driver (or other type of occupant) is—to the best of our knowledge—unknown in the literature.

2.1.4. Poor Sleep and Fatigue

Long-haul truckers have extremely short durations of sleep each day on the job [36]. Sleep deficit can occur due to short durations of sleep over days at a time [36]. Only one known study has examined Canadian long-haul truck drivers' sleep habits. Mitler, Miller, Lipsitz, Walsh and Wylie (1997) studied 40 Canadian long-haul truck drivers, over a five-day work shift, and found that nearly all of the drivers were sleeping approximately three to five hours each day [36].

Note that the authors did not record any of the drivers' non-sleeping activities and thus, it is unclear how these drivers were spending their time beyond sleep. It is estimated that 17% of U.S. long-haul truckers sleep for less than six hours each day during their workdays [32].

Fatigue, or mental and physical tiredness, is another frequently reported hazard in long-haul trucking [17]. Long-haul truck drivers are vulnerable to fatigue due to a combination of tight delivery timelines and driving pressures, high durations of driving, road hazards such as poor weather and irregular work and sleep schedules, among other workplace stressors [32]. Physical fatigue can refer to a person's current need to sleep (i.e., feelings of sleepiness) but can also refer to a "lack of energy", such as due to illness or certain medical conditions [39]. Some drivers have reported the stress, isolation and loneliness of being a truck driver as reasons for feeling mentally drained and fatigued [17].

2.1.5. Poor Nutrition and Obesity

Long work hours and poor sleep can also make it difficult for many drivers to find the time to exercise or prepare a healthy meal to take on the road [40]. It is estimated that nearly 69% of U.S. long-haul truckers (versus 31% of U.S. adults) are obese [40]. Much of this obesity is due to a lack of low-calorie food options while on the road [40]. It can also be difficult to keep food fresh while making long journeys [40].

2.1.6. A Cold Climate and Sparse Population for Those Who Drive in Canada

Finally, it is worth mentioning that truckers who drive in Canada versus the U.S. may be subjected to different working environments. Canada is generally colder for most of the year and receives fewer hours of annual sunshine, on average, than the U.S. [41,42]. Poor weather and dangerous roads (e.g., due to ice; or slush and snow in the snowbelt regions of Canada) may also

be more common in Canada [43,44]. Poor road conditions could result in greater difficulties with driving and job stress. A loss of traction may also lead to crashes.

Another difference between the two countries is that most of Canada is uninhabited or sparsely populated relative to the U.S. [45]. In fact, most of Canada's population resides by the U.S. border [45]. Truck stops may be few and far in between in Canada, with significantly more being found in major cities or Southern Canada [43]. Truck stops may be used for showering, eating, rest, doing laundry, going to the washroom, or addressing other needs on the road [43].

2.2. *Long-haul Truck Driving is a High-risk Occupation for Depression*

Long-haul truckers exhibit a higher prevalence of major depression and more frequent bouts of mental distress when compared to both the general population and workers from many other occupations [17,46,47]. Only one study by Fan et al. (2012) compared the odds for depression among long-haul truckers (and 18 other occupations in the U.S.) relative to executives and manager-related occupations [46]. These 18 occupations included: health-diagnosing and health treatment-related occupations (e.g., nurses); engineers, architects and other professional scientists (e.g., computer scientists); teachers; finance workers; retail and service workers; farming, forestry and fishing [46]. Long-haul truckers were found to have the highest risk for current major depression (with managers and executives as the referent group; OR = 6.18, 95% CI: 2.52-15.16), out of all the other 18 tested occupations by Fan et al. (2012) [46]. Current major depression was defined as those with a Patient Health Questionnaire-8 score of ten or greater (from a range of 0-24) on the presence of depressive symptoms over the past two weeks [46]. Although this study included only U.S. workers, it is expected that a similar risk of depression would have occurred among Canadian workers, due to the similarities of both countries' workplace structures and cultures, as well as economies.

2.2.1. What is Major Depression?

Major depression is a mental health disorder (MHD) characterized by appetite loss, insomnia, fatigue, irritability, thoughts of suicide, depressed mood and a loss of interest towards hobbies, among other symptoms [48]. Medical diagnoses of depression occur when an individual experiences five or more depressive symptoms over a period of two weeks or more [49]. Though different types of depression exist—such as postpartum depression and seasonal affective disorder (SAD)—clinical, or major depression is the most typical [49,50]. SAD is a subtype of depression where an individual may experience recurrent episodes of major depression around autumn and winter [51].

Major depression tends to occur more frequently among women than men, with up to 5.8% of women and 3.6% of men reporting depressive symptoms in Canada in 2012 [52]. Major depression is also most prevalent among young people aged 15-24, with up to 5% experiencing depressive symptoms in Canada in 2012 [49,52,53]. The prevalence of major depression was reported to be 4.7% among Canadians aged 15 years and over in 2012 [50].

2.3. *Prevalence and Incidence of Depression in Long-haul Truckers*

Studies on U.S., Brazilian, Italian, Iranian, Chinese, Australian and Canadian long-haul truckers have found the current prevalence of major depression to range between 9.2% to as high as 53.7% [18,47,54–58]. It should be noted that only one study on Chinese long-haul truck drivers has reported a prevalence of depression of 53.7%, and this prevalence was significantly higher than the prevalence of 9.2% to 26.9% found in most other studies (section 2.3.4 provides an explanation as to why this Chinese study may have recorded an above-average prevalence of depression) [18,47,54–58]. A recent study reported a prevalence of depressive symptoms of 44% among 107 Canadian long-haul truckers [59]. However, the authors only stated that 44% of the

sample showed symptoms of depression [59]; it is unclear if they mean that these truckers were actually depressed or if these were simply all the truckers which showed some—or any—signs of depression [59]. Further comments on this study are made in section 2.3.1. Only one other study has measured a prevalence of major depression in Canadian long-haul truckers and this was found to be 19% in 2012 [54].

The incidence of major depression among long-haul truck drivers is currently unknown [60]. However, one study by Thiese et al. (2015) has reported a statistically significant, positive increasing trend in the prevalence of psychiatric disorders (MHDs) among long-haul truck drivers across 48 U.S. states, for each year from 2005 to 2012 (Prevalence odds ratio in 2005, POR_{2005}, = 1.00 [referent], POR_{2006} = 1.05, 95% CI: 0.85-1.31; POR_{2007} = 1.31, 95% CI: 1.07-1.61…POR_{2012} = 2.12, 95% CI: 1.71-2.63; $p < .0001$) [61]. The prevalence of MHDs has nearly doubled from 2005 to 2012 among U.S. long-haul truck drivers (OR = 2.12, 95% CI: 1.71-2.63) [61]. Thiese et al. (2015) assessed unique truck drivers each year from 2005 to 2012 by only examining a driver's first commercial driver medical examination (CDME) record—if they had more than one entry—from an online database of CDMEs [61]. The CDME is a mandatory examination that must be done every two years for U.S. commercial drivers to maintain their licence [61]. A limitation of the results by Thiese et al. (2015) is that they do not specifically distinguish major depression from other MHD and thus, it is difficult to determine whether the incidence of depression among truckers is on the rise [61]. A second limitation is, Thiese et al. (2015) are only comparing prevalence numbers, thus, the increasing prevalence could be due to a combination of greater depression incidence, longer durations of depression illness or depression treatment and other factors [61,62]. Weinberger et al. (2018) have reported that, surprisingly, the incidence of depression in the U.S. population over time has not yet been determined [62]. The

cumulative incidence of depression in the Canadian population; however, was 12.1% from 1994 to 2010 [63]. Assuming that the incidence of depression has also increased in the U.S. general population, a positive trend in the prevalence of MHDs among U.S. long-haul truckers may be due to a combination of greater depression incidence, a greater incidence of non-depressive MHD and less frequent or prolonged cases of MHD treatment [61,62]. Ultimately, there is not enough information to draw any conclusions on the nature of the incidence of depression among U.S. long-haul truckers and in turn, translate this into information on Canadian truck drivers.

To the best of our knowledge, only one study has examined the risk for depression of truckers relative to non-truckers [46] and only one study has looked at increases (changes) in the prevalence of depression over time in long-haul truckers [61]. Overall, very few studies on depression in trucking are available, and depression is poorly understood among long-haul truck drivers. Section 2.4. will describe currently-known risk factors for depression among long-haul truck drivers. Sections 2.3.1 to 2.3.4 will critique current studies on the prevalence of depression among long-haul truckers.

2.3.1. U.S. and Canadian Studies on the Prevalence of Depression

Only two U.S. studies and two Canadian studies have examined the prevalence of major depression among long-haul truck drivers [18,46,59,64]. Fan et al. (2012) have reported the prevalence for major depression to be 14.6% in U.S. truck drivers while Shattell, Apostolopoulos, Collins, Sönmez and Fehrenbacher (2012) have reported the prevalence to be 26.9% among U.S. truck drivers [33,46]. It should be pointed out that Fan et al. (2012) had used online medical records from truck drivers throughout Washington State, U.S. [46]. In contrast, Shattell, Apostolopoulos, Collins, Sönmez and Fehrenbacher (2012) had recruited drivers from a 100-mile radius from a large truck stop in Greensboro, in North Carolina, U.S. [33]. Greensboro

also has a below-average household income relative to the rest of the U.S., while Washington state has an above-average household income [65]. Furthermore, the poverty level of Greensboro was 19.2% in 2017 while in Washington it was 11.0% [65]. Poverty and low family income are known predictors for depression [66]. Poverty and low family income thus, could have resulted in a higher prevalence of depression found by Shattell, Apostolopoulos, Collins, Sönmez and Fehrenbacher (2012) than Fan et al. (2012), though this is without controlling for confounders [33,46].

Bigelow et al. (2012) performed one of the two Canadian studies thus far which reported a prevalence of major depression among Canadian long-haul truck drivers [64]. The prevalence they recorded was 19% [64]. Two limitations of their study, however, are that i) they had only recruited participants from the Southwestern Ontario region and ii) they had used a fairly small sample size (N = 107) [64]. These limitations may reduce the generalisability of their results for all truckers in Canada. A second study was recently done by Crizzle, McLean and Malkin (2020) on 107 Canadian long-haul truck drivers in Alberta and Saskatchewan [59]. The authors reported that 44% of the sample had symptoms of depression [59]. However, their study may have had some methodological issues (see Section 2.4.1.). Thus, their results should be interpreted with caution.

2.3.2. Brazilian and Italian Studies on the Prevalence of Depression in Truck Drivers

One Brazilian and one Italian study investigated the prevalence of depression in long-haul truck drivers. Da Silva-Júnior, de Pindo, de Mello, VM de Bruin and PFD de Bruin (2009) have reported the prevalence of depression to be 13.6% among Brazilian truckers [47]. It should be pointed out that the general population of Brazil has a lower prevalence of depression overall (3.9%) than Canada (4.7%) and the U.S. (6.0-8.1%) [62,67,68]. Thus, fewer truck drivers could

have had depression in their study simply due to a lower prevalence of depression overall, among the Brazilian population. This lower prevalence could be due to a lack of mental health testing, treatment, and awareness in Brazil, as well as fewer mental health facilities (and a lack of resources) to record cases of MHD in rural and low-income areas of Brazil when compared to Canada and the U.S [69].

Garbarino et al. (2017) have reported the prevalence of depression to be 9.2% among Italian truck drivers. One serious concern of their study is that they do not indicate how, or what instrument they had used to measure and determine "depression" in their participants [70]. Thus, their measurements of depression may not have been valid, and thus, may have lacked accuracy.

2.3.3. Iranian Studies on the Prevalence of Depression in Truck Drivers

One Iranian study reported the prevalence of major depression to be 14.8% among Iranian truck drivers [55]. However, it is unclear if the study is referring to all truck drivers in general (e.g., including short haul truckers) or specifically long-haul truck drivers. Another caveat is that most of the study's text—including its methods—is in Persian, thus any further information on the study is very limited [55].

A second Iranian study has examined the severity of depressive symptoms in truck drivers. The study was a case-control design, and looked at the prevalence of depression between truckers who drove with a co-driver (acquaintance or co-worker; "cases") versus alone ("controls") [71]. However, the authors did not measure major depression, and instead, grouped the severity of depressive symptoms into "unlikely", "minor", "moderate" and "severe" categories based on the Goldberg Depression Inventory [71]. Depression was also only measured in co-driver (cases) and solo driver (controls) groups separately, thus, any data on the prevalence

of depression among the entire sample (all the truckers altogether, without dividing them into groups) is unknown.

2.3.4. Chinese and Australian Studies on the Prevalence of Depression in Truck Drivers

One study by Shen et al. (2013) examined the prevalence of depression among 441 commercial truck drivers in China [58]. Shen et al. (2013) used the Self-rating Depression Scale (SDS) to measure depression, which consists of 20 items each scored on a four-point Likert scale with an overall range of 20 to 80 summed points [72]. A cut-off of 50 points is generally used to indicate the presence of major depression [72,73]. However, Dunstan and Scott (2019) report that some Chinese studies have used an older cut-off of 42 points [73].

The prevalence of depression that Shen et al. (2013) found was 53.7% [58]. However, it is unclear which cut-off point the authors had used and thus, whether their measurement of depression may have lacked specificity. It is also unclear where and how participants had been recruited and only individuals aged 17 to 35 were recruited, with no rationale [58]. Truck drivers who are aged 45 or older, however, have been found to have a lower odds of depression (OR = 0.19, 95% CI: 0.04-0.78) when compared to those aged 18-29 [47]. Young adults, in fact, exhibit an above-average prevalence of depression when compared to the general population [52]. Sampling only young drivers could have thus, resulted in a higher prevalence of depression. The study, and results of Shen et al. (2013) should ultimately, be interpreted with caution.

A second study from China reported a prevalence of depression of 14.5% [74]. This study involved 193 cross-border truck drivers in China and Hong Kong [74]. However, non-standardized measurement tools were used for most, if not all of the study's questionnaire, and the validity and reliability of the tools—and the overall questionnaire—were not reported [74].

Rice, Aucote, Eleftheriadis and Möller-Leimkühler (2018) and Hilton, Staddon, Sheridan and Whiteford (2009) have reported the prevalence of major depression to be 22.0% and 13.3%, respectively, among Australian truck drivers [56,75]. However, some criticisms are that Rice, Aucote, Eleftheriadis and Möller-Leimkühler (2018) had a fairly small sample size (N = 91) [56]. Their study also lacked demographic information on its participants. Hilton, Staddon, Sheridan and Whiteford (2009) had a response rate of 35.9%, which raises the possibility for response bias [75].

2.4. *Significant Risk Factors for Depression in Long-haul Truck Drivers*

2.4.1. Recent Research on the Factors Associated with Depression

Few studies have been done on the determinants for depression in long-haul truck drivers. Crizzle, McLean, and Malkin (2020), however, recently conducted a case-control study on 107 Canadian truckers which looked at several factors related to the trucker themselves and their environment [59]. They then determined what association these factors had with symptoms of depression. The authors found that only severe job-related stress (unstandardized b = 1.329, 95% CI: 1.031, 13.845), psychiatric medication use (unstandardized b = 2.794, 95% CI: 1.232, 216.817), and broken sleep had statistically significant associations with depressive symptoms (unstandardized b = 1.639, 95% CI: 1.345, 19.711). This was despite testing a long list of other factors (e.g., age, income, education, marijuana use, alcohol consumption, self-reported general health, sleep apnea, frequency of drowsiness while driving, number of weeks worked per year, fatigue), some of which, have been previously associated with depression, in either truckers themselves or the general public (refer to Sections 2.4.2. to 2.4.6. for these exact factors) [59]. It is worth pointing out, however, that Crizzle, McLean, and Malkin (2020) did not indicate what tool was used to measure their outcome, its cut-off point, or how many (or which) symptoms of

depression they were looking at [59]. Thus, without further information, it is hard to say what outcome, exactly, was being modeled against these variables. Crizzle, McLean, and Malkin (2020) also dichotomized their outcome, which increases the risk for misclassification. This could have biased some of their associations towards the null (resulting in a type II error). Few truckers in their case/control categories (due to dichotomizing their outcome), sparse truckers in some categories, and a small sample size could have also increased the risk of having a type II error. Ultimately, their findings should be interpreted with caution, as it is possible that some of the variables they tested (but which lacked an association with their outcome) could have truly had an association with symptoms of depression in truckers.

2.4.2. Young Age and Low Driving Experience

Those aged 45 and older have been found to be significantly less likely to be depressed than younger truck drivers (OR = 0.19, 95% CI: 0.04-0.78) [47]. Age was not associated with depressive symptoms in the study by Crizzle, McLean, and Malkin (2020), though their study should also be interpreted with caution, as noted in Section 2.4.1. Younger truck drivers may be at a greater risk for depression due to having less trucking experience than their older counterparts [17,33,58]. In particular, driving experience of less than a year has been shown to be positively associated with depression in Chinese truck drivers, as truckers with three to four years of driving experience have lower SDS scores (M = 51.06, SD = 12.61) than those with less than one year (M = 56.37, SD = 10.81), $p < .05$ [58]. Similarly, truckers with more than seven years of driving experience have lower SDS scores (M = 50.21, SD = 11.68) than those with less than one year ($p < .05$) [58].

Young, or inexperienced truck drivers can be at a greater risk for depression as they may be unprepared for road hazards and physical injury, or be unprepared for coping with violence

and crime [18]. These factors may put young drivers at a greater risk for mental stress than older drivers [18]. In addition, young or new truck drivers may have had less driver training, such as a lack of crash avoidance techniques and defensive driving training relative to veteran truck drivers [76]. A lack of training on these materials may put young and inexperienced truck drivers at a greater risk for experiencing roadway accidents, "close call" crashes, injury, and ultimately, stress at work [76]. High occupational stress has been positively associated with depression in non-trucking samples of working men [18,33,47].

2.4.3. Low Educational Attainment

Truck drivers with *less* than a high school education are more likely to be depressed (OR = 3.03, 95% CI: 1.29-7.11) than those with a high school education or more [47]. Furthermore, truck drivers with a high school education have been found to be more likely to be depressed (SDS score, M = 53.41, SD = 11.67) than those with a college education (SDS score, M = 52.86, SD = 10.58), though this effect was not statistically significant [58]. Crizzle, McLean, and Malkin (2020) did not find an association between any level of education (e.g., less than high school versus completed high school; less than high school versus completed post-secondary) and depressive symptoms in truckers, though their study also some methodological issues (see Section 2.4.1.) [59]. Regardless, lower levels of formal education have been positively associated with a risk for depression in several other groups of individuals, inclusive of general working men, minority women and the general population [33,47,77]. Truck drivers with less formal education may be at a greater risk for depression due to difficulties in accessing information and resources which promote health [78,79]. Winkleby, Jatulis, Frank and Fortmann (1992) conducted a cross-sectional study on 2380 U.S. adults of the general population to investigate the association between three key aspects of socioeconomic status (education, income and

occupation) and the occurrence of various cardiovascular disease risk factors (e.g., cigarette smoking, high blood pressure, high blood cholesterol, etc.) [79]. Education was found to be the only factor which had a statistically significant, negative association with multiple cardiovascular risk factors after controlling for age—and the time of their survey—among U.S. adults [79].

2.4.4. Use of Stimulants

The use of stimulants (such as cocaine, methamphetamine and amphetamine) has been associated with a greater odds of being depressed in long-haul truck drivers when compared to non-use (OR = 5.03, 95% CI: 2.26-11.18) [47]. One U.S. study reported that 9.5% of long-haul truck drivers tested positive for non-caffeinated stimulants during a field sobriety test, though this number is likely higher because 19% of the drivers had refused to be tested [80]. In a second U.S. study, 13% of the long-haul truck drivers reported using cocaine between once a day, to once per month [18]. Many long-haul truck drivers have reported that the use of stimulants—for suppressing sleep and fatigue—is common in their industry [18,80,81].

It is unclear why the use of stimulants is positively associated with depression, but a likely mechanism is that using stimulants increases the risk for sleeplessness (insomnia), which then increases the risk for depression [57,82]. Indeed, research between the 1970s and 1990s had found that regularly consuming caffeine throughout the day, for several days, could in fact, be used to mimic chronic insomnia in humans [83]. Though some studies have reported the causal relationship between insomnia and depression to be bidirectional (in that some depressed individuals develop insomnia), clinical research and cohort studies of up to 40 years have shown that insomnia actually precedes depression [57,82,84,85]. One meta-analysis of 34 cohort studies found that insomniacs have a much greater risk of developing future depression (pooled RR = 2.27, 95% CI: 1.89-2.71) than non-insomniacs, over a mean of five years [85]. Note, however,

that even though coffee and most teas (e.g., black and green) contain caffeine, both substances have generally *not* been positively associated with depression in the general public (when compared to non-drinking), (RR = 0.76, 95% CI: 0.64-0.91 and RR = 0.70, 95% CI: 0.48-1.01, respectively) [86].

2.4.5. Company Employment

Company-employed truck drivers have a significantly greater odds of being depressed (OR = 2.84, 95% CI: 1.23-6.59) than self-employed truck drivers [47]. Company-employed truck drivers may have a greater risk of depression due to having less freedom, less self-determination, poor control over their work hours and stricter deadlines than self-employed drivers [3,18]. Studies have found that excessive job demands, irregular and long work hours and little control over one's own work can increase the risk for mental distress among general workers [18]. Crizzle, McLean, and Malkin (2020) did not find that type of trucker (company employee, owner-operator leased to carrier, owner-operator who owns own truck) was positively associated with depressive symptoms, though their findings should also be interpreted with caution (refer to Section 2.4.1.) [59].

2.4.6. Other Risk Factors for Depression

Certain, common occupational hazards of trucking have been found to be significant risk factors for depression, though much of this research was done on samples of non-trucking individuals. Social isolation, for instance, has been found to increase the risk for depression and other MHDs in several studies and systematic reviews involving non-truck drivers [34,87,88]. Living alone has been found to be positively associated with thoughts of suicide and suicidal attempts, in a literature review of 40 observational studies on the general population [37]. Marital status (single, separated, divorced or widowed), in particular, has been found to have a

significant effect on the risk of suicide among men [89]. Divorced men have over two-fold risk of committing suicide than married men (RR = 2.38, 95% CI: 1.77-3.20) [89]. Suicide, suicidal ideation and attempts of suicide are often severe symptoms of clinical depression [89].

Exposures to violence and harassment, such as through assault, incarceration, theft and racism, are also likely risk factors for depression in long-haul truck drivers. Though no study has examined the association between violence and depression in truck drivers, ample research has shown that being exposed to violence and trauma—such as abuse—is a strong risk factor for future depression [49]. Montesó-Curto et al. (2016) found that men and women with any prior exposure to violence (regardless of whether it was physical, psychological, verbal or sexual; and regardless of whether it was at work or at home) have a significantly greater risk for depression than those who have never experienced violence (OR = 7.93, 95% CI: 3.34-18.86) [90]. Violence is positively associated with experiencing post-traumatic stress disorder, insomnia and low self-esteem, the latter three conditions of which, are known to increase the risk for depression [90].

Poor sleep quality—in terms of not only insomnia, but also high frequencies of disturbed sleep, for instance—has also been associated with a greater risk of depression in several studies [57,84,91]. One study on 1,394 U.S. farmers found that poor sleep quality, according to the Pittsburg Sleep Quality Index, was significantly associated with higher Center for Epidemiologic Studies Depression Scale (CES-D) scores (unstandardized b = 3.589, SE = 0.350; $p < .001$) [91]. Higher CES-D scores indicate a greater frequency of depressive symptoms [92]. Garbarino et al. (2018) have found that poor sleep quality among long-haul truck drivers is associated with a greater risk for psychological distress (OR = 2.56, 95% CI: 1.55-4.23) than those with good sleep quality [57]. Psychological distress is a known risk factor for depression [33,49]. Crizzle, McLean, and Malkin (2020) also found that broken sleep (poor sleep quality) was associated

with more depressive symptoms in truckers, even after controlling for a few other factors (e.g., severe job-related stress, fatigue, use of psychiatric medication), although their study also had some concerns (Section 2.4.1.) [59].

High job-related stress has been positively associated with depression in non-trucking samples of working men [18,33,47]. According to Shattell, Apostolopoulos, Sönmez and Griffin (2010), common work-related stressors for long-haul truckers include: tight time and delivery pressures, being away from home (family and friends), poor sleep, poor driving conditions (weather, crashes, construction), road rage, poor driving behaviours from the general public (whose vehicles are referred to as "four-wheelers"), violence (such as being assaulted or mugged) and harassment while on the job, among others [18]. Time pressures, in particular, have been reported as a common stressor in trucking [18]. Though the effect that each of these work stressors have on the risk of depression is unknown among long-haul truckers, high job strain (wherein one feels excessive job demands and poor job control) has been found to increase the risk for depression among working adults of the general population (RR = 1.77, 95% CI: 1.47-2.13) [93]. Crizzle, McLean, and Malkin (2020) similarly found that severe job-related stress was associated with more depressive symptoms (Section 2.4.1.) [59].

Fatigue is commonly recognized as a symptom of depression [48,94]. However, some research has suggested that fatigue may also be an independent risk factor for depression, as Addington, Gallo, Ford and Eaton (2001) found that those with unexplained fatigue have a much greater risk of developing depression than those with no fatigue, over a 13-year period (RR = 28.4, 95% CI: 11.7-68.0) [94]. Many long-haul truck drivers have also reported using stimulants to relieve symptoms of fatigue [18,80,81]. The use of stimulants is a known risk factor for insomnia [83]. Insomnia can then, increase the risk for depression, as previously stated. Crizzle,

McLean, and Malkin (2020) did not find that fatigue was associated with depressive symptoms, though this could have been due to several potential issues (see Section 2.4.1.) [59].

Females are at a greater risk for depression than men (OR = 1.95, 95% CI: 1.88-2.03) [95]. Females also experience a higher number of depressive symptoms than men (Cohen's *d* = 0.27, 95% CI: 0.26=0.29) [95]. It is unclear why women are at a greater risk for depression. But research has indicated that this increased risk (for depression) among women may be due to a combination of biology (neurodevelopmental and hormonal differences), income inequality, gender inequality and violence [95]. Crizzle, McLean, and Malkin (2020) did not find that female sex was associated with depressive symptoms in truckers, though only four out of 107 of the truckers were female (4.4%), thus they may have lacked power [59].

Recent immigrants may also have a higher risk of depression [96,97]. A study on Asian and Hispanic U.S. immigrants found that those who lived in the country for ten years or less had a higher risk of depression than those who had lived in the U.S. for longer [96]. Newer immigrants may have poorer English fluency skills, fewer employment opportunities, and have higher stress due to challenges in acculturation than those who have lived in the country for longer [96]. One's legal residency status may factor in with depression as well, in the sense that one's legal status may affect their access to employment opportunities or health services [96].

Poverty and low family income are known risk factors for depression [66]. Financial strain—such as the presence of monetary debt—has been positively associated with depression in non-trucking samples of working men, in particular [33]. One study on 2,937 adults from the Netherlands found that individuals with mild or severe financial strain had a higher odds of being depressed than those without financial strain (OR = 1.68, 95% CI: 1.35-2.09 and OR = 3.88, 95% CI: 2.58-5.81, respectively) [98]. Note that no financial strain was defined as "usually

having money left" at the end of the month [98]. Mild and severe financial strain were defined as having "just enough money to manage" at the end of the month, and having "not enough money to manage" at the end of the month, respectively [98].

The presence of other MHD (such as anxiety), poor physical ability or health (e.g., disability) and family history (genetics) have been associated with depression in studies involving the general public [49,99]. Cigarette smoking, alcohol use, the presence of chronic comorbidities (e.g., diabetes, hypertension), a history of accidents, income, and being paid minimum wage (as opposed to receiving above minimum wage) have *not* been significantly associated with depression in long-haul truck drivers, even after controlling for confounders such as age, education, and marital status, among other factors [47,59]. Crizzle, McLean, and Malkin (2020) found that neither marijuana use, nor low back pain, were associated with depressive symptoms in truckers after controlling for several potential confounders (e.g., severe job-related stress, fatigue, broken sleep, use of psychiatric medication; although their study's findings should also be interpreted with caution) [59]. Marijuana use, in general, is also not considered to be strongly associated with depression in the general public [100]. Although multiple studies on the general public have found that low back pain—which can result in chronic pain and disability—can be both a precursor and consequence of mild depression [101–103]. Low back pain afflicts approximately 60% of long-haul truck drivers [104].

There is mixed evidence as to whether obesity may be a risk factor of depression. One meta-analysis of eight cohort studies reported a pooled unadjusted OR of 1.57 (95% CI: 1.23-2.01) for an obese individual's risk of depression [105]. However, this pooled odds ratio does not adjust for any confounders. A five-year cohort study on over 7,000 British adults found that obesity increased the risk of depression in women only, but not men [106]. This was after

adjusting for confounders such as socioeconomic position at birth, socioeconomic position at current age, sex, sedentary behaviour, fruit consumption, and smoking [106,107]. Research on human genetics has revealed that the association between obesity and depression appears to be either due to reverse causality (depression leading to obesity) or due to residual confounding [108]: those who are depressed are at risk of becoming obese [108]. Alternatively, other confounders may explain the association between these two factors rather than obesity on its own [108]. The gene for obesity does not appear to be a risk factor for depression [108].

There is some evidence that diet and physical activity could have a protective effect on depression. Fruits and vegetables contain antioxidants, vitamins, nutrients and polyphenols [109]. These chemicals may have anti-inflammatory and neuroprotective effects which lead to improved mood and improved cognitive function [109]. All of these effects may, biologically, protect against the development of depression [109]. Physical activity, meanwhile, can help the body resist oxidative stress and hormonally-induced stress (i.e., cortisol) [110]. Physical activity may also help with brain function and enhance self-esteem [110]. Some of these factors may reduce one's risk of developing depression [110]. One study on Canadian truckers, however, did not find that diet and physical activity had any associations at all with depressive symptoms, although their findings should be interpreted with caution (Section 2.4.1.) [59].

There is mixed evidence as to whether climate could be associated with depression. One study in the Netherlands found that temperature and the daily duration of rainfall were not associated with depression, although they only controlled for the time of year and demographics [111]. Another study found that hotter temperatures (28ºC) relative to cooler ones (19.4ºC) were associated with more frequent hospitalizations due to MHDs [107]. Although the study did not control for any confounders, thus, there could have been other reasons why the MHD-related

hospitalizations became more frequent during hot weather (such as some people with MHDs going to the hospital for shelter during hot weather) [107]. A third study, however, found that people living in dwellings with low levels of light have a greater odds of depression, even after controlling for factors such as age, health, income, employment, and city (OR = 1.3, 95% CI: 1.1, 1.6) [112]. It is known that sunlight increases serotonin and reduces melatonin [113]. A dysregulation in these biochemicals may lead to the development of depression [113]. Low levels of light may also be causal of SAD [111]. Sunlight is furthermore, the biggest source of vitamin D for most adults and children, and vitamin D may be neuroprotective against depression [114]. Ultimately, there is some evidence that light might be associated with depression, however other climactic factors (i.e., weather, temperature) may not have a strong association with depression [41].

Finally, Crizzle, McLean and Malkin (2020) found that the use of psychiatric medication (within the past year) had a positive association with symptoms of depression, even after controlling for a few potential confounders such as poor sleep, fatigue, and severe job-related stress [59]. This was likely due to some truckers with depression using medication for their symptoms. Although their study, again, may have had some methodological issues (see Section 2.4.1.). Those with the most severe symptoms of depression (or symptoms of other MHD) would have also likely had an easier time remembering whether they had used psychiatric medication over the past year or not (recall bias) [59]. Their findings should thus, be interpreted with some level of caution.

It is worth knowing that several MHDs—such as bipolar disorder, anxiety disorders, obsessive-compulsive disorder, post-traumatic stress disorder, and schizophrenia—can be risk factors of depression [113–115]. It is, unfortunately, unclear how prevalent these MHDs are in

truckers but one study on 316 U.S. truckers reported that 14.5% of the sample had anxiety [34]. Meanwhile, 18.1% of U.S. adults are estimated to experience an anxiety disorder each year [116,117]. Anxiety has been found to be a risk factor for future depression in longitudinal studies of the general public, even after controlling for confounders such as sex, age, current place of residence, and current calendar year [118–120]. Although some caution should be given to these findings, as some of these studies measured anxiety in terms of trait anxiety (neuroticism), while others measured anxiety in terms of anyone with: generalized anxiety disorder, a phobia (including specific phobia, social phobia, and agoraphobia), obsessive-compulsive disorder, a panic disorder, and/or post-traumatic stress disorder [118,119]. There is some conflicting evidence regarding which of these conditions count as an anxiety disorder and which do not [118,121,122].

2.5. *Driving Duration as a Risk Factor for Depression*

2.5.1. Dangers of Long Driving Hours and the Creation of the Hours of Service

Many studies have examined the association between long durations of driving and the risk of crashing, and long durations of driving and sleep among long-haul truckers [16,115–117]. In particular, driving for eight to ten hours or more has been generally accepted as a significant risk factor for crashing [16]. Jones and Stein (1987) have found that long-haul truck drivers who drive for more than eight hours nonstop are more likely to end up in a crash (OR = 1.80, 95% CI: 1.01-3.22) than those who drive for zero to two hours nonstop [117]. Chen and Xie (2014) found that long-haul truckers who take one, two and three 15-minute to two-hour rest breaks during 11 hours of driving have a reduced odds of crashing by 68%, 83% and 85%, respectively (OR = 0.32, 95% CI: 0.21-0.48; OR = 0.17, 95% CI: 0.11-0.28; OR = 0.15, 95% CI: 0.10-0.22), compared to drivers who take no breaks at all [115]. Chen and Xie (2014) have furthermore,

observed that driving for 11 hours or more in total in one day—irrespective of the number or duration of rest breaks taken—is significantly associated with crashing overall, among long-haul truck drivers (OR = 4.51, 95% CI: 1.58-12.90) [115]. The results of these studies suggest that long periods of driving have a negative impact on the safety of long-haul truckers.

The results of Jones and Stein (1987) and Chen and Xie (2014) also support the research that those who drive for long periods of time—particularly without breaks or rest—are prone to developing fatigue [16,39,115,117–119]. Driving duration has been positively associated with both subjective and objective—in terms of slower median response times to random stimuli—measures of fatigue in long-haul truckers [120]. Similarly, in a survey on 1007 Australian long-haul truck drivers, 51.2% of the drivers felt fatigued after ten hours of driving while 75.1% felt fatigued after 14 hours of driving [119].

Longer durations of driving may also result in poor sleep quality in general, due to a combination of disrupted sleep, irregular sleep and sleep deprivation [36]. Driving duration has been found to have a positive association with falling asleep at the wheel (in terms of the frequency of incidents over the past 12 months) in commercial bus and truck drivers (OR = 1.14, 95% CI: 1.02-1.27) [121]. Similarly, working for over 12 hours each day as opposed to less than 12 has been associated with falling asleep at the wheel in U.S. truckers (OR = 2.13, 95% CI: 1.26-3.62) [122]. Though falling asleep at the wheel is commonly categorized as a safety hazard in trucking, it is also a common symptom of a driver having poor and insufficient sleep [122].

Regardless, early Hours of Service (HoS) regulations from 1938 to 1963-as set by the U.S. government-only allowed for eight hours of off-duty time each day for sleep [123]. It wasn't until 2004 that new HoS allowed longer off-duty time (10 hours) to reduce fatigue and encourage sleep in truckers [124]. This change sought to improve driver alertness, prevent safety

hazards (such as falling asleep at the wheel) and improve the safety of commercial drivers [123,124].

2.5.2. The Association between Driving Duration and Depression

To the best of my knowledge, no studies have yet examined the effect of long durations of driving, or long working hours, on the risk for depression (or even MHDs in general) among long-haul truck drivers. However, one systematic review of 36 studies has found that long work hours (defined as working 40 or more hours per week, or eight or more hours per day) were generally associated with a greater risk of depression among various working populations [125]. Another study has found that those who work for 12 or more hours per day are significantly more likely to be depressed than those who work for six to eight hours per day (OR = 1.49, 95% CI: 1.00-2.22) [126]. It should be noted that some studies have found that working more than 40 hours per week does not increase the risk of depression, particularly among men [125]. However, Nakata (2017) reports that this is likely due to some types of occupations having long work days but offering high job satisfaction [126]. It is expected that, given the high-stress environment and hazards of trucking, long-haul truck drivers would *not* experience high job satisfaction when working (driving) for long hours on the job, and thus, job satisfaction would not have a protective effect on the association between long work (driving) hours and their risk for depression.

2.5.3. Summary

Few studies have examined possible predictors for depression in long-haul truck drivers. Several studies in non-trucking populations have revealed that there may be multiple risk factors for depression (such as poor sleep, fatigue, and low back pain) in the long-haul trucking environment. Also unknown in the literature is the association between driving duration and

depression in long-haul truckers. A positive association is expected to exist given that many truck drivers have expressed low satisfaction with their jobs, and that working (driving) for longer periods of time would increase a driver's likelihood of being exposed to an occupational hazard or stressor (including violence, fatigue, and social isolation) at work. In addition, it is highly possible that long-haul truckers who drive for long periods of time may be more likely to be under financial strain (since remuneration often occurs by the distance travelled, or by the number of loads delivered). Financial strain is a known predictor for depression, as previously described in the literature [33]. Thus, longer durations of driving are expected to be positively associated with depression, due to the association with several risk factors for depression.

2.6. *References*

1. Gill V, Macdonald A. Understanding the truck driver supply and demand gap and its implications for the Canadian economy [Internet]. The Conference Board of Canada; 2013. Available from: http://www.drivershortage.ca/wp-content/uploads/2013/03/Understanding-the-Truck-Driver-Supply-and-Demand-Gap1.pdf

2. U.S. Census Bureau. America keeps on truckin' [Internet]. 2019 [cited 2019 Oct 4]. Available from: https://www.census.gov/library/stories/2019/06/america-keeps-on-trucking.html

3. Statistics Canada. Perspectives on labour and income: on the road again [Internet]. 2006 [cited 2019 May 11]. Available from: https://www150.statcan.gc.ca/n1/pub/75-001-x/10106/9061-eng.htm

4. Martins AJ, Martini LA, Moreno CRC. Prudent diet is associated with low sleepiness among short-haul truck drivers. Nutrition. 2019;63(Complete):61–8.

5. National Institute for Occupational Safety and Health. National survey of truck driver injury and health main questionnaire. U.S. Department of Health & Human Services; 2011.

6. Canada Revenue Agency. Truck drivers [Internet]. 2018 [cited 2019 May 13]. Available from: https://www.canada.ca/en/revenue-agency/services/tax/canada-pension-plan-cpp-employment-insurance-ei-rulings/cpp-ei-explained/truck-drivers.html

7. Federal Motor Carrier Safety Administration. Lesson 2: motor carrier identification [Internet]. n.d. [cited 2020 Jun 22]. Available from: https://ai.fmcsa.dot.gov/DataQuality/CrashCollectionTraining/lesson2/owner.html

8. U.S. Customs and Border Protection. How do I enter the United States as a commercial truck driver? [Internet]. 2003 [cited 2019 Jul 15]. Available from: https://www.cbp.gov/border-security/ports-entry/cargo-security/carriers/land-carriers/how

9. Federal Motor Carrier Safety Administration. Hours of Service requirements for cross-border drivers [Internet]. 2018 [cited 2019 Jul 15]. Available from: https://www.fmcsa.dot.gov/international-programs/hours-service-requirements-cross-border-drivers

10. BBradUMA. Companies that run 48 states, Canada, and Mexico [Internet]. TruckersReport.com. 2011 [cited 2019 Sep 8]. Available from: https://www.thetruckersreport.com/truckingindustryforum/threads/companies-that-run-48-states-canada-and-mexico.141231/

11. Federal Motor Carrier Safety Administration. Cross-border operating requirements for Mexico-domiciled motor carriers [Internet]. 2018 [cited 2019 Sep 8]. Available from: https://www.fmcsa.dot.gov/international-programs/cross-border-operating-requirements-mexico-domiciled-motor-carriers

12. Burks SV, Monaco K. Is the U.S. labor market for truck drivers broken? [Internet]. U.S. Bureau of Labor Statistics; 2019 [cited 2019 Oct 21]. Available from: https://www.bls.gov/opub/mlr/2019/article/is-the-us-labor-market-for-truck-drivers-broken.htm

13. Ontario Trucking Association. Mag: immigrants more than half of truck drivers in major cities [Internet]. 2018 [cited 2019 Oct 21]. Available from: http://ontruck.org/mag-immigrants-more-than-half-of-truck-drivers-in-major-cities/

14. Layne DM, Rogers B, Randolph SA. Health and gender comparisons in the long-haul trucking industry: a pilot study. AAOHN Journal. 2009 Oct 1;57(10):405–13.

15. Lembright MF, Riemer JW. Women truckers' problems and the impact of sponsorship. Work Occup. 1982 Nov 1;9(4):457–74.

16. McCartt AT, Hellinga LA, Solomon MG. Work schedules of long-distance truck drivers before and after 2004 Hours-of-Service rule change. Traffic Inj Prev. 2008;9(3):201–10.

17. Apostolopoulos Y, Sönmez S, Hege A, Lemke M. Work strain, social isolation and mental health of long-haul truckers. Occup Ther Ment Health. 2016 Jan 2;32(1):50–69.

18. Shattell M, Apostolopoulos Y, Sönmez S, Griffin M. Occupational stressors and the mental health of truckers. Issues Ment Health Nurs. 2010 Aug;31(9):561–8.

20. Belzer MH, Sedo SA. Why do long distance truck drivers work extremely long hours? Econ Labour Relat Rev. 2018 Mar 1;29(1):59–79.

21. Belman DL, Monaco KA, Brooks TJ. Sailors of the concrete sea: a portrait of truck drivers' work and lives. East Lansing: Michigan State University Press; 2004.

22. Roetting M, Huang Y-H, McDevitt JR, Melton D. When technology tells you how you drive—truck drivers' attitudes towards feedback by technology. Transp Res Part F Traffic Psychol Behav. 2003 Dec 1;6(4):275–87.

23. Chen GX, Sieber WK, Lincoln JE, Birdsey J, Hitchcock EM, Nakata A, et al. NIOSH national survey of long-haul truck drivers: injury and safety. Accid Anal Prev. 2015 Dec;85:66–72.

24. Federal Motor Carrier Safety Administration, U.S. Department of Transportation. FMCSA field HOS survey: motor carrier industry implementation and use of the April 2003 Hours of Service regulations. FMCSA, U.S. Department of Transportation.; 2005.

25. Government of Canada. Commercial vehicle drivers Hours of Service regulations [Internet]. 2009 [cited 2019 May 9]. Available from: https://laws-lois.justice.gc.ca/eng/regulations/SOR-2005-313/page-2.html#h-9

26. Government of Yukon. Driving commercial vehicles: a guide for professional drivers. In Whitehorse, Yukon; 2014 [cited 2019 May 9]. p. 129–40. Available from: https://yukon.ca/sites/yukon.ca/files/hpw-yukon-commercial-vehicle-handbook-web.pdf

27. Federal Motor Carrier Safety Administration. Interstate truck driver's guide to Hours of Service [Internet]. 2015 p. 27. Available from: https://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/Drivers%20Guide%20to%20HOS%202015_508.pdf

28. Government of Alberta. Module 7: federal Hours of Service regulations [Internet]. 2018. Available from: https://www.alberta.ca/assets/documents/tr-module-7-federal-hours-of-service-regulations.pdf

29. Contract Freighters, Inc. Pay and bonuses – CFI [Internet]. 2020 [cited 2020 Jun 23]. Available from: https://cfidrive.com/careers/drive-for-cfi/pay-and-bonuses/

30. Roadmaster Drivers School. How much money do truck drivers make? [Internet]. n.d. [cited 2020 Jun 23]. Available from: https://www.roadmaster.com/how-much-money-do-truck-drivers-make/

31. Cerrada CJ, Dzubur E, Blackman KCA, Mays V, Shoptaw S, Huh J. Development of a just-in-time adaptive intervention for smoking cessation among Korean American emerging adults. Int J Behav Med. 2017 Oct;24(5):665–72.

32. Hege A, Perko M, Johnson A, Yu CH, Sönmez S, Apostolopoulos Y. Surveying the impact of work hours and schedules on commercial motor vehicle driver sleep. Saf Health Work. 2015 Jun;6(2):104–13.

33. Shattell M, Apostolopoulos Y, Collins C, Sönmez S, Fehrenbacher C. Trucking organization and mental health disorders of truck drivers. Issues Ment Health Nurs. 2012 Jun 29;33(7):436–44.

34. Wang J, Lloyd-Evans B, Giacco D, Forsyth R, Nebo C, Mann F, et al. Social isolation in mental health: a conceptual and methodological review. Soc Psychiatry Psychiatr Epidemiol. 2017;52(12):1451–61.

35. Jensen A, Dahl S. Truck drivers Hours-of-Service regulations and occupational health. Work. 2009;33(3):363–8.

36. Mitler MM, Miller JC, Lipsitz JJ, Walsh JK, Wylie CD. The sleep of long-haul truck drivers. N Engl J Med. 1997 Sep 11;337(11):755–61.

37. Calati R, Ferrari C, Brittner M, Oasi O, Olié E, Carvalho AF, et al. Suicidal thoughts and behaviors and social isolation: a narrative review of the literature. J Affect Disord. 2019 15;245:653–67.

38. Truck Driver Institute. Can truck drivers bring their family and friends on the road? [Internet]. n.d. [cited 2020 Jul 18]. Available from: https://www.drivebigtrucks.com/can-truck-drivers-bring-their-family-and-friends-on-the-road/

39. Friswell R, Williamson A. Exploratory study of fatigue in light and short haul transport drivers in NSW, Australia. Accid Anal Prev. 2008 Jan;40(1):410–7.

40. Olson R, Wipfli B, Thompson SV, Elliot DL, Anger WK, Bodner T, et al. Weight control intervention for truck drivers: the SHIFT randomized controlled trial, United States. Am J Public Health. 2016 Sep;106(9):1698–706.

41. Government of Canada. Land and climate [Internet]. 2009 [cited 2020 Jul 4]. Available from: https://www.canada.ca/en/immigration-refugees-citizenship/services/new-immigrants/learn-about-canada/land-climate.html

42. de Jong S, Auping WL, Oosterveld WT, Usanov A, Abdalla M, van de Bovenkamp A. The geopolitical impact of climate mitigation policies [Internet]. The Hague Centre for Strategic Studies; 2017. Available from: https://hcss.nl/sites/default/files/files/reports/HCSS_Energytransition.pdf

43. Smart Trucking. A quick guide to the state of truck driving in Canada [Internet]. 2019 [cited 2020 Jul 1]. Available from: https://www.smart-trucking.com/truck-driving-in-canada/

44. Ministry of Transportation. Winter driving: be prepared, be safe! [Internet]. Government of Ontario; n.d. Available from: http://www.mto.gov.on.ca/english/ontario-511/pdfs/winter-safe-driving.pdf

45. Statistics Canada. Canadian demographics at a glance: provinces and regions [Internet]. n.d. [cited 2020 Jun 22]. Available from: https://www150.statcan.gc.ca/n1/pub/91-003-x/2007001/4129908-eng.htm

46. Fan ZJ, Bonauto DK, Foley MP, Anderson NJ, Yragui NL, Silverstein BA. Occupation and the prevalence of current depression and frequent mental distress, Washington Behavioral Risk Factor Surveillance System 2006 and 2008. Am J Ind Med. 2012 Oct;55(10):893–903.

47. da Silva-Júnior FP, de Pinho RSN, de Mello MT, de Bruin VMS, de Bruin PFC. Risk factors for depression in truck drivers. Soc Psychiatry Psychiatr Epidemiol. 2009 Feb;44(2):125–9.

48. Fried EI, Epskamp S, Nesse RM, Tuerlinckx F, Borsboom D. What are "good" depression symptoms? Comparing the centrality of DSM and non-DSM symptoms of depression in a network analysis. J Affect Disord. 2016;189(Complete):314–20.

49. Mood Disorders Society of Canada. What is depression? [Internet]. 2019. Available from: https://mdsc.ca/docs/MDSC_What_is_Depression.pdf

50. Public Health Agency of Canada. What is depression? [Internet]. 2009 [cited 2019 Jul 4]. Available from: https://www.canada.ca/en/public-health/services/chronic-diseases/mental-illness/what-depression.html

51. Winthorst WH, Roest AM, Bos EH, Meesters Y, Penninx BWJH, Nolen WA, et al. Seasonal affective disorder and non-seasonal affective disorders: results from the Netherlands Study of Depression and Anxiety study. BJPsych Open. 2017 Jul;3(4):196–203.

52. Statistics Canada. Mental and substance use disorders in Canada [Internet]. 2013 [cited 2019 Jul 4]. Available from: https://www150.statcan.gc.ca/n1/pub/82-624-x/2013001/article/11855-eng.htm

53. Patten SB, Wang JL, Williams JVA, Currie S, Beck CA, Maxwell CJ, et al. Descriptive epidemiology of major depression in Canada. Can J Psychiatry. 2006 Feb;51(2):84–90.

54. Bigelow P, Myers AM, Crizzle AM, Shubair M, Thiffault P. Health and wellness of commercial motor vehicle drivers in Canada: literature review, discussion and directions for further research [Internet]. Transport Canada; 2014. Available from: https://buyandsell.gc.ca/cds/public/2014/09/24/cf03ae960e86303a593693298995bcfc/final_tc_report_cmv_health_and_wellness.pdf

55. Vakili M, Farsani SE, Hossein SMH, Tafti MHD. Prevalence of depression and its related factors among truck drivers in Yazd Province -2008. Iran Occup Health. 2010;6(4):9.

56. Rice SM, Aucote HM, Eleftheriadis D, Möller-Leimkühler AM. Prevalence and co-occurrence of internalizing and externalizing depression symptoms in a community sample of Australian male truck drivers. Am J Mens Health. 2018 Jan;12(1):74–7.

57. Garbarino S, Guglielmi O, Sannita WG, Magnavita N, Lanteri P. Sleep and mental health in truck drivers: descriptive review of the current evidence and proposal of strategies for primary prevention. Int J Environ Res Public Health [Internet]. 2018 Sep [cited 2019 Mar 22];15(9). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6164547/

58. Shen S, Li Y, Zhou M, Zhang C, Jiang Y, Kang Y. Depression status and associated factors in Chinese occupational truck drivers. Cell Biochem Biophys. 2013;67(3):1497–500.

59. Crizzle AM, McLean M, Malkin J. Risk factors for depressive symptoms in long-haul truck drivers. Int J Environ Res Public Health [Internet]. 2020 Jun [cited 2020 Jul 13];17(11). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7312166/

60. Crizzle AM, Bigelow P, Adams D, Gooderham S, Myers AM, Thiffault P. Health and wellness of long-haul truck and bus drivers: a systematic literature review and directions for future research. J Transp Health. 2017 Dec;7:90–109.

61. Thiese MS, Moffitt GL, Hanowski RJ, Kales SN, Porter RJ, Hegmann KT. Repeated cross-sectional assessment of commercial truck driver health. J Occup Environ Med. 2015;57(9):1022–7.

62. Weinberger AH, Gbedemah M, Martinez AM, Nash D, Galea S, Goodwin RD. Trends in depression prevalence in the USA from 2005 to 2015: widening disparities in vulnerable groups. Psychol Med. 2018 Jun;48(8):1308–15.

63. Meng X, D'Arcy C. The projected effect of risk factor reduction on major depression incidence: a 16-year longitudinal Canadian cohort of the National Population Health Survey. J Affect Disord. 2014 Apr;158:56–61.

64. Bigelow PI, Betts D, Hogg-Johnson S, Amick BC, Sieber WK, Skinner M, et al. Health, safety, and wellness of truck drivers in Canada: results of a pilot study. Research on the Health and Wellness of Commercial Truck and Bus Drivers: Summary of an International Conference; 2012; Transportation Research Board, Washington, DC.

65. U.S. Census Bureau QuickFacts: United States; Washington; Greensboro city, North Carolina [Internet]. n.d. [cited 2019 Jul 2]. Available from: https://www.census.gov/quickfacts/fact/table/US,WA,greensborocitynorthcarolina/PST045218

66. Bøe T, Balaj M, Eikemo TA, McNamara CL, Solheim EF. Financial difficulties in childhood and adult depression in Europe. Eur J Public Health. 2017 Feb 1;27(suppl_1):96–101.

67. Barros MB de A, Lima MG, de Azevedo RCS, Medina LB de P, Lopes C de S, Menezes PR, et al. Depression and health behaviors in Brazilian adults – Pesquisa Nacional de Saúde 2013. Rev Saude Publica [Internet]. 2017 Jun 1 [cited 2019 Jul 4];51(Suppl 1). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5676399/

68. Brody DJ, Pratt LA, Hughes JP. Prevalence of depression among adults aged 20 and over: United States, 2013–2016 [Internet]. Centers for Disease Control and Prevention; 2018. Available from: https://www.cdc.gov/nchs/data/databriefs/db303.pdf

69. Lopes CS, Hellwig N, e Silva G de A, Menezes PR. Inequities in access to depression treatment: results of the Brazilian National Health Survey – Pesquisa Nacional de Saúde. Int J Equity Health [Internet]. 2016 Nov 17 [cited 2020 Jun 23];15. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5112732/

70. Garbarino S, Magnavita N, Guglielmi O, Maestri M, Dini G, Bersi FM, et al. Insomnia is associated with road accidents. Further evidence from a study on truck drivers. PLoS One [Internet]. 2017 Oct 31 [cited 2019 Jun 30];12(10). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5663450/

71. Hatami A, Vosoughi S, Hosseini AF, Ebrahimi H. Effect of co-driver on job content and depression of truck drivers. Saf Health Work. 2019 Mar;10(1):75–9.

72. WHO. The Zung Self-Rating Depression Scale [Internet]. n.d. [cited 2019 Jul 10]. Available from: https://www.who.int/substance_abuse/research_tools/zungdepressionscale/en/

73. Dunstan DA, Scott N. Clarification of the cut-off score for Zung's self-rating depression scale. BMC Psychiatry [Internet]. 2019 Jun 11 [cited 2019 Jul 5];19. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6558728/

74. Wong WCW, Tam SM, Leung PWS. Cross-border truck drivers in Hong Kong: their psychological health, sexual dysfunctions and sexual risk behaviors. J Travel Med. 2007 Jan 1;14(1):20–30.

75. Hilton MF, Staddon Z, Sheridan J, Whiteford HA. The impact of mental health symptoms on heavy goods vehicle drivers' performance. Accid Anal Prev. 2009;41(3):453–61.

76. Occupational Safety and Health Administration. Guidelines for employers to reduce motor vehicle crashes [Internet]. n.d. [cited 2019 Sep 11]. Available from: https://www.osha.gov/Publications/motor_vehicle_guide.html

77. De Oliveira G, Cianelli R, Gattamorta K, Kowalski N, Peragallo N. Social determinants of depression among Hispanic women. J Am Psychiatr Nurses Assoc. 2017 Feb;23(1):28–36.

78. Adler NE, Newman K. Socioeconomic disparities in health: pathways and policies. Health Aff. 2002 Mar;21(2):60–76.

79. Winkleby MA, Jatulis DE, Frank E, Fortmann SP. Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. Am J Public Health. 1992 Jun;82(6):816–20.

80. Couper FJ, Pemberton M, Jarvis A, Hughes M, Logan BK. Prevalence of drug use in commercial tractor-trailer drivers. J Forensic Sci. 2002 May;47(3):562–7.

81. Williamson A. Predictors of psychostimulant use by long-distance truck drivers. Am J Epidemiol. 2007 Dec 1;166(11):1320–6.

82. Baglioni C, Riemann D. Is chronic insomnia a precursor to major depression? Epidemiological and biological findings. Curr Psychiatry Rep. 2012 Oct;14(5):511–8.

83. Bonnet MH, Arand DL. Caffeine use as a model of acute and chronic insomnia. Sleep. 1992 Dec;15(6):526–36.

84. Khurshid KA. Comorbid insomnia and psychiatric disorders. Innov Clin Neurosci. 2018 Apr 1;15(3–4):28–32.

85. Li L, Wu C, Gan Y, Qu X, Lu Z. Insomnia and the risk of depression: a meta-analysis of prospective cohort studies. BMC Psychiatry. 2016 Nov 5;16(1):375.

86. Grosso G, Micek A, Castellano S, Pajak A, Galvano F. Coffee, tea, caffeine and risk of depression: a systematic review and dose-response meta-analysis of observational studies. Mol Nutr Food Res. 2016 Jan;60(1):223–34.

87. Leigh-Hunt N, Bagguley D, Bash K, Turner V, Turnbull S, Valtorta N, et al. An overview of systematic reviews on the public health consequences of social isolation and loneliness. Public Health. 2017;152(Complete):157–71.

88. Cacioppo JT, Hughes ME, Waite LJ, Hawkley LC, Thisted RA. Loneliness as a specific risk factor for depressive symptoms: cross-sectional and longitudinal analyses. Psychol Aging. 2006;21(1):140–51.

89. Kposowa A. Marital status and suicide in the National Longitudinal Mortality Study. J Epidemiol Community Health. 2000 Apr;54(4):254–61.

90. Montesó-Curto P, Aguilar C, Lejeune M, Casadó-Marin L, Casanova Garrigós G, Ferré-Grau C. Violence and depression in a community sample. J Clin Nurs. 2017 Aug;26(15–16):2392–8.

91. Hawes NJ, Wiggins AT, Reed DB, Hardin-Fanning F. Poor sleep quality is associated with obesity and depression in farmers. Public Health Nurs. 2019 May;36(3):270–5.

92. Andresen EM, Byers K, Friary J, Kosloski K, Montgomery R. Performance of the 10-item Center for Epidemiologic Studies Depression scale for caregiving research. SAGE Open Med [Internet]. 2013 Dec 2 [cited 2019 Apr 30];1. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4687763/

93. Madsen IEH, Nyberg ST, Magnusson Hanson LL, Ferrie JE, Ahola K, Alfredsson L, et al. Job strain as a risk factor for clinical depression: systematic review and meta-analysis with additional individual participant data. Psychol Med. 2017 Jun;47(8):1342–56.

94. Addington AM, Gallo JJ, Ford DE, Eaton WW. Epidemiology of unexplained fatigue and major depression in the community: the Baltimore ECA follow-up, 1981-1994. Psychol Med. 2001 Aug;31(6):1037–44.

95. Salk RH, Hyde JS, Abramson LY. Gender differences in depression in representative national samples: meta-analyses of diagnoses and symptoms. Psychol Bull. 2017 Aug;143(8):783–822.

96. Singh S, Schulz AJ, Neighbors HW, Griffith DM. Interactive effect of immigration-related factors with legal and discrimination acculturative stress in predicting depression among Asian American immigrants. Community Ment Health J. 2017 Aug;53(6):638–46.

97. Foo SQ, Tam WW, Ho CS, Tran BX, Nguyen LH, McIntyre RS, et al. Prevalence of depression among migrants: a systematic review and meta-analysis. Int J Environ Res Public Health. 2018 12;15(9).

98. Dijkstra-Kersten SMA, Biesheuvel-Leliefeld KEM, van der Wouden JC, Penninx BWJH, van Marwijk HWJ. Associations of financial strain and income with depressive and anxiety disorders. J Epidemiol Community Health. 2015 Jul;69(7):660–5.

99. Lewinsohn PM, Roberts RE, Seeley JR, Rohde P, Gotlib IH, Hops H. Adolescent psychopathology: II. psychosocial risk factors for depression. J Abnorm Psychol. 1994;103(2):302–15.

100. Konefal S, Gabrys R, Porath A. Clearing the smoke on cannabis: regular use and mental health [Internet]. Canadian Centre on Substance Use and Addiction; 2019. Available from: https://www.ccsa.ca/clearing-smoke-cannabis-regular-use-and-mental-health

101. Konietzny K, Chehadi O, Streitlein-Böhme I, Rusche H, Willburger R, Hasenbring MI. Mild depression in low back pain: the interaction of thought suppression and stress plays a role, especially in female patients. Int J Behav Med. 2018 Apr;25(2):207–14.

102. Pinheiro MB, Ferreira ML, Refshauge K, Ordoñana JR, Machado GC, Prado LR, et al. Symptoms of depression and risk of new episodes of low back pain: a systematic review and meta-analysis. Arthritis Care Res. 2015;67(11):1591–603.

103. Fernandez M, Colodro-Conde L, Hartvigsen J, Ferreira ML, Refshauge KM, Pinheiro MB, et al. Chronic low back pain and the risk of depression or anxiety symptoms: insights from a longitudinal twin study. Spine J. 2017 Jul;17(7):905–12.

104. Andrusaitis SF, Oliveira RP, Barros Filho TEP. Study of the prevalence and risk factors for low back pain in truck drivers in the state of São Paulo, Brazil. Clinics (Sao Paulo). 2006 Dec;61(6):503–10.

105. Luppino FS, Wit LM de, Bouvy PF, Stijnen T, Cuijpers P, Penninx BWJH, et al. Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. Arch Gen Psychiatry. 2010 Mar 1;67(3):220–9.

106. Mulugeta A, Zhou A, Power C, Hyppönen E. Obesity and depressive symptoms in mid-life: a population-based cohort study. BMC Psychiatry [Internet]. 2018 Dec [cited 2020 Jul 13];18(1). Available from: https://bmcpsychiatry.biomedcentral.com/articles/10.1186/s12888-018-1877-6

107. Chan EYY, Lam HCY, So SHW, Goggins WB, Ho JY, Liu S, et al. Association between ambient temperatures and mental disorder hospitalizations in a subtropical city: a time-series study of Hong Kong special administrative region. Int J Environ Res Public Health [Internet]. 2018 Apr [cited 2020 Jul 19];15(4). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5923796/

108. Hung C-F, Rivera M, Craddock N, Owen MJ, Gill M, Korszun A, et al. Relationship between obesity and the risk of clinically significant depression: Mendelian randomisation study. Br J Psychiatry. 2014 Jul;205(1):24–8.

109. Firth J, Marx W, Dash S, Carney R, Teasdale SB, Solmi M, et al. The effects of dietary improvement on symptoms of depression and anxiety: a meta-analysis of randomized controlled trials. Psychosom Med. 2019 Apr;81(3):265–80.

110. Kandola A, Ashdown-Franks G, Hendrikse J, Sabiston CM, Stubbs B. Physical activity and depression: towards understanding the antidepressant mechanisms of physical activity. Neurosci Biobehav Rev. 2019 Dec 1;107:525–39.

111. Huibers MJH, de Graaf LE, Peeters FPML, Arntz A. Does the weather make us sad? Meteorological determinants of mood and depression in the general population. Psychiatry Res. 2010 Dec 30;180(2):143–6.

112. Brown MJ, Jacobs DE. Residential light and risk for depression and falls: results from the LARES study of eight European cities. Public Health Rep. 2011;126(Suppl 1):131–40.

113. Kent ST, McClure LA, Crosson WL, Arnett DK, Wadley VG, Sathiakumar N. Effect of sunlight exposure on cognitive function among depressed and non-depressed participants: a REGARDS cross-sectional study. Environ Health. 2009 Jul 28;8:34.

114. Nair R, Maseeh A. Vitamin D: the "sunshine" vitamin. J Pharmacol Pharmacother. 2012;3(2):118–26.

115. Chen C, Xie Y. Modeling the safety impacts of driving hours and rest breaks on truck drivers considering time-dependent covariates. J Safety Res. 2014 Dec;51:57–63.

116. Braver ER, Preusser CW, Preusser DF, Baum HM, Beilock R, Ulmer R. Long hours and fatigue: a survey of tractor-trailer drivers. J Public Health Policy. 1992;13(3):341–66.

117. Jones IS, Stein HS. Effect of driver Hours of Service on tractor-trailer crash involvement [Internet]. Arlington, VA: Insurance Institute for Highway Safety; 1987 p. 34. Available from: http://184.2.141.40/frontend/iihs/documents/masterfiledocs.ashx?id=355

118. Société de l'assurance automobile du Québec. Driver fatigue: fatigue management guide. [Internet]. Québec: Gouvernement du Québec; 2011. Available from: https://saaq.gouv.qc.ca/fileadmin/documents/publications/driver-fatigue-guide.pdf

119. Williamson A, Feyer A-M, Friswell R, Sadural S. Driver fatigue: a survey of long distance heavy vehicle drivers in Australia [Internet]. 2001. Available from: https://www.infrastructure.gov.au/roads/safety/publications/2001/pdf/Fatig_Trans_6.pdf

120. Wylie C, Shultz T, Miller J, Mitler M, Mackie R. Commercial motor vehicle driver fatigue and alertness study: technical summary [Internet]. Transport Canada; 1996. Available from: https://rosap.ntl.bts.gov/view/dot/2212

121. Rosso GL, Perotto M, Feola M, Caramella M. Falling asleep at the wheel among Italian professional drivers (PDs): results from the HiRis PD study. Int J Occup Med Environ Health. 2014 Dec;27(6):1005–12.

122. Heaton K, Browning S, Anderson D. Identifying variables that predict falling asleep at the wheel among long-haul truck drivers. AAOHN journal. 2008 Oct 1;56:379–85.

123. Panel on Research Methodologies and Statistical Approaches to Understanding Driver Fatigue Factors in Motor Carrier Safety and Driver Health, Committee on National Statistics, Board on Human-Systems Integration, Division of Behavioral and Social Sciences and Education, Transportation Research Board, National Academies of Sciences, Engineering, and Medicine. Hours-of-Service regulations [Internet]. National Academies Press (US); 2016 [cited 2019 Jul 13]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK384967/

124. Hanowski RJ, Hickman J, Fumero MC, Olson RL, Dingus TA. The sleep of commercial vehicle drivers under the 2003 Hours-of-Service regulations. Accid Anal Prev. 2007 Nov;39(6):1140–5.

125. Bannai A, Tamakoshi A. The association between long working hours and health: a systematic review of epidemiological evidence. Scand J Work Environ Health. 2014 Jan;40(1):5–18.

126. Nakata A. Long working hours, job satisfaction, and depressive symptoms: a community-based cross-sectional study among Japanese employees in small- and medium-scale businesses. Oncotarget. 2017 May 23;8(32):53041–52.

Chapter 3: Summary of Thesis

3.1. *Justification for the Study*

Chapter Two identified several possible risk factors for depression in non-trucking populations. These included: poor sleep, fatigue, legal residency status, low back pain and financial strain. However, many of these factors, to the best of our knowledge, have not yet been tested for their association (if present) with depression in long-haul truck drivers. Da Silva-Júnior, de Pindo, de Mello, VM de Bruin and PFD de Bruin (2009) in particular, did not test these variables in their study of Brazilian truck drivers. A recent study by Crizzle, McLean and Malkin (2020) did test many of these factors for their associations with (symptoms of) depression in long-haul truckers. However, their study had several methodological concerns, as mentioned in Section 2.4.1. They also did not test some of the other possible risk factors of depression which were previously mentioned in the literature: legal residency status, being a recent immigrant, financial strain, stimulant use, and violence at work (or outside of work).

We believe that we can improve upon these studies by examining other factors (which these studies did not test) for their association with depression in long-haul truck drivers. We can also improve upon these studies by selecting a more valid and reliable measure of their outcome (depression). We recruited both Canadian and U.S. truck drivers which allows us to uniquely assess whether a trucker's country of work could be associated with depression. To the best of our knowledge, country of work has not yet been examined for its association with depression in truckers. This thesis will thus determine if several new variables from the literature could be associated with depression in long-haul truckers, while also improving upon previous studies' methodologies.

The nature of the association (if present) between driving duration and depression in long-haul truck drivers is also—to the best of our knowledge—unknown. Long durations of driving, however, are associated with many negative health effects [1–6]. Long durations of driving may also increase the risk for fatigue, increase the time a trucker spends in social isolation, and increase the risk of encountering a stressor at work, such as violence, among several possible hazards. We will thus determine the association (if present) between driving duration and depression and address this gap in the literature.

We will lastly determine if a trucker's working country modifies the association between driving duration and depression. Dangerous road conditions (e.g., ice, snow) leading to lower job satisfaction, fewer hours of annual sunlight, and the sparser population of Canada (leading to greater social isolation and fewer truck stops at work) could result in a stronger association between driving duration and depression among truckers in Canada. Whether working country could interact in the relationship between driving duration and depression, however, is currently unknown in the literature.

3.2. *Objectives*

3.2.1. Primary Objective

The primary objective of this study is to determine the factors associated with depression in long-haul truck drivers.

3.2.2. Secondary Objective

The secondary objective of this study is to determine the association between driving duration and depression among long-haul truck drivers.

3.2.3. Tertiary Objective

The tertiary objective of this study is to determine the moderating effect of a long-haul trucker's working country (Canada or the U.S.) on the association between driving duration and depression. Note that the truck driver's primary country of residence is not being assessed as the moderating factor, as a Canadian truck driver could be working in the U.S., or working between both countries, for instance [7].

3.3. *Hypotheses*

We hypothesize that all of the possible risk factors for depression which are investigated in this thesis will be significantly associated with depression. We hypothesize that longer durations of driving will have a positive association with depression in truck drivers. For our tertiary objective, we hypothesize that working in Canada will lead to a more positive association between driving duration and depression than working in the U.S.

3.4. *Approach to Thesis*

This thesis will follow a manuscript-style approach to present the results of this research project. The findings, and any conclusions drawn from this thesis, aim to be disseminated in journal publications. Chapter Two of this thesis featured a comprehensive literature review. Chapters Four and Five will consist of separate manuscripts which each address the research objectives of this study. Specifically, the primary objective will be addressed in Chapter Four.

Chapter Five will address the secondary and tertiary objectives. This chapter will investigate the association between driving duration and depression as well as the modifying effect of a trucker's country of work in this association. Chapters Four and Five will each include an abstract, background, methods, results, discussion, and conclusion section as part of the

manuscript. Chapter Six of this thesis will feature a general overall discussion of our research findings and the implications of our results from chapters Four and Five.

3.5. *Overview of Contents of Thesis*

The literature review of Chapter Two included information on the working conditions-including maximum driving duration limits, types of long-haul truck drivers (e.g., company versus self-employed), and method of renumeration-of long-haul truck drivers. Also featured in this chapter was a review of several currently known, significant predictors of depression in both truckers and non-truckers. The current chapter presents an overview of the thesis and its objectives. The next two chapters (Four and Five) address the research objectives of this thesis. Chapter Six includes a discussion of the overall findings of this thesis. Chapter Seven presents the ethical considerations of the study. The strengths, limitations, and relevance of the study to health science, epidemiology, and public health are featured in Chapter Eight. Chapter Nine consisted of an overall summary and conclusion of the thesis findings, as well as possible future directions resulting from this project's findings.

3.6. *References*

1. Chen C, Xie Y. Modeling the safety impacts of driving hours and rest breaks on truck drivers considering time-dependent covariates. J Safety Res. 2014 Dec;51:57–63.

2. Braver ER, Preusser CW, Preusser DF, Baum HM, Beilock R, Ulmer R. Long hours and fatigue: a survey of tractor-trailer drivers. J Public Health Policy. 1992;13(3):341–66.

3. Arnold PK, Hartley LR, Corry A, Hochstadt D, Penna F, Feyer AM. Hours of work, and perceptions of fatigue among truck drivers. Accid Anal Prev. 1997 Jul;29(4):471–7.

4. Durdle K. Understanding the new federal Hours of Service regulations [Internet]. Available from: https://moam.info/new-federal-drivers-hours-of-service-regulations-alberta-ministry-_5a33180f1723dd7d03e37372.html

5. Panel on Research Methodologies and Statistical Approaches to Understanding Driver Fatigue Factors in Motor Carrier Safety and Driver Health, Committee on National Statistics, Board on Human-Systems Integration, Division of Behavioral and Social Sciences and Education, Transportation Research Board, National Academies of Sciences, Engineering, and Medicine. Hours-of-Service regulations [Internet]. National Academies Press (US); 2016 [cited 2019 Jul 13]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK384967/

6. Hanowski RJ, Hickman J, Fumero MC, Olson RL, Dingus TA. The sleep of commercial vehicle drivers under the 2003 Hours-of-Service regulations. Accid Anal Prev. 2007 Nov;39(6):1140–5.

7. Federal Motor Carrier Safety Administration. Hours of Service requirements for cross-border drivers [Internet]. 2018 [cited 2019 Jul 15]. Available from: https://www.fmcsa.dot.gov/international-programs/hours-service-requirements-cross-border-drivers

Chapter 4: Factors Associated with Depressive Symptoms in Long-haul Truck Drivers

4.1. *Abstract*

Background: Long-haul truckers are more likely to be depressed than many other occupations. However, little is known on their risk factors for depression. This study will determine which variables in trucking have a significant association with depressive symptoms, and thus, help narrow down which variables could be risk factors of depression.

Methods: We distributed an online, cross-sectional survey to Canadian and U.S. long-haul truck drivers. Our survey measured various at-work and outside-of-work factors as exposures. Depressive symptoms (the outcome) was measured continuously using the 10-item Center for Epidemiological Studies Depression scale (CES-D-10). Univariate analyses were conducted on all variables and later stratified by sex. Bivariate analyses were conducted between each exposure and depression for exploratory purposes. We then regressed all exposure variables against depression in a multiple linear regression model. Only exposures which had a statistically significant association ($p \leq .05$) with the outcome were kept in the final model. We also developed two final multiple linear regression models which were stratified by male/female sex.

Results: There were 303 truckers who completed the survey. Good sleep quality on workdays and good health both had the most negative associations with depression (standardized $\beta = -0.17$, 95% CI: -0.27, -0.07 and standardized $\beta = -0.16$, 95% CI: -0.24, -0.07 respectively), out of all factors. Good health (unstandardized b = -2.13, 95% CI: -3.35, -0.91), and good quality sleep on workdays (unstandardized b = -2.23, 95% CI: -3.59, -0.87) and non-workdays (unstandardized b = -1.86, 95% CI: -3.15, -0.57) were all associated with a nearly 2-point decrease in a trucker's CES-D-10 score. High stress due to being away from social relationships and fatigue both had the most positive associations with depression (standardized $\beta = 0.27$, 95% CI: 0.18, 0.36 and

standardized β = 0.26, 95% CI: 0.16, 0.36 respectively). High stress due to being away from social relations was associated with a (unstandardized b) 3.54-point (95% CI: 2.28, 4.80) greater CES-D-10 score while each additional day of fatigue was associated with a (unstandardized b) 0.74-point (95% CI: 0.45, 1.04) increase. High stress due to tight delivery deadlines (unstandardized b = 2.14, 95% CI: 0.84, 3.44) and poor road conditions (unstandardized b = 1.81, 95% CI: 0.56, 3.07) were also both positively associated with depression. Meanwhile, being never married, relative to being married, was associated with a (unstandardized b) 2.08-point (95% CI: 0.02, 4.14) higher CES-D-10 score in the male model only. High stress due to violence outside of work, relative to low stress in this factor, was associated with a (unstandardized b) 5.83-point (95% CI: 0.41, 11.24) higher CES-D-10 score in the female-only model.

Conclusion: Truckers in poor health, with poor sleep, chronic fatigue, and high stress at work have more depressive symptoms than those without these characteristics. These truckers may want to be recommended a mental health service. Truckers who experience high stress due to being away from social relationships are especially vulnerable to having depressive symptoms. Peer and social support groups should be developed for truckers either at work or outside of work to prevent loneliness, which could lead to depression. Truckers should also try to obtain a good night's sleep on workdays and non-workdays (which may decrease their fatigue), reduce their levels of stress, and keep themselves in good health, as these factors were all negatively associated with depression. In addition, truck drivers who are male may need different mental health supports depending on their marital status. Truckers who are female may need easy access to supports for domestic violence. Future studies should test whether any of the factors associated with depression in this study could be risk factors of depression. These studies should

also consider using a larger sample size and a random pool of truckers. Future studies may finally, want to consider performing a targeted sample of female truckers to obtain more power on which factors are associated with depression in their demographic.

4.2. *Introduction*

Depression is a mental health disorder (MHD) which is characterized by feelings of sadness and hopelessness, fatigue and restlessness, and thoughts of suicide, among other symptoms [1]. Depression, a common MHD of the general population, afflicts approximately 11.3 and 20.6% of Canadian and U.S. adults, respectively, during their lifetimes [1,2].

The prevalence of depression was 4.7% in Canada 2012 (among those aged 15 years and older) and ranged from 6.0 to 8.1% for U.S. adults between 2001 and 2017 [1,3–6]. Certain demographics, however, tend to develop depression more frequently than others. There were 8.2% Canadian youth who experienced depression or another depressive mood disorder (such as bipolar disorder) in 2012 [1,7]. Women experience depression nearly twice as often as men [1,7]. Other risk factors for depression include living in poverty or having a low family income [8–10].

Another risk factor for depression appears to be one's occupation. In particular, one study by Fan et al. (2012) discovered that long-haul truck drivers have a higher risk of depression when compared to workers from managerial-type occupations (OR = 6.18, 95% CI: 2.52-15.16) and 18 other occupational types [11]. Long-haul truckers also have a much higher prevalence of depression than the general public [11–13]. A study on Canadian truckers found their prevalence of depression to be 19% while studies on U.S. truckers found this prevalence to range from 14.6% to 26.9% [11–13].

4.2.1. Risk Factors for Depression in Long-haul Truckers

Few studies have examined why depression is more frequent in long-haul truckers. Long-haul truckers, however, are often away from friends and family for days at a time and are often alone while working and on breaks [8,14,15]. Social isolation—such as in the form of living alone, or being separated, single, divorced, or widowed—is a risk factor for depression [16].

The long and erratic shifts of trucking also make it difficult for truckers to maintain good quality social relationships [17]. Shattell, Apostolopoulos, Collins, Sönmez and Fehrenbacher (2012) have reported that the majority of U.S. long-haul truckers (64.4%) are separated, divorced, single or widowed [12]. Men who are divorced are, in particular, more vulnerable to committing suicide than married men [18]. Thoughts of suicide can be a symptom of severe depression [19].

The long shifts of trucking also mean that many truckers often obtain poor sleep [20]. Many long-haul truckers have reported feeling chronically fatigued as a result of their work [15]. Though poor sleep and fatigue are symptoms of depression, both variables have also been shown to be independent risk factors for depression on their own [21–24]. Insomniacs, and those with a high frequency of disturbed sleep, are also at a greater risk of developing depression [21,24].

It is furthermore worth mentioning that as much as 13% of U.S. long-haul truckers are estimated to use stimulants between once a day and once per month while on the job [8,25]. Though stimulant use has been positively associated with depression in trucking, the mechanism behind this association is likely that truckers who consume stimulants are more prone to developing insomnia, and this insomnia can increase their risk for depression [21,24,26].

Many long-haul truckers have reported feeling stressed due to their work [15]. Truckers in Canada can drive for up to 13 hours per day while this limit is 11 hours per day in the U.S. [27,28]. Weekly, Canadians truckers can work (in which, most of a trucker's time could consist of driving) for 70 hours per week while this limit is 60 hours per week in the U.S. [27,28]. Most long-haul truckers drive for their maximum duration of driving or higher, however, due to tight delivery deadlines as well as a method of renumeration that is typically paid by the mile or kilometer [29]. Many long-haul truckers also report that they experience stress at work due to

violence (such as assault, harassment, and mugging), poor road conditions (such as poor weather, accidents, or construction), and poor driving behaviours from the public, such as in the form of cutting them off or driving slowly [8]. People who have been exposed to violence or abuse, or who work a high-stress job, are known to be at a greater risk for depression [8,12,30].

Approximately 17.8% of today's truckers are South Asian in Canada while 18.7% are Hispanic in the U.S. [31,32]. Many of these individuals are also recent immigrants [31,32]. A meta-analysis of 25 studies found an inverse relationship between the number of years an immigrant spent in their new country and depression [33]. An immigrant's legal residency status may also be a risk factor for depression such that non-citizens often have poorer access to employment opportunities and health services when compared to full citizens [34]. These disadvantages may explain why non-citizenship is positively associated with depression [34].

Finally, more than half of truckers (60%) have reported experiencing low back pain [35,36]. Individuals who suffer from low back pain may experience chronic pain and disability [36]. Chronic pain and disability have both been positively associated with depression [35,36].

4.2.2. Current Research and Purpose of Conducting the Study

Truckers display a higher than average prevalence of depression when compared to many other occupations as well as the general public. They also encounter many possible risk factors for depression through their work. There is a gap in the literature, however, on which of these factors could explain why long-haul truckers have a high risk of depression. To the best of our knowledge, only two studies have examined what some of these potential risk factors for depression in long-haul truckers could be [37]. Da Silva-Júnior, de Pindo, de Mello, VM de Bruin and PFD de Bruin (2009) found that young age, stimulant use, low driving experience (less than one year of experience), low education (high-school or less), and company

employment (as opposed to working as an owner-operator) were positively associated with depression [37]. However, many other common elements of trucking, such as social isolation, work stressors, violence, fatigue, and poor sleep, were not examined in this study. A second study by Crizzle, McLean and Malkin (2020) looked at factors associated with symptoms of depression in long-haul truckers. However, they did not indicate what instrument was used to measure depression and what cut-offs were used to consider who had depressive symptoms or not. It is also unclear what, or how many depressive symptoms, they were looking for to define a "case", and they did not specifically state that they were measuring depression. Thus, their findings should be interpreted with caution.

The objective of our study was to measure many common elements of the trucking environment and determine which variables are associated with symptoms of depression. We hypothesize that all of the possible risk factors for depression which were presented in this introduction will have a statistically significant association with depressive symptoms in this study. As a secondary objective, we will also determine which variables are associated with depressive symptoms by sex.

4.3. *Methods*

4.3.1. Study Design

This study consisted of an online, cross-sectional survey open to both American and Canadian truck drivers. The survey was housed on Qualtrics (Provo, Utah: Qualtrics) software, an online survey platform. Qualtrics was also used to obtain electronic informed consent (see Appendix A for the consent form) which preceded the survey (Appendix B). All participants were required to provide informed consent prior to accessing the survey. Only participants who consented to being in the study were automatically redirected to the survey upon completing the

consent form. Ethics approval was granted by the ethics committee of Lakehead University (Appendix E).

The link to the online consent form (which led to the survey) was distributed both offline and online through a variety of methods. We contacted a number of Canadian trucking magazines as well as trucking organizations, radio talk shows for truck drivers, and individuals involved in the trucking industry in both Canada and the U.S. to promote our study. We also promoted the study and link to the consent form over local TV, on posters (Appendix C) displayed at local truck stops and businesses, and through posts on Canadian and American social media groups and pages tailored towards truck drivers. For specifics on the organizations and individuals we contacted, as well as social media pages we used, please refer to Appendix D.

All truck drivers were recruited, and completed the consent form and survey, voluntarily. The survey was available from January 15, 2020 until April 16, 2020. All participants who had completed the consent form and who indicated they would like to be entered into a draw for a $100 CAD prepaid gift card, were included in the draw upon the completion of the study.

4.3.2. Participants

Long-haul truck drivers whose primary country of residence is Canada or the U.S. and who are 18 years of age or older were eligible to participate in this study. Eligible participants must have slept away from home for a day or more, over the past 30 days. The latter question was used to screen out individuals who may not be long-haul truck drivers, as it is common for long-haul truckers to be on the road for days at a time. Individuals who did not meet these eligibility requirements were excluded from the study.

4.3.3. Measures

Depressive symptoms were the outcome. We measured depression as a continuous variable, using the summed scores of the 10-item Center for Epidemiological Studies Depression scale (CES-D-10). The CES-D-10 is a shortened form of the original CES-D. The CES-D-10 measures clinically relevant symptoms of depression over the last week [38]. Each item in the CES-D-10 is scored from 0 (no symptoms) to 3 (extreme symptoms) [38]. The items are summed together and a score of 10 or more indicates severe depressive symptoms [39]. Sums range from 0 to 30. While the CES-D-10 has not been validated among long-haul truckers, the scale has been validated among adolescents, the elderly, and various ethnic groups in Africa [40–42]. The CES-D-10 has been shown to have good internal consistency (Cronbach's $\alpha = 0.86$) [43].

Various demographic variables were measured as well: age and biological sex (male, female, other), education level (high-school or less, some trade college or university, completed a trade college or university, some post-graduate, completed post-graduate), marital status (married now, widowed, divorced, separated, never married, living with partner), and primary country of residence (Canada, U.S.A., other). We measured age continuously. Sex and marital status were measured using questions from the U.S. National Institute for Occupational Safety and Health's (NIOSH) National Survey of Truck Driver Injury and Health: Main Questionnaire [44]. We later collapsed the variables for education (dichotomized into the levels: some post-secondary or less, completed post-secondary or higher) and marital status (collapsed into: married now, widowed/divorced/separated, never married, living with partner) during our data analyses, due to a small number of individuals in some categories.

Financial strain was measured using the measure for financial strain by Dijkstra-Kersten, Biesheuvel-Leliefeld, van der Wouden, Penninx and van Marwijk (2015). Participants are asked,

"in general, how is your financial status at the end of each month?" and can respond to the categories: usually have money left, just enough to get by, and not enough to get by [45]. Legal status in Canada or the U.S. (Canadian/U.S. citizen, permanent resident of Canada/the U.S., work permit for Canada/the U.S., other, don't know) and being a recent immigrant ("have you immigrated to the U.S. or Canada in the past 5 years?": yes, no) were also measured. Legal status was measured using the measure for legal status by Srirangson, Thavorn, Moon and Noh (2013) [46]. We collapsed the categories for this variable into: non-citizen/other, citizen, and don't know during our analyses, due to sparse data in some categories.

Various elements of the trucker and their working environment were also measured: we looked at the type of truck driver (company employee, owner-operator leased to a motor carrier, owner-operator who operates their own truck, truck driver for a temporary employment or personnel agency, don't know), the country a trucker was driving in over the last week (Canada, U.S.A., Mexico, other), the number of hours driven over the past week, the number of years a participant has worked as a truck driver (less than one year, one to less than two years, two to less than five years, five to less than ten years, ten years or more, don't know), any formal training beyond having a truck driver's licence (yes, no, don't know), and the number of days a trucker slept away from home due to work within the last 30 days. We used a question from NIOSH's National Survey of Truck Driver Injury and Health: Main Questionnaire was used to measure the type of truck driver [44]. The number of years employed as a truck driver, the number of hours spent driving over the past week, and the number of days spent sleeping away from home were also measured using modified versions of questions from the NIOSH questionnaire. We dichotomized the number of years employed as a trucker into categories: less than five years, and five years or more. This was due to sparse numbers in some categories.

Multiple elements of a trucker's health were measured as further exposure variables. These included: the trucker's general self-perceived health (poor, fair, good, very good, excellent, don't know), low back pain (yes, no, don't know), and the use of stimulants (never, less than once a month, one or more times a month, one or more times a week, every one or two days). Low back pain was measured using a question from the NIOSH questionnaire. Self-perceived health was measured using a modified version of a question from the NIOSH questionnaire. We later collapsed the levels for health into: poor/fair, good, very good or excellent, and don't know; and the levels for stimulant use into: never, used less than once a month or more (tried at least once), and don't know. We collapsed these variables to avoid problems with sparse data.

Sleep quality, fatigue, stress (at work/outside of work) and violence (at work/outside of work) were measured last. Sleep quality was measured using a modified version of the sleep quality scale by Hege, Lemke, Apostolopoulos, Whitaker and Sönmez (2019) [47]. The original scale asks respondents the question, "how often do you feel that you get a good night's sleep…" and is followed by the two sub-questions, "on workdays?" followed by, "on non-workdays?". The available responses to both categories are: never or rarely, and almost every night or every night. The two response options were initially divided into the levels: never, rarely, almost every night, and every night (four dummy variables), in order to see if we could increase the specificity of this measure. We later dichotomized both sleep quality variables back into their original categories during our analyses, however, due to multicollinearity between all four dummies in each sleep quality variable. Fatigue, which asked respondents to indicate the number of days they felt fatigued over the past seven days, was measured continuously using a question from the NIOSH questionnaire. Stress was measured by asking participants to, "please indicate the level

of stress, if any, that you experience due to the following factors…". The wording of this phrase was based on the leading phrase of the CES-D-10. Our leading phrase was followed by the statements, "at work" and "outside of work", to measure stress within these two sub-areas. The work-related factors measured were: tight delivery times and pressures, poor driving behaviours from the public, poor road conditions (such as due to weather, construction, ice), being away from social relationships (such as family, friends, or other relationships), poor sleep (on workdays), and violence (at work). The outside-of-work factors were: poor sleep (on non-workdays) and violence (outside of work). All stress-related items had the response options of: none, mild, moderate, high, extreme, and chronic. We used the same options as those used by Hege, Lemke, Apostolopoulos, Whitaker and Sönmez (2019) in their measure for stress [47]. Violence was measured as a sub-scale within the measure for stress, using the two violence-related items (violence at work, violence outside of work) and used the same options. We later dichotomized our stress and violence variables into the levels: none/mild/moderate, and high/extreme/chronic due to collinearity.

4.3.4. Data Analysis

Data was analyzed in Stata SE/15.2 (College Station, TX: StataCorp LP). We removed observations with more than two missing responses in the CES-D-10, as suggested by the Boston Roybal Center for Active Lifestyle Interventions and Kimberlin, Pendergast, Berardo and McKenzie (1998) [48,49]. Univariate analyses were conducted on all variables (means and standard deviations for continuous variables, frequency counts for categorical ones). We stratified the descriptive statistics by sex and depression status (depressed/non-depressed, based on the threshold for depression in the CES-D-10) to see if there could be differences in the characteristics of our sample within these strata. Depression was only dichotomized during the

univariate analysis for descriptive purposes and was kept as a continuous variable for the remainder of the analyses.

Individuals with one or two missing responses in the CES-D-10 had their missing responses imputed with their mean CES-D-10 score. We conducted a sensitivity analysis to assess the effect of imputation versus a complete-data approach. The sensitivity analysis consisted of running univariate and bivariate analyses across all variables, with and without imputation. The bivariate analyses consisted of running simple linear regression models between all continuous exposures and depression, and ANOVAs between all categorical variables and depression. We looked for any noticeable changes in the distributions and crude associations of our variables with and without imputation. Cronbach's alpha was also computed for all measures with more than one item: sleep quality, stress, violence, and the CES-D-10. The reliability of the CES-D-10 was computed with and without imputation.

We regressed all continuous variables and categorical dummy variables on depression in a full multiple linear regression model. Backward-stepwise selection was then used to develop our final model. We used repeated likelihood ratio tests to identify variables to remove from the model. Each variable was put back in if the test was significant ($p \leq .05$) and confirmed that it should be removed if not ($p > .05$). Once no more variables could be removed from the model, the reduced model was used with the entire dataset, to include any observations which may have been previously removed. We repeated the backward-stepwise selection process for any variables which now became non-significant ($p > .05$) in the entire dataset. Our reduced model became our final model once i) no more variables could be removed through backward-stepwise elimination and ii) all remaining variables were significant ($p < .05$).

We also developed two additional multiple regression models which were stratified by sex. The same backward-stepwise process was used to develop a final model for men. Forward-stepwise selection was used for women due to a sparse number of female truckers. Likelihood ratio tests were used to confirm a variable's addition to the model. A variable was left in if the test was significant ($p \leq .05$).

4.4. *Results*

A total of 355 truckers participated in the study. There were 303 (85.4%) truckers who met the eligibility criteria and who had fewer than three missing responses in the CES-D-10. There were 34 truckers who had three or more missing responses to the CES-D-10. There were 12 who had two or fewer missing CES-D-10 responses.

The mean age was 47 years old (SD = 11.8). Three quarters of the truck drivers were male and approximately half were currently married (Table 1). Two-thirds had some post-secondary education or less. Most of the truck drivers were citizens (of Canada or the U.S.) and lived in Canada. In contrast, most of the truck drivers reported driving in the U.S. for their work.

When stratified by sex, there were three truckers who reported that they were of "other" sex. We did not perform univariate analyses nor modelling for this group due to the limited number of participants. Over three times as many female truck drivers were widowed, divorced, or separated than the men.

Table 1. Characteristics of long-haul truck drivers in Canada and the U.S. stratified by sex

		Sex[a]	
Variable	Total[b]	Male	Female
N	N = 303	232 (76.6%)	54 (17.8%)
Age (SD)	47.0 (11.8)	46.9 (12.2)	47.5 (10.1)
Sex			

Male	232 (76.6%)	-	-
Female	54 (17.8%)		
Other	3 (1.0%)		
Missing	14 (4.6%)		
Marital status			
Married now	147 (48.5%)	128 (55.2%)	18 (33.3%)
Widowed/divorced/separated	49 (16.2%)	28 (12.1%)	21 (38.9%)
Never married	39 (12.9%)	31 (13.4%)	7 (13.0%)
Living with a partner	54 (17.8%)	45 (19.4%)	8 (14.8%)
Missing	14 (4.6%)	0	0
Education			
Some post-secondary or less	197 (65.0%)	169 (72.8%)	27 (50.0%)
Completed post-secondary or higher	92 (30.4%)	63 (27.2%)	27 (50.0%)
Missing	14 (4.6%)	0	0
Legal status			
Non-citizen/other	26 (8.6%)	22 (9.5%)	4 (7.4%)
Canadian or U.S. citizen	263 (86.8%)	210 (90.5%)	50 (92.6%)
Don't know	0	0	0
Missing	14 (4.6%)	0	0
Financial strain			
Usually have money left	138 (45.5%)	110 (47.4%)	27 (50.0%)
Just enough to get by	125 (41.3%)	100 (43.1%)	23 (42.6%)
Not enough to get by	26 (8.6%)	22 (9.5%)	4 (7.4%)
Don't know	0	0	0
Missing	14 (4.6%)	0	0
Immigrated within past 5 years			
No	282 (93.1%)	226 (97.4%)	53 (98.2%)
Yes	6 (2.0%)	5 (2.2%)	1 (1.9%)
Missing	15 (5.0%)	1 (0.4%)	0
Days away from home over last 30 days (SD)	22.1 (6.2)	21.6 (6.3)	24.1 (5.9)
Primary country of residence			
Canada	187 (61.7%)	154 (66.4%)	23 (42.6%)
U.S.	116 (38.3%)	78 (33.6%)	31 (57.4%)
Missing	0	0	0
Countries driven in, over last week			
Canada	85 (28.1%)	74 (31.9%)	8 (14.8%)
U.S.	127 (41.9%)	87 (37.5%)	33 (61.11%)
Mexico	0	0	0
Canada, U.S.	84 (27.7%)	65 (28.0%)	12 (22.2%)
Canada, U.S., Mexico	1 (0.3%)	0	1 (1.9%)
U.S., Mexico	0	0	0

Missing	6 (2.0%)	0	0
Type of truck driver			
Company employee	220 (72.6%)	168 (72.4%)	39 (72.2%)
Owner-operator, truck leased to motor carrier	66 (21.8%)	51 (22.0%)	12 (22.2%)
Owner-operator, operates own truck	15 (5.0%)	11 (4.7%)	3 (5.6%)
Temporary employment/ personnel agency	1 (0.3%)	1 (0.4%)	0
Don't know	0	0	0
Missing	1 (0.3%)	1 (0.4%)	0
Years employed as a truck driver			
< 5 years	84 (27.7%)	57 (24.6%)	18 (33.3%)
5 years or more	218 (72.0%)	174 (75.0%)	36 (66.7%)
Missing	1 (0.3%)	1 (0.4%)	0
Professional training as trucker			
No	101 (33.3%)	77 (33.2%)	21 (38.9%)
Yes	201 (66.3%)	154 (66.4%)	33 (61.1%)
Don't know	1 (0.3%)	1 (0.4%)	0
Missing	0	0	0
Driving duration, in hours per week (SD)	62.4 (10.5)	62.5 (10.1)	62.5 (11.6)
CES-D-10 score (SD), without imputation	11.5 (6.4)	11.5 (6.7)	10.6 (5.4)
CES-D-10 score (SD), with imputation	11.6 (6.4)	11.6 (6.7)	10.6 (5.4)
General health			
Poor/ fair	95 (31.4%)	77 (33.2%)	11 (20.4%)
Good, very good or excellent	208 (68.7%)	155 (66.8%)	43 (79.6%)
Don't know	0	0	0
Missing	0	0	0
Low back pain			
No	135 (44.6%)	103 (44.4%)	26 (48.2%)
Yes	166 (54.8%)	127 (54.7%)	28 (51.9%)
Don't know	1 (0.3%)	1 (0.4%)	0
Missing	1 (0.3%)	1 (0.4%)	0
How often do you feel you get a good night's sleep…			
On workdays?			
Never/ rarely	167 (55.12%)	131 (56.5%)	29 (53.7%)
Almost every night/ every night	128 (42.2%)	99 (42.7%)	25 (46.3%)
Missing	8 (2.6%)	2 (0.9%)	0
On non-workdays?			

Never/ rarely	96 (31.7%)	73 (31.5%)	20 (37.0%)
Almost every night/ every night	188 (62.1%)	149 (64.2%)	32 (59.3%)
Missing	19 (6.3%)	10 (4.3%)	2 (3.7%)
Number of days fatigued over past week (SD)	3.5 (2.3)	3.5 (2.3)	3.4 (2.1)
Stimulant use			
Never	202 (66.7%)	157 (67.7%)	37 (68.5%)
once a month or more	91 (30.0%)	72 (30.6%)	17 (31.5%)
Don't know	4 (1.32%)	4 (1.7%)	0
Missing	6 (1.98%)	0	0
Stress…			
At work			
Tight delivery times and pressures			
None/ mild/ moderate	208 (68.7%)	157 (67.7%)	44 (81.5%)
High/ extreme/ chronic	86 (28.4%)	75 (32.3%)	10 (18.5%)
Missing	9 (3.0%)	0	0
Poor driving behaviours from 4-wheelers			
None/ mild/ moderate	131 (43.2%)	104 (44.8%)	24 (44.4%)
High/ extreme/ chronic	163 (53.8%)	128 (55.2%)	30 (55.6%)
Missing	9 (3.0%)	0	0
Poor road conditions (e.g., weather, ice)			
None/ mild/ moderate	197 (65.0%)	158 (68.1%)	33 (61.1%)
High/ extreme/ chronic	97 (32.0%)	74 (31.9%)	21 (38.9%)
Missing	9 (3.0%)	0	0
Being away from family, friends, other social relationships			
None/ mild/ moderate	179 (59.1%)	142 (61.2%)	34 (63.0%)
High/ extreme/ chronic	114 (37.6%)	89 (38.4%)	20 (37.0%)
Missing	10 (3.3%)	1 (0.4%)	0
Poor sleep, on workdays			
None/ mild/ moderate	185 (61.1%)	144 (62.1%)	36 (66.7%)
High/ extreme/ chronic	108 (35.6%)	87 (37.5%)	18 (33.3%)
Missing	10 (3.3%)	1 (0.4%)	0
Violence (e.g., being mugged, harassment)			
None/ mild/ moderate	269 (88.8%)	211 (91.0%)	50 (92.6%)
High/ extreme/ chronic	25 (8.3%)	21 (9.1%)	4 (7.4%)
Missing	9 (3.0%)	0	0
Outside of work			
Poor sleep, on non-workdays			
None/ mild/ moderate	250 (82.5%)	195 (84.1%)	48 (88.9%)

High/ extreme/ chronic	42 (13.9%)	35 (15.1%)	6 (11.1%)
Missing	11 (3.6%)	2 (0.9%)	0
Violence			
None/ mild/ moderate	284 (93.7%)	224 (96.6%)	52 (96.3%)
High/ extreme/ chronic	6 (2.0%)	4 (1.7%)	2 (3.7%)
Missing	13 (4.3%)	4 (1.7%)	0

Note: Standard Deviation (SD); [a] The three individuals of "other" sex were not displayed; [b] Numbers and frequencies may not sum to row total due to some individuals being of other sex or not indicating their sex

Nearly 60% of the truck drivers were depressed according to the CES-D-10 cut-point of ten (Table 2). Depressed drivers showed a higher frequency of financial strain, having less than five years of driving experience, and being in poorer health than non-depressed drivers. Poorer sleep and high, extreme, or chronic levels of stress were also more frequent in the depressed group than in the non-depressed group.

The Cronbach's alpha for the CES-D-10 was equally high with (0.86) and without (0.86) imputation. The measures for poor sleep (0.67), stress (0.77, using all stress-related variables including stress due to violence), and violence (0.58, using the two violence variables only) showed stable to acceptable levels of internal reliability. Our sensitivity analyses revealed no significant differences between imputation and a complete case analysis. We thus used the imputed data for more power in our models.

Table 2. Characteristics of long-haul truck drivers by depression status

	Depression status (CES-D-10)	
Variable	Depressed	Non-depressed
N	179 (59.1%)	124 (40.9%)
Age (SD)	45.8 (12.4)	48.8 (10.6)
Sex		
Male	136 (76.0%)	96 (77.4%)
Female	30 (16.8%)	24 (19.4%)
Other	2 (1.1%)	1 (0.8%)
Missing	0	3 (2.4%)

Marital status		
Married now	84 (46.9%)	63 (50.8%)
Widowed/divorced/separated	25 (14.0%)	24 (19.4%)
Never married	28 (15.6%)	11 (8.9%)
Living with a partner	31 (17.3%)	23 (18.6%)
Missing	11 (6.2%)	3 (2.4%)
Education		
Some post-secondary or less	119 (66.5%)	78 (62.9%)
Completed post-secondary or higher	49 (27.4%)	43 (34.7%)
Missing	11 (6.2%)	3 (2.4%)
Legal status		
Non-citizen/other	13 (7.3%)	13 (10.5%)
Canadian or U.S. citizen	155 (86.6%)	108 (87.1%)
Don't know	0	0
Missing	11 (6.2%)	3 (2.4%)
Financial strain		
Usually have money left	60 (33.5%)	78 (62.9%)
Just enough to get by	83 (46.4%)	42 (33.9%)
Not enough to get by	25 (14.0%)	1 (0.8%)
Don't know	0	0
Missing	11 (6.2%)	3 (2.4%)
Immigrated within past 5 years		
No	163 (91.1%)	119 (96.0%)
Yes	4 (2.2%)	2 (1.6%)
Missing	12 (6.7%)	3 (2.4%)
Days away from home over last 30 days (SD)	22.2 (5.8)	21.9 (6.7)
Primary country of residence		
Canada	113 (63.1%)	74 (59.7%)
U.S.	66 (36.9%)	50 (40.3%)
Missing	0	0
Countries driven in, over last week		
Canada	60 (33.5%)	25 (20.2%)
U.S.	66 (36.9%)	61 (49.2%)
Mexico	0	0
Canada, U.S.	46 (25.7%)	38 (30.7%)
Canada, U.S., Mexico	1 (0.6%)	0
U.S., Mexico	0	0
Missing	6 (3.4%)	0
Type of truck driver		
Company employee	135 (75.4%)	85 (68.6%)
Owner-operator, truck leased to motor carrier	35 (19.6%)	31 (25.0%)
Owner-operator, operates own truck	8 (4.5%)	7 (5.7%)
Temporary employment/ personnel agency	0	1 (0.8%)

Don't know	0	0
Missing	1 (0.6%)	0
Years employed as a truck driver		
< 5 years	57 (31.8%)	27 (21.8%)
5 years or more	121 (67.6%)	97 (78.2%)
Missing	1 (0.6%)	0
Professional training as trucker		
No	57 (31.8%)	44 (35.5%)
Yes	122 (68.2%)	79 (63.7%)
Don't know	0	1 (0.8%)
Missing	0	0
Driving duration, in hours per week (SD)	63.3 (9.6)	61.1 (11.7)
CES-D-10 score (SD), without imputation	15.9 (4.4)	5.3 (2.5)
CES-D-10 score (SD), with imputation	15.9 (4.4)	5.3 (2.5)
General health		
Poor/ fair	71 (39.7%)	24 (19.4%)
Good, very good or excellent	108 (60.3%)	100 (80.7%)
Don't know	0	0
Missing	0	0
Low back pain		
No	62 (34.6%)	73 (58.9%)
Yes	116 (64.8%)	50 (40.3%)
Don't know	1 (0.6%)	0
Missing	0	1 (0.8%)
How often do you feel you get a good night's sleep…		
On workdays?		
Never/ rarely	132 (73.7%)	35 (28.2%)
Almost every night/ every night	40 (22.4%)	88 (71.0%)
Missing	7 (3.9%)	1 (0.8%)
On non-workdays?		
Never/ rarely	73 (40.8%)	23 (18.6%)
Almost every night/ every night	93 (52.0%)	95 (76.6%)
Missing	13 (7.3%)	6 (4.8%)
Days fatigued, over past week (SD)	4.5 (2.1)	2.0 (1.7)
Stimulant use		
Never	108 (60.3%)	94 (75.8%)
< once a month or more	61 (34.1%)	30 (24.2%)
Don't know	4 (2.2%)	0
Missing	6 (3.4%)	0
Stress…		
At work		
Tight delivery times and pressures		

None/ mild/ moderate	103 (57.5%)	105 (84.7%)
High/ extreme/ chronic	69 (38.6%)	17 (13.7%)
Missing	7 (3.9%)	2 (1.6%)
Poor driving behaviours from 4-wheelers		
None/ mild/ moderate	57 (31.8%)	74 (59.7%)
High/ extreme/ chronic	115 (64.3%)	48 (38.7%)
Missing	7 (3.9%)	2 (1.6%)
Poor road conditions (e.g., weather, ice)		
None/ mild/ moderate	93 (52.0%)	104 (83.9%)
High/ extreme/ chronic	79 (44.1%)	18 (14.5%)
Missing	7 (3.9%)	2 (1.6%)
Being away from family, friends, other social relationships		
None/ mild/ moderate	77 (43.0%)	102 (82.3%)
High/ extreme/ chronic	94 (52.5%)	20 (16.1%)
Missing	8 (4.5%)	2 (1.6%)
Poor sleep, on workdays		
None/ mild/ moderate	80 (44.7%)	105 (84.7%)
High/ extreme/ chronic	92 (51.4%)	16 (12.9%)
Missing	7 (3.9%)	3 (2.4%)
Violence (e.g., being mugged, harassment)		
None/ mild/ moderate	150 (83.8%)	119 (96.0%)
High/ extreme/ chronic	22 (12.3%)	3 (2.4%)
Missing	7 (3.9%)	2 (1.6%)
Outside of work		
Poor sleep, on non-workdays		
None/ mild/ moderate	133 (74.3%)	117 (94.4%)
High/ extreme/ chronic	37 (20.7%)	5 (4.0%)
Missing	9 (5.0%)	2 (1.6%)
Violence		
None/ mild/ moderate	165 (92.2%)	119 (96.0%)
High/ extreme/ chronic	5 (2.8%)	1 (0.8%)
Missing	9 (5.0%)	4 (3.2%)

4.4.1. Regression Models

Table 3 shows all variables included in the initial (full) regression model with their standardized betas. The initial model contained 206 observations and explained 53.2% of the variance (adjusted-$R^2 = 0.532$). Table 4 shows the final model using the entire dataset. The final

model contained 245 observations and similarly, explained 53.2% of the variance (adjusted-R^2 = 0.532).

High stress due to being away from being away from friends, family, or other personal relationships had the most positive association with depressive symptoms, relative to all other factors (Table 4). Truckers with high, extreme, or chronic levels of stress in this factor had (unstandardized b) 3.54-point (95% CI: 2.28, 4.80) higher CES-D-10 scores, relative to those with no, low, or moderate levels of stress in this factor. Fatigue had the second highest positive association with depression (Table 4). Each additional day of fatigue was associated with a (unstandardized b) 0.74-point (95% CI: 0.45, 1.04) increase in a trucker's CES-D-10 score. High, extreme, or chronic levels of stress due to tight delivery deadlines and poor road conditions were both also positively associated with depressive symptoms (Table 4). The former stressor was associated with a (unstandardized b) 2.14-point (95% CI: 0.84, 3.44) increase with a trucker's CES-D-10 score while the latter was associated with a (unstandardized b) 1.81-point (95% CI: 0.56, 3.07) increase (relative to those with no, low, or moderate levels of stress in these factors).

Sleeping well almost every night or every night on workdays and being in good, very good, or excellent health both had the most negative associations with depressive symptoms, relative to all other factors (Table 4). Good quality sleep on workdays and on non-workdays were both associated with a nearly 2-point decrease in a trucker's CES-D-10 score (unstandardized b = -2.23, 95% CI: -3.59, -0.87 and unstandardized b = -1.86, 95% CI: -3.15, -0.57 respectively), relative to never or rarely sleeping well on these days. Being in good, very good, or excellent health—relative to poor or fair health—was also associated with a nearly 2-point lower CES-D-10 score (unstandardized b = -2.13, 95% CI: -3.35, -0.91).

Table 3. Full multivariable linear regression model including all exposure variables regressed on depression across the entire sample of truck drivers (N = 206)

Exposure variable	Standardized regression coefficient (β)	[95% CI]
Age	-0.04	-0.14, 0.07
Sex		
Male (ref)	-	-
Female	0.02	-0.08, 0.12
Other	-0.03	-0.12, 0.06
Marital status		
Married now (ref)	-	-
Widowed/ divorced/ separated	-0.06	-0.16, 0.05
Never married	0.11	0.01, 0.21
Living with partner	0.00	-0.10, 0.10
Education		
Some post-secondary or less (ref)	-	-
Completed post-secondary or higher	-0.04	-0.13, 0.06
Legal status		
Non-citizen/ other (ref)	-	-
Citizen	0.02	-0.07, 0.12
Financial strain*		
Usually have enough (ref)	-	-
Just enough	0.02	-0.08, 0.13
Not enough	-0.01	-0.11, 0.10
Recent immigrant		
No (ref)	-	-
Yes	0.08	-0.02, 0.19
Days away from home	-0.01	-0.11, 0.10
Country of residence		
Canada (ref)	-	-
U.S.	0.13	-0.04, 0.30
Country last drove in		
Canada (ref)	-	-
U.S.	-0.18	-0.37, 0.01
Canada, U.S.	-0.04	-0.16, 0.08
Canada, U.S., Mexico	-0.03	-0.14, 0.08

Type of truck driver*		
Company driver (ref)	-	-
Owner-operator, leased to motor carrier	0.03	-0.06, 0.13
Owner-operator, drives own truck	0.00	-0.10, 0.09
Temporary employment/ personnel agency	-0.07	-0.17, 0.03
Years employed as a truck driver		
< 5 years (ref)	-	-
5 years or more	-0.02	-0.12, 0.09
Professional training		
No (ref)	-	-
Yes	0.01	-0.09, 0.10
Driving duration	0.08	-0.03, 0.18
General health*		
Poor/ fair (ref)	-	-
Good/ very good/ excellent	-0.12	-0.21, -0.02
Lower back pain		
No (ref)	-	-
Yes	0.02	-0.08, 0.12
Don't know	0.02	-0.07, 0.12
Sleep quality: workdays		
Never/ rarely (ref)	-	-
Almost every night/ every night	-0.12	-0.24, 0.00
Sleep quality: non-workdays		
Never/ rarely (ref)	-	-
Almost every night/ every night	-0.15	-0.27, -0.03
Number of days fatigued	0.26	0.15, 0.36
Stimulant use		
Never (ref)	-	-
Used at least once	-0.07	-0.16, 0.02
Don't know	0.01	-0.08, 0.10
Stress: tight deadlines		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.10	0.00, 0.20
Stress: public driving behaviours		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.02	-0.08, 0.12
Stress: poor road conditions		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.13	0.03, 0.23
Stress: away from social relationships		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.22	0.11, 0.32

Stress: due to poor sleep, on workdays		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.04	-0.08, 0.17
Stress: violence at work		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.14	0.04, 0.25
Stress: due to poor sleep, on non-workdays		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.04	-0.07, 0.15
Stress: violence outside of work		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	-0.03	-0.16, 0.09

*Note: Confidence Interval (CI); *The levels "Don't know" were not displayed as these contained only empty observations and were thus dropped from the model*

Table 4. Final multivariable linear regression model including only significant exposure variables regressed on depression across the entire sample of truck drivers (N = 245)

Exposure variable	Standardized regression coefficient (β)	[95% CI]
General health*		
Poor/ fair (ref)	-	-
Good/ very good/ excellent	-0.16	-0.24, -0.07
Sleep quality: workdays		
Never/ rarely (ref)	-	-
Almost every night/ every night	-0.17	-0.27, -0.07
Sleep quality: non-workdays		
Never/ rarely (ref)	-	-
Almost every night/ every night	-0.14	-0.23, -0.04
Number of days fatigued	0.26	0.16, 0.36
Stress: tight deadlines		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.15	0.06, 0.24
Stress: poor road conditions		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.13	0.04, 0.22
Stress: away from social relationships		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.27	0.18, 0.36

*Note: Confidence Interval (CI); *The level "Don't know" was not displayed as it contained only empty observations and was thus dropped from the model*

When stratified by sex, the final model for men (Table 5) explained 53.9% of the variance in the data (adjusted $R^2 = 0.539$). High stress due to being away from social relationships remained as the factor which had the most positive association with depressive symptoms, followed by high stress due to poor road conditions and fatigue (Table 5). Being never married, interestingly, also appeared to have a positive association with depression in the model for men only (Table 5). Being never married, relative to being married, was associated with a nearly (unstandardized b) 2.08-point (95% CI: 0.02, 4.14) higher CES-D-10 score. Poor sleep on workdays remained as the factor which had the most negative association with depression (Table 5).

The final model for women (Table 6) explained 56.5% of the variance in the data (adjusted $R^2 = 0.565$). Fatigue had the most positive association with depressive symptoms (Table 6). Each additional day of fatigue during the week was associated with a (unstandardized b) 1.65-point (95% CI: 1.09, 2.21) increase in a female trucker's CES-D-10 score. Stress due to violence outside of work, meanwhile, was significantly associated with symptoms of depression in female truckers only. High, extreme, or chronic levels of stress in this factor (relative to no, low, or moderate levels of stress) was associated with a (unstandardized b) 5.83-point (95% CI: 0.41, 11.24) higher CES-D-10 score. Good sleep quality on workdays remained as a factor which was negatively associated with depression (Table 6). We did not create a model stratified by "other" sex due to the limited number of truckers from this category.

Table 5. Final multivariable linear regression model including only significant exposure variables regressed on depression for male truck drivers (N = 194)

Exposure variable	Standardized regression coefficient (β)	[95% CI]
General health*		
Poor/ fair (ref)	-	-
Good/ very good/ excellent	-0.12	-0.22, -0.03
Sleep quality: workdays		
Never/ rarely (ref)	-	-
Almost every night/ every night	-0.21	-0.33, -0.10
Sleep quality: non-workdays		
Never/ rarely (ref)	-	-
Almost every night/ every night	-0.18	-0.28, -0.07
Number of days fatigued	0.19	0.07, 0.30
Stress: poor road conditions		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.20	0.10, 0.30
Stress: away from social relationships		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.30	0.21, 0.40
Marital status		
Married now (ref)	-	-
Widowed/ divorced/ separated	-0.08	-0.18, 0.02
Never married	0.10	0.01, 0.20
Living with partner	0.00	-0.10, 0.10

*Note: Confidence Interval (CI); *The level "Don't know" was not displayed as it contained only empty observations and was thus dropped from the model*

Table 6. Final multivariable linear regression model including only significant exposure variables regressed on depression for female truck drivers (N = 46)

Exposure variable	Standardized regression coefficient (β)	[95% CI]
Number of days fatigued	0.62	0.47, 0.77
Sleep quality: workdays		
Never/ rarely (ref)	-	-
Almost every night/ every night	-0.25	-0.44, -0.06
Stress: violence outside of work		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	0.21	0.03, 0.39

Note: Confidence Interval (CI)

4.5. *Discussion*

4.5.1. Primary Objective

The majority of our participating truck drivers were depressed. This finding was likely an inaccurate representation of the frequency of depression among this population, however, given that we were using a voluntary sample. As truckers could self-enroll into the study, there was likely selection bias in who decided to participate and whether they had depressive symptoms. Previous research has indicated that people are more likely to participate in surveys if the topic is of high salience (i.e., interest) to them [50]. People are also more likely to participate in studies if they believe that they have knowledge to contribute to the study's area of interest [51]. Those with depression could have also been more likely to be temporarily off work and consequently, had more time to voluntarily complete a survey. These are likely some of the major reasons why we could have had an above-average frequency (response rate) of truckers with depression. Indeed, past surveys done by the United Kingdom's National Health Service found that those with depression had higher response rates than members of the general public during their annual surveys on mental health [52]. Thus, our findings appear to be supported by the literature.

The primary objective of this study was to measure many common elements of the trucking environment and to determine which ones could be associated with depression in long-haul truckers. We hypothesized that all of the risk factors for depression in the introduction would have been significantly associated with our outcome. However, our results showed that not all of our exposure variables were statistically significant. Poor health, poor sleep on workdays and non-workdays, the number of days a trucker felt fatigued, and stress due to tight delivery timelines, poor road conditions, or being away from social relationships were the only

factors associated with depression. We also found that high stress due to being away from social relationships and fatigue had the most positive associations with depression, across the entire sample. Good quality sleep on workdays and good health meanwhile, both had the most negative associations with depression. Some of the variables we tested were likely non-significant in our models due to a lack of participants in certain categories—other sex, for instance, consisted of only of three truckers. Similarly, only six truckers were recent immigrants and 26 were non-citizens. The lack of participants (positive cases) in some categories could have resulted in some type II error.

The lack of an association between financial strain and depression appears to contradict the literature. This variable has not previously been tested in truckers. However, financial strain has been associated with depression even after adjusting for various confounders (e.g., demographics unemployment, income, having insurance, age) in studies of the general public [45,53]. It has been suggested, however, that financial strain may not independently cause depression [53]; rather, it is thought that other underlying factors—which are risk factors for both financial strain and depression—explain this association [53]. Indeed, certain personality traits or disorders, MHDs, and some health issues may increase the risk for both financial strain and depression [53]. However, trucking could be selective of people without these conditions, given that truckers must pass a biennial medical exam to retain their licence [54]. Those who can fail this exam include: people who are alcoholics or who abuse drugs; people with neurological, psychiatric, or musculoskeletal disorders; and people with physical or mental disabilities, among other factors [55]. It is possible that some of these factors might explain the association between financial strain and depression in the general public. Another explanation for our lack of association could be due to the smaller gap in socioeconomic status and wealth inequality

between truckers of low/high financial strain relative to the general public. As everyone is working as a trucker, perhaps these gaps are smaller, and truckers of low financial strain do not experience as many benefits relative to truckers of high financial strain. Consequently, financial strain might not have as significant of an association with depression in truckers relative to the general public, whereas in the latter population, the lived experiences (and social and economic advantages/disadvantages) between those of low/high financial strain could be larger.

We did not find an association between female sex and depression, which appears to contradict the literature. Female sex is typically a risk factor for depression for a combination of biological, psychological and social factors [56]. Similarly to our findings, Crizzle, McLean, and Malkin (2020) did not find that female sex was associated with depressive symptoms in truckers [57]. Although only four out of 107 truckers (4.4%) in their study were female, thus they may have lacked power [57]. They also did not report what tool was used to measure their outcome and its cut-off point [57]. Thus, their results should be interpreted with caution.

One large case-control study of working adults in the U.S. population did find that female sex was associated with a greater odds of depression relative to men, even after controlling for confounders (e.g., age, age upon entry in workforce, education, occupation) [58]. Interestingly, the magnitude of this association was reduced (but remained significant) when the women made equal or greater incomes relative to men [58]. Thus, one explanation for our findings is that we could have eliminated part of the association between female sex and depression after controlling for financial strain (which could have controlled for women in the workforce—including in trucking—generally making lower incomes than men) [58,59]. A second explanation for our findings could be that female and male truckers might be entering the trucking industry for different reasons. Females tend to enter trucking after they are done raising their children [60].

Some may also become truckers to re-enter the workforce, spend time with a partner, supplement their spouse's income, or explore the country for leisure (Carson J, personal communication, February 2020) [60]. Some may have had a career prior to trucking [60]. These characteristics could make it easier for more women (relative to men) to leave trucking if they felt depressed, particularly if they already had a previous career, no longer have children to support at home, or if their spouse was already providing a significant amount of the household income. The women who remain in trucking could, consequently, be more likely to be those who enjoy their workplace and/or who are not depressed [61]. This could have contributed to the lack of association between female sex and depression.

We did not observe a positive association between some of the exposures which were previously associated with depression in truckers. These exposures included: education, type of driver, stimulant use, and a trucker's years of driving experience. One study of Brazilian truckers found that low education (less than high school versus a high school education) was positively associated with depression even after controlling for confounders (e.g., age, stimulant use, self-employed/ company driver) [37]. However, a study on Chinese truck drivers did not find an association when comparing between those with a college education and those with less than high school (although they did not control for confounders) [62]. A study by Crizzle, McLean, and Malkin (2020) also found that less than high school education versus post-secondary education was not associated with depressive symptoms in Canadian truck drivers, although they also did not specify what tool was used to measure their outcome and they had a small sample size [57]. Regardless, the lack of a protective effect from higher education on depression could be due to the phenomenon of overeducation [63–66]; truckers with a post-secondary education may have not needed their current level of education for their work and thus, could have derived

little benefit in having their current levels of education [63–66]. In contrast, the completion of a high school education versus less than high school could have afforded the truckers in Brazil the benefits of having an education (e.g., increased health literacy) while also not making them overeducated for their jobs [67]. These could be some reasons as to why post-secondary education was not associated with lower CES-D-10 scores in this study.

Type of truck driver may not have been associated with depression due to differences between the trucking industries of North America and Brazil. Da Silva-Júnior, de Pindo, de Mello, VM de Bruin and PFD de Bruin (2009) had recruited Brazilian truckers for their study which found that company driving (as opposed to being self-employed) was associated with depression, even after controlling for various factors (e.g., demographics, alcohol use, smoking, being paid minimum/ above minimum wage) [37]. Brazil, however, did not have any laws or rights for truckers on their working hours and driving periods prior to 2012, which was years after their study [68,69]. Thus, the company drivers in their study could have been more vulnerable to poor working conditions (when compared to Canadian and U.S. drivers) due to a lack of legal protections. This lack of protections could have made the company drivers more depressed. Crizzle, McLean, and Malkin (2020) similarly, did not find that type of trucker (company employee, owner-operator, etc.) was associated with depressive symptoms, though they had a small sample size and they may have been using an invalid measure for their outcome [57].

We did not observe a positive association between stimulant use and depression in our study which contradicted again, with the findings of da Silva-Júnior, de Pindo, de Mello, VM de Bruin and PFD de Bruin (2009) [37]. The authors found that stimulant use was positively associated with depression even after controlling for multiple confounders including

demographics, type of trucker, and working ten or more hours a day [37]. They did not state, however, whether these stimulants were licit or illicit, which could have made a difference in their findings [37]. Several studies have found that amphetamines and cocaine are the two most commonly-used types of stimulants by truckers in Brazil [68–70]. Both are illicit products in Brazil, Canada, and the U.S. [71]. Illicit stimulants, however, are a risk factor of depression, whereas the same is not necessarily true of licit stimulants [72–74]. A greater proportion of their drivers could have been using illicit stimulants than those in our study, which could have explained their positive association [75]. Indeed, licit stimulant use is popular among U.S. truckers [73,74,76]. Although one study in Australia found that only 18% of the truckers consumed a licit, caffeinated product within the past month to stay awake while on the job (9.5% to 13% of U.S. truckers are estimated to consume illicit stimulants at least once a month on the job), thus the frequency of licit versus illicit use may not have been that different in our sample [8,25,77]. Regardless, it is possible that we could have obtained a high enough number of licit users in this study to remove the association between stimulant use and depression.

Another explanation for the lack of association between stimulant use and depression could be due to the greater social, economic, and geographic disparities between people in Brazil—as well as lack of mental health facilities—when compared to Canada and the U.S. [78]. Nearly 80% of Brazilians with depression never receive any form of treatment for their illness, which is often due to difficulties in accessing treatment [78]. Only 14.1% of Brazilians with depression receive pharmacotherapy [78]. These issues could have made self-medication more prevalent among truckers in Brazil when compared those in Canada or the U.S. [79]. Indeed, stimulants—mainly illicit ones—release dopamine, a chemical which incites feelings of pleasure [72,80]. However, increased use of these substances (such as through addiction) can result in

increasingly intense emotional “crashes”, wherein one experiences feelings of depression and fatigue [72]. Thus, da Silva-Júnior, de Pindo, de Mello, VM de Bruin and PFD de Bruin (2009) could have observed a positive association between stimulant use and depression if their truckers were more likely to self-medicate in this way than ours.

Years of driving experience was not associated with depression, which contradicts with the literature. To the best of our knowledge, only one study in China has looked at driving experience and its association with depression in truckers. The study found that 3-4 years, 5-6 years, and eight years or more of driving experience (with less than one year of experience, as the referent) were associated with fewer depressive symptoms [62]. However, this study also did not control for confounders. Thus, other factors—such as age, or income—could have explained these associations. Those with more driving experience could have had more seniority and better incomes than those with poor driving experience. In addition, toll roads (both legal and illegal, as well as in both urban and rural areas) are common in China [81]. The fees to enter these roads, however, can be high and accumulate throughout the day [81]. Heavy fines may also be given for real, minor, or imagined misdeeds by traffic police [82]. Those with low driving experience may not yet know how to avoid these hazards. Consequently, drivers with low experience could have experienced greater losses in income, which could have been particularly devastating given that over 85% of truckers in China are self-employed [83]. Self-employed drivers in China are typically responsible for all fuel, food, lodging, and maintenance costs (the same is true of owner-operators in Canada and the U.S.; though some may qualify for reimbursement and/or social service support from their respective governments) [82–85]. Self-employed truckers in China also do not receive social insurance [83].

Our findings that poor sleep and fatigue were positively associated with depression have support from the literature. It is well-known that poor sleep and fatigue are symptoms of depression. However, cohort studies on the general public have suggested that both variables may also be risk factors of depression [21,22,24,86]. This bidirectional relationship might explain why good sleep quality (on workdays) and fatigue both had beta coefficients which were high in magnitude, in our final model across all truckers. In particular, good sleep quality on workdays could have been more negatively associated with depressive symptoms than sleeping well on non-workdays if those with depression were more likely to end up sleeping for longer, or more frequently, on their days off [1]. Fatigue, decreased energy (lethargy), and sleep disturbances—which are all symptoms of depression—could have made those with depression want to sleep more during the week [1]. However, the long and irregular hours of trucking could have made it difficult for these individuals to achieve this on a workday. Those with depressive symptoms could have instead, chosen to pursue this extra sleep on their days off. Consequently, some truckers with depression could have felt that they had better sleep quality on their non-workdays, while still experiencing poor sleep on workdays. This phenomenon might explain why poor sleep quality on workdays had a slightly more positive association with depression than poor sleep on non-workdays.

Interestingly, one recent study by Crizzle, McLean, and Malkin (2020) found that broken sleep (poor sleep quality) was positively associated with depressive symptoms in long-haul truckers but not fatigue [57]. However, they did not mention the tool that was used to measure their outcome, its cut-off point, and what these depressive symptoms were [57]. They also dichotomized their outcome but had few cases/ controls. Thus, they might not have been using a sensitive enough measure for their outcome and their study could have had some type II error.

Overall, the positive associations we found between poor sleep and fatigue with depression appear sensible, based on the general literature on depression.

The association we found between poor health and depression similarly, corroborates with the literature. Those with depression are more likely to develop poor health [87]. But those in poor health are also more likely to become depressed [87]. This bidirectional relationship likely explains why good health had one of the most negative associations with depression. Interestingly, Crizzle, McLean, and Malkin (2020) did not find that poor health was associated with depressive symptoms in their study on long-haul truckers. However, this could have been due to the use of an unvalidated measure for their outcome, an inappropriate cut-off point for their outcome, sparse numbers in their case/control categories and ultimately, a type II error.

To the best of our knowledge, stress due to tight and unrealistic delivery timelines is a factor which has not yet been studied for its association with depression in truckers, nor in other types of commercial drivers. Crizzle, McLean, and Malkin (2020) did find that severe job-related stress was positively associated with symptoms of depression in their study of truckers, even after accounting for a few potential confounders such as poor sleep, the number of hours of sleep per night, and fatigue (though fatigue was not found to be associated with their outcome in their study) [57]. Although they did not specify what stressors they were looking at, what measure they used for job stress, and their measure of depressive symptoms may not have been valid [57]. Regardless, we did observe a positive association between high stress due to tight and unrealistic delivery timelines and higher CES-D-10 scores, which appears to match their findings. One explanation for our association could be that high stress due to tight delivery deadlines could have contributed to feelings of job strain (i.e., high job demands and poor control over one's work) and job overload (high amounts of work in little time) [88,89]. A systematic review of 19

studies on workers from male-dominated industries (≥ 70% male) found that job overload and high job demands (work requiring high levels of physical or mental effort) were both positively associated with depression [89]. Two longitudinal studies have similarly found that job overload and job strain both increase one's risk of depression, even after controlling for various factors (e.g., socioeconomics, juvenile MHD, demographics, job grade, drug use, physical activity) [90,91]. Job strain and low job satisfaction both have positive associations with depression [61,90,92]. Overall, the literature supports the association we found.

To the best of our knowledge, stress due to poor road conditions has also not been previously tested for its association with depression in long-haul truckers (although Crizzle, McLean, and Malkin [2020] did find that severe job-related stress was associated with depressive symptoms in their study). We observed a positive association between these two variables. One explanation for this finding is that poor roads could have led some truckers to feel more stressed about meeting their delivery deadlines. Unsafe roads and weather could have also led some truckers to feel disengaged, demoralized, anxious, and less satisfied with their jobs [93]. Low job satisfaction was associated with a greater odds of depression even after adjusting for demographics, lifestyle factors (e.g., smoking, alcohol, caffeine intake), sleep, type of industry, and other factors in a study of over 2,000 Japanese workers from nine industries [61]. Stress due to poor road conditions could thus, be associated with higher stress in meeting delivery deadlines and lower job satisfaction, which are both associated with depression.

Though stress due to social isolation has not been previously examined for its association with depression in truckers, it is well-known that social isolation is a risk factor of depression in other individuals [94,95]. Loneliness, which can often occur from social isolation, is especially predictive of depression [95]. Interestingly, our finding that stress due to social isolation also had

the most positive association with depression appears to be supported by the literature: loneliness had the most positive association with depression out of any other tested factor (all other factors were all sociodemographic: e.g., age, income, education, sex), in a study of over 2,000 adults from the general U.S. public [16]. It is unclear why stress due to being away from social relationships could have had such a strongly positive association with depression in this study (and why loneliness was similarly, found to have such a strong association with depression in the general public). The strong association between loneliness/social isolation and depression is thought to be due to either evolutionary reasons (i.e., humans have "biologically evolved" to feel strong pain during social isolation as a way to motivate them to return to a social group, for survival reasons), or genetic factors (i.e., the same genes which predispose someone to feel lonely—such as "negative" attribution styles, wherein one is prone to pessimistic thinking and self-blame—are risk factors for depression) [96]. Overall, the positive association we observed between stress due to being away from social relationships and depression appears to be supported by the literature.

We did not observe a positive association between stress due to poor driving behaviours from the public and truckers' CES-D-10 scores. Crizzle, McLean, and Malkin (2020) did observe a positive association between severe job-related stress and symptoms of depression in Canadian truckers [57]. However, they did not specify what stressors they were measuring, what measure of stress they were using, and how many truckers could have felt stressed due to the public's driving behaviours. One study by Wijngaards, Hendriks and Burger (2019) involving transport truck drivers found that road congestion was associated with lower momentary happiness, within the past hour [97]. Momentary happiness was measured on a scale from 0 ("very unhappy") to 10 ("very happy") [97]. However, traffic congestion might not necessarily be analogous to poor

driving behaviours from the public. The truckers in their study could have also felt unhappy out of frustration and not necessarily out of feeling more depressed [8]. Overall, there might not be a significant association between stress due to poor driving behaviours from the public and depression in truckers. However more data are needed.

Though poor sleep was positively associated with depression in this study, we did not observe a positive relationship between stress due to poor sleep on workdays/ non-workdays with depression. To the best of our knowledge, there are no previous studies which have looked at these associations. One explanation for our findings it that poor sleep, in our model, could have already explained much of the association between stress due to poor sleep on workdays/ non-workdays and depression. Poor sleep could have had a more significant association with depression due to it being a symptom of depression.

We did not observe a positive association between high stress due to violence at work/ outside of work and depression. This finding contradicts with the background literature, such that those who are exposed to violence (whether at work/ outside of work) are more likely to become depressed [30,98]. We may not have observed an association due to sparse numbers in the "high stress due to violence" category.

4.5.2. Secondary Objective

Our secondary objective sought to determine which variables were significantly associated with depression, stratified by sex. We excluded the "other" sex during our analyses due to sparse numbers in this category. Separate regression models were developed for males and females.

Most of the variables in the model for all truckers versus that for men only remained the same. However, never married became significantly associated with depression while stress due

to tight delivery timelines became non-significant. We expected that being separated/divorced/widowed would have also had a positive association with depression in the male model based upon the background literature. However, it is possible that truckers who are separated/divorced/widowed may actually experience less stress and depression than those from the other categories due to these individuals no longer being attached to a partner. Perhaps those who are already divorced/separated/widowed would have not been exposed to the same potential marital or relationship problems in being away for several days at a time (due to work) than the truckers who currently have a partner. Meanwhile, there is evidence to support our finding that men who are never married are more likely to be depressed relative to men who are married [99,100]. One reason for this is that men who are never married can develop low self-esteem and feel depressed in never being married [99]. Although one study by da Silva-Júnior, de Pindo, de Mello, VM de Bruin and PFD de Bruin (2009) did not find that being never married was positively associated with depression in Brazilian truck drivers [37]. However, it is worth pointing out that most of their sample was significantly younger than ours, thus most of the truckers might not have yet had negative feelings about being never married.

Being never married, meanwhile, could have lacked an association with depression in the female model due to marriage (the referent group) not being as protective against depression in women as compared to men [18,101]. As for the association between stress due to tight delivery deadlines and depression, this association likely disappeared in the male model due to the slight reduction in sample size (in the male model) from stratifying the truckers by sex. The removal of this stressor from their model might also explain why high stress due to poor road conditions had a larger beta coefficient in the male-only model, relative to the model for all truckers. High stress due to tight delivery deadlines could have accounted for part of the association between high

stress from poor road conditions and depressive symptoms, if part of the reason why a trucker felt stressed from bad road conditions was due to difficulties in meeting their delivery deadlines.

The regression model for women contained the fewest variables out of all models, likely due to the small sample size of females. The high beta coefficient for fatigue in the female-only model was likely due to the absence of other factors which could have accounted for part of the association between fatigue and depression (such as poor sleep on non-workdays, more stressors, and poor health). Previous research has also found that the relationship between loneliness and depression is slightly attenuated (lower in magnitude) in females relative to males [16]. This finding could be due to women having a tendency of forming more meaningful and emotionally supportive friendships than men [16,18]. This last finding (in addition to the small sample of truckers in the female-only model) might explain why stress due to social isolation lost its significance in (and thus, ended up dropped from) the female-only model.

4.5.3. Limitations & Strengths

One major limitation is that this study was cross-sectional. As such, we were not able to establish any causations. We did observe several significant associations between our tested exposures and depression. However, these associations should not be assumed to be causal.

A second limitation of this study was in our use of voluntary recruitment. The frequency of depression we observed was likely an overestimate of the prevalence of depression among long-haul truck drivers. We also were not able to calculate a prevalence of depression given our method of sampling. In addition, the use of social media to promote the study (and the requisite for truckers to have internet access) could have resulted in some selection bias among those who participated, such that we could have been less likely to sample those who are on the road for

many days at a time, who have high durations of driving, and who have high financial strain (not enough money to get by each month) if these individuals were less likely to have internet access.

Another limitation is that our sample size was not large enough to stratify the truckers by age. We observed differences in the descriptive statistics and exposures associated with depression between the sexes. It is possible that some of the exposures associated with depression could differ by age groups. In addition, the small number of females in our study also limits the power of our model from Table 6. This model has the risk of having some type II error. Over-fitting is also a possibility. Although Babyak (2004) reported that a minimum of 10 to 15 observations per predictor is generally required to produce good estimates [104]. Note that our model for female truckers contains 15 observations per independent variable, which is at the very top of this range. Regardless, sparse numbers in the categories of some variables could have resulted in some type II error in the final models we developed for all, male, and female truckers.

The short duration of our survey means that we did not ask the truck drivers a large number of questions. Hence, we might not have been able to account for other factors associated with depression in long-haul truckers. Although our final models for all, male, and female truckers explained 53.2%, 53.9%, and 56.5% of the variance in our outcome, respectively. Thus, our models were still acceptable in indicating which factors—out of all the possible variables in a trucker's environment—are associated with depression in long-haul truck drivers.

The measures for poor sleep and violence had fairly low Cronbach's alphas (0.67 and 0.58, respectively). There may have been some inconsistency in the items measuring poor sleep and violence. Though sleep quality was associated with depression, inconsistency in the measure for violence could have contributed to the reason why we might not have observed an association

between this factor and depression. The consistency of these measures could have likely been improved upon by adding more items.

Finally, we included both sleep and fatigue in our models in this study. Both variables, however, are also symptoms of depression. As such, there is the risk that the inclusion of these variables could have inflated the fit (adjusted-R^2) of our full and reduced models. The association between these factors and depression could have also been slightly biased away from the null, given that the CES-D-10 also measures symptoms of fatigue and poor sleep.

One strength of this study was in our large sample of truck drivers. To the best of our knowledge, this is one of the largest samples of Canadian and U.S. long-haul truckers in a research study to date [13,15,20,47,105]. This enables our study's findings to be more powerful, even though we could have recruited more female drivers. Our survey, while short, also measured a large number of variables. Thus, we were able to determine the association between many factors related to truck driving and depression as well as the magnitude of these associations. We also assessed whether country of work could have had an association with depression in truckers; we do not believe that any other studies to date have tested for this association. Finally, we were able to determine that there are factors associated with depression which differ by a trucker's sex. To the best of our knowledge, this is one of the few studies to date which have specifically looked at female truckers.

4.6. *Conclusion*

Several variables are associated with depression in Canadian and U.S. long-haul truck drivers. Truckers in poor health, with poor sleep, chronic fatigue, and high stress at work have more depressive symptoms than those without these characteristics. Truckers with these characteristics may want to be recommended a mental health service. Truckers who experience

high stress due to being away from social relationships are furthermore, especially likely to have depressive symptoms. Peer and social support groups should be developed for truckers either at work or outside of work to prevent loneliness, which could lead to depression. Truckers should also try to obtain a good night's sleep on workdays and non-workdays (which may also reduce their fatigue), decrease their levels of stress, and keep themselves in good health, as these factors were all negatively associated with depression.

Stratifying the long-haul truck drivers by sex revealed that men and women differed in some of their exposures associated with depression. Though their models did not differ greatly in these exposures, high stress due to tight deadlines lost its association with depression while being never married gained a significant association with depression in the male-only model. The final model for men revealed that male truckers who have been never been married may need extra support for depression.

Never or rarely sleeping well on workdays, the number of the days they felt fatigued, and high stress due to violence outside of work were the exposures which were significantly associated with higher CES-D-10 scores in the female-only model. Their model suggests that efforts should be made so that supports for domestic violence are easily available for female truckers.

The findings of this study are important in that they examined previously untested factors for their association—if present—with depression. We addressed this current gap in the literature. Though we could not establish any causations, some of the factors in this study may be risk factors, symptoms, or have other underlying reasons for their associations with depression. We also observed some sex differences in which factors were associated with depression. The never married and violence outside of work factors in the male and female truckers, respectively,

suggest that these individuals may require extra mental health supports. To the best of our knowledge, these factors have not previously been identified as factors associated with depression in male and female truckers; thus, we are addressing this second gap in the literature.

Future studies should test whether some of factors in our final models (for all, male or female truckers) are risk factors of depression. Future studies should consider using a targeted sample of female truckers to obtain more power on which of their factors have an association with depression. Future studies should also consider using a larger sample size to stratify the truckers by age; a strong study design and recruitment strategy should be used to recruit many truck drivers. Finally, random sampling should be done to compute a prevalence of depression.

4.7. *References*

1. Public Health Agency of Canada. What is depression? [Internet]. 2009 [cited 2019 Jul 4]. Available from: https://www.canada.ca/en/public-health/services/chronic-diseases/mental-illness/what-depression.html

2. Hasin DS, Sarvet AL, Meyers JL, Saha TD, Ruan WJ, Stohl M, et al. Epidemiology of adult DSM-5 major depressive disorder and its specifiers in the United States. JAMA Psychiatry. 2018 Apr 1;75(4):336–46.

3. Weinberger AH, Gbedemah M, Martinez AM, Nash D, Galea S, Goodwin RD. Trends in depression prevalence in the USA from 2005 to 2015: widening disparities in vulnerable groups. Psychol Med. 2018 Jun;48(8):1308–15.

4. Brody DJ, Pratt LA, Hughes JP. Prevalence of depression among adults aged 20 and over: United States, 2013–2016 [Internet]. Centers for Disease Control and Prevention; 2018. Available from: https://www.cdc.gov/nchs/data/databriefs/db303.pdf

5. Pilon D, Joshi K, Sheehan JJ, Zichlin ML, Zuckerman P, Lefebvre P, et al. Burden of treatment-resistant depression in Medicare: a retrospective claims database analysis. PLoS One [Internet]. 2019 Oct 10 [cited 2020 Sep 12];14(10). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6786597/

6. Centers for Disease Control and Prevention. Current depression among adults --- United States, 2006 and 2008. U.S. Department of Health and Human Services. 2010 Oct 1;59(38):1229–35.

7. Statistics Canada. Mental and substance use disorders in Canada [Internet]. 2013 [cited 2019 Jul 4]. Available from: https://www150.statcan.gc.ca/n1/pub/82-624-x/2013001/article/11855-eng.htm

8. Shattell M, Apostolopoulos Y, Sönmez S, Griffin M. Occupational stressors and the mental health of truckers. Issues Ment Health Nurs. 2010 Aug;31(9):561–8.

9. Bøe T, Balaj M, Eikemo TA, McNamara CL, Solheim EF. Financial difficulties in childhood and adult depression in Europe. Eur J Public Health. 2017 Feb 1;27(suppl_1):96–101.

10. Weich S, Lewis G. Poverty, unemployment, and common mental disorders: population based cohort study. BMJ. 1998 Jul 11;317(7151):115–9.

11. Fan ZJ, Bonauto DK, Foley MP, Anderson NJ, Yragui NL, Silverstein BA. Occupation and the prevalence of current depression and frequent mental distress, Washington Behavioral Risk Factor Surveillance System 2006 and 2008. Am J Ind Med. 2012 Oct;55(10):893–903.

12. Shattell M, Apostolopoulos Y, Collins C, Sönmez S, Fehrenbacher C. Trucking organization and mental health disorders of truck drivers. Issues Ment Health Nurs. 2012 Jun 29;33(7):436–44.

13. Bigelow P, Myers AM, Crizzle AM, Shubair M, Thiffault P. Health and wellness of commercial motor vehicle drivers in Canada: literature review, discussion and directions for further research [Internet]. Transport Canada; 2014. Available from: https://buyandsell.gc.ca/cds/public/2014/09/24/cf03ae960e86303a593693298995bcfc/final_tc_report_cmv_health_and_wellness.pdf

14. Jensen A, Dahl S. Truck drivers Hours-of-Service regulations and occupational health. Work. 2009;33(3):363–8.

15. Apostolopoulos Y, Sönmez S, Hege A, Lemke M. Work strain, social isolation and mental health of long-haul truckers. Occup Ther Ment Health. 2016 Jan 2;32(1):50–69.

16. Cacioppo JT, Hughes ME, Waite LJ, Hawkley LC, Thisted RA. Loneliness as a specific risk factor for depressive symptoms: cross-sectional and longitudinal analyses. Psychol Aging. 2006;21(1):140–51.

17. Statistics Canada. Perspectives on labour and income: on the road again [Internet]. 2006 [cited 2019 May 11]. Available from: https://www150.statcan.gc.ca/n1/pub/75-001-x/10106/9061-eng.htm

18. Kposowa A. Marital status and suicide in the National Longitudinal Mortality Study. J Epidemiol Community Health. 2000 Apr;54(4):254–61.

19. Melhem NM, Porta G, Oquendo MA, Zelazny J, Keilp JG, Iyengar S, et al. Severity and variability of depression symptoms predicting suicide attempt in high-risk individuals. JAMA Psychiatry. 2019 Jun;76(6):603–13.

20. Mitler MM, Miller JC, Lipsitz JJ, Walsh JK, Wylie CD. The sleep of long-haul truck drivers. N Engl J Med. 1997 Sep 11;337(11):755–61.

21. Hawes NJ, Wiggins AT, Reed DB, Hardin-Fanning F. Poor sleep quality is associated with obesity and depression in farmers. Public Health Nurs. 2019 May;36(3):270–5.

22. Addington AM, Gallo JJ, Ford DE, Eaton WW. Epidemiology of unexplained fatigue and major depression in the community: the Baltimore ECA follow-up, 1981-1994. Psychol Med. 2001 Aug;31(6):1037–44.

23. Khurshid KA. Comorbid insomnia and psychiatric disorders. Innov Clin Neurosci. 2018 Apr 1;15(3–4):28–32.

24. Li L, Wu C, Gan Y, Qu X, Lu Z. Insomnia and the risk of depression: a meta-analysis of prospective cohort studies. BMC Psychiatry. 2016 Nov 5;16(1):375.

25. Couper FJ, Pemberton M, Jarvis A, Hughes M, Logan BK. Prevalence of drug use in commercial tractor-trailer drivers. J Forensic Sci. 2002 May;47(3):562–7.

26. Bonnet MH, Arand DL. Caffeine use as a model of acute and chronic insomnia. Sleep. 1992 Dec;15(6):526–36.

27. Federal Motor Carrier Safety Administration. Interstate truck driver's guide to Hours of Service [Internet]. 2015 p. 27. Available from: https://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/Drivers%20Guide%20to%20HOS%202015_508.pdf

28. Government of Yukon. Driving commercial vehicles: a guide for professional drivers. In Whitehorse, Yukon; 2014 [cited 2019 May 9]. p. 129–40. Available from: https://yukon.ca/sites/yukon.ca/files/hpw-yukon-commercial-vehicle-handbook-web.pdf

29. Belzer MH, Sedo SA. Why do long distance truck drivers work extremely long hours? Econ Labour Relat Rev. 2018 Mar 1;29(1):59–79.

30. Montesó-Curto P, Aguilar C, Lejeune M, Casadó-Marin L, Casanova Garrigós G, Ferré-Grau C. Violence and depression in a community sample. J Clin Nurs. 2017 Aug;26(15–16):2392–8.

31. Ontario Trucking Association. Mag: immigrants more than half of truck drivers in major cities [Internet]. 2018 [cited 2019 Oct 21]. Available from: http://ontruck.org/mag-immigrants-more-than-half-of-truck-drivers-in-major-cities/

32. Guan J, Hsiao H, Bradtmiller B, Kau T-Y, Reed MR, Jahns SK, et al. U.S. truck driver anthropometric study and multivariate anthropometric models for cab designs. Hum Factors. 2012 Oct;54(5):849–71.

33. Foo SQ, Tam WW, Ho CS, Tran BX, Nguyen LH, McIntyre RS, et al. Prevalence of depression among migrants: a systematic review and meta-analysis. Int J Environ Res Public Health. 2018 12;15(9).

34. Singh S, Schulz AJ, Neighbors HW, Griffith DM. Interactive effect of immigration-related factors with legal and discrimination acculturative stress in predicting depression among Asian American immigrants. Community Ment Health J. 2017 Aug;53(6):638–46.

35. Andrusaitis SF, Oliveira RP, Barros Filho TEP. Study of the prevalence and risk factors for low back pain in truck drivers in the state of São Paulo, Brazil. Clinics (Sao Paulo). 2006 Dec;61(6):503–10.

36. Konietzny K, Chehadi O, Streitlein-Böhme I, Rusche H, Willburger R, Hasenbring MI. Mild depression in low back pain: the interaction of thought suppression and stress plays a role, especially in female patients. Int J Behav Med. 2018 Apr;25(2):207–14.

37. da Silva-Júnior FP, de Pinho RSN, de Mello MT, de Bruin VMS, de Bruin PFC. Risk factors for depression in truck drivers. Soc Psychiatry Psychiatr Epidemiol. 2009 Feb;44(2):125–9.

38. Andresen EM, Byers K, Friary J, Kosloski K, Montgomery R. Performance of the 10-item Center for Epidemiologic Studies Depression scale for caregiving research. SAGE Open Med [Internet]. 2013 Dec 2 [cited 2019 Apr 30];1. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4687763/

39. Zhang W, O'Brien N, Forrest JI, Salters KA, Patterson TL, Montaner JSG, et al. Validating a shortened depression scale (10 Item CES-D) among HIV-positive people in British Columbia, Canada. PLoS One. 2012 Jul 19;7(7):e40793.

40. Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). Am J Prev Med. 1994 Apr;10(2):77–84.

41. Bradley KL, Bagnell AL, Brannen CL. Factorial validity of the Center for Epidemiological Studies Depression 10 in adolescents. Issues Ment Health Nurs. 2010 Jun;31(6):408–12.

42. Baron EC, Davies T, Lund C. Validation of the 10-item Centre for Epidemiological Studies Depression Scale (CES-D-10) in Zulu, Xhosa and Afrikaans populations in South Africa. BMC Psychiatry. 2017 09;17(1):6.

43. Miller WC, Anton HA, Townson AF. Measurement properties of the CESD scale among individuals with spinal cord injury. Spinal Cord. 2008 Apr;46(4):287–92.

44. National Institute for Occupational Safety and Health. National survey of truck driver injury and health main questionnaire. U.S. Department of Health & Human Services; 2011.

45. Dijkstra-Kersten SMA, Biesheuvel-Leliefeld KEM, van der Wouden JC, Penninx BWJH, van Marwijk HWJ. Associations of financial strain and income with depressive and anxiety disorders. J Epidemiol Community Health. 2015 Jul;69(7):660–5.

46. Srirangson A, Thavorn K, Moon M, Noh S. Mental health problems in Thai immigrants in Toronto, Canada. Int J Cult Ment Health. 2013 Aug;6(2):156–69.

47. Hege A, Lemke MK, Apostolopoulos Y, Whitaker B, Sönmez S. Work-life conflict among U.S. long-haul truck drivers: influences of work organization, perceived job stress, sleep, and organizational support. Int J Environ Res Public Health. 2019 19;16(6).

48. Kimberlin CL, Pendergast JF, Berardo DH, McKenzie LC. Issues related to using a short-form of the Center for Epidemiological Studies–Depression scale. Psychol Rep. 1998 Oct 1;83(2):411–21.

49. Boston Roybal Center for Active Lifestyle Interventions. Center for Epidemiologic Studies Depression Scale Revised (CESD-R10) [Internet]. Brandeis University; n.d. Available from: https://www.brandeis.edu/roybal/docs/CESD-10_website_PDF.pdf

50. Fan W, Yan Z. Factors affecting response rates of the web survey: a systematic review. Comput Hum Behav. 2010 Mar 1;26(2):132–9.

51. Möller-Leimkühler AM. Barriers to help-seeking by men: a review of sociocultural and clinical literature with particular reference to depression. J Affect Disord. 2002 Sep;71(1–3):1–9.

52. National Health Service Patient Survey Programme. Response rates for the community mental health survey [Internet]. Care Quality Commission; 2016. Available from: http://www.nhssurveys.org/Filestore/Community_mental_health_response_rates.pdf

53. Zimmerman FJ, Katon W. Socioeconomic status, depression disparities, and financial strain: what lies behind the income-depression relationship? Health Econ. 14(12):1197–215.

54. Thiese MS, Moffitt GL, Hanowski RJ, Kales SN, Porter RJ, Hegmann KT. Repeated cross-sectional assessment of commercial truck driver health. J Occup Environ Med. 2015;57(9):1022–7.

55. Federal Motor Carrier Safety Administration. Medical examination report: for commercial driver fitness determination [Internet]. n.d. Available from: https://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/Medical_Examination_Report_for_Commercial_Driver_Fitness_Determination_649-F%286045%29.pdf

56. Van de Velde S, Bracke P, Levecque K. Gender differences in depression in 23 European countries. Cross-national variation in the gender gap in depression. Soc Sci Med. 2010 Jul;71(2):305–13.

57. Crizzle AM, McLean M, Malkin J. Risk factors for depressive symptoms in long-haul truck drivers. Int J Environ Res Public Health [Internet]. 2020 Jun [cited 2020 Jul 13];17(11). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7312166/

58. Platt J, Prins S, Bates L, Keyes K. Unequal depression for equal work? How the wage gap explains gendered disparities in mood disorders. Soc Sci Med. 2016 Jan;149:1–8.

59. Layne DM, Rogers B, Randolph SA. Health and gender comparisons in the long-haul trucking industry: a pilot study. AAOHN Journal. 2009 Oct 1;57(10):405–13.

60. Reed DB, Cronin JS. Health on the road: issues faced by female truck drivers. AAOHN Journal. 2003 Mar 1;51(3):120–5.

61. Nakata A. Long working hours, job satisfaction, and depressive symptoms: a community-based cross-sectional study among Japanese employees in small- and medium-scale businesses. Oncotarget. 2017 May 23;8(32):53041–52.

62. Shen S, Li Y, Zhou M, Zhang C, Jiang Y, Kang Y. Depression status and associated factors in Chinese occupational truck drivers. Cell Biochem Biophys. 2013;67(3):1497–500.

63. High school grads: the “new” recruits for trucking? [Internet]. 2014 [cited 2020 May 28]. Available from: https://www.fleetowner.com/industry-perspectives/trucks-at-work/article/21698241/high-school-grads-the-new-recruits-for-trucking

64. Ministry of Transportation. Commercial truck driver training standard (Class A) [Internet]. Government of Ontario; 2016. Available from: http://www.mto.gov.on.ca/english/driver/pdfs/commercial-truck-driver-training-standard.pdf

65. Ministry of Transportation. Get a truck driver's licence [Internet]. [cited 2020 May 28]. Available from: http://www.mto.gov.on.ca/english/driver/truck-driver-licence.shtml

66. Infrastructure Health & Safety Association. Fleet Signing Authority - MTO Driver Certification Program [Internet]. n.d. [cited 2020 May 28]. Available from: https://www.ihsa.ca/Training/Courses/Fleet-Signing-Authority-MTO-Driver-Certification.aspx

67. Adler NE, Newman K. Socioeconomic disparities in health: pathways and policies. Health Aff. 2002 Mar;21(2):60–76.

68. Messias J, Cavieres H, Silva R, Facundo G, Lessa R. Being a truck driver in Brazil: from implicit self-stereotypes to system justification. Estudos de Psicologia (Campinas). 2019 Jan 1;36.

69. de Oliveira LG, de Souza LM de A, Barroso LP, Gouvêa MJC, de Almeida CVD, Muñoz DR, et al. Occupational conditions and the risk of the use of amphetamines by truck drivers. Rev Saude Publica [Internet]. 2015 Sep 29 [cited 2019 Jul 14];49. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4617435/

70. Leyton V, Sinagawa DM, Oliveira KCBG, Schmitz W, Andreuccetti G, De Martinis BS, et al. Amphetamine, cocaine and cannabinoids use among truck drivers on the roads in the state of Sao Paulo, Brazil. Forensic Sci Int. 2012 Feb;215(1–3):25–7.

71. Ribeiro M, Perrenoud LO, Duailibi S, Duailibi LB, Madruga C, Marques ACPR, et al. The Brazilian drug policy situation: the public health approach based on research undertaken in a developing country. Public Health Reviews [Internet]. 2013 Dec [cited 2020 Jul 7];35(2). Available from: http://publichealthreviews.biomedcentral.com/articles/10.1007/BF03391706

72. Berridge KC, Kringelbach ML. Pleasure systems in the brain. Neuron. 2015 May 6;86(3):646–64.

73. Richards G, Smith AP. A review of energy drinks and mental health, with a focus on stress, anxiety, and depression. J Caffeine Res. 2016 Jun 1;6(2):49–63.

74. Grosso G, Micek A, Castellano S, Pajak A, Galvano F. Coffee, tea, caffeine and risk of depression: a systematic review and dose-response meta-analysis of observational studies. Mol Nutr Food Res. 2016 Jan;60(1):223–34.

75. Australian Government Department of Health. Chapter 4: risks associated with psychostimulant use [Internet]. 2004 [cited 2020 May 28]. Available from: https://www1.health.gov.au/internet/publications/publishing.nsf/Content/drugtreat-pubs-modpsy-toc~drugtreat-pubs-modpsy-2~drugtreat-pubs-modpsy-2-4#men

76. Heaton K, Griffin R. The effects of caffeine use on driving safety among truck drivers who are habitual caffeine users. Workplace Health Saf. 2015 Aug 1;63(8):333–41.

77. Meuleners L, Fraser ML, Govorko MH, Stevenson MR. Obstructive sleep apnea, health-related factors, and long distance heavy vehicle crashes in western Australia: a case control study. J Clin Sleep Med. 2015 Apr 15;11(4):413–8.

78. Lopes CS, Hellwig N, e Silva G de A, Menezes PR. Inequities in access to depression treatment: results of the Brazilian National Health Survey – Pesquisa Nacional de Saúde. Int J Equity Health [Internet]. 2016 Nov 17 [cited 2020 Jun 23];15. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5112732/

79. American Addiction Centers. Are you self-medicating? [Internet]. 2020 [cited 2020 Jul 7]. Available from: https://americanaddictioncenters.org/adult-addiction-treatment-programs/self-medicating

80. National Institute on Drug Abuse for Teens. Your brain on stimulants, part 2: types of stimulants [Internet]. 2017 [cited 2020 Jul 10]. Available from: https://teens.drugabuse.gov/blog/post/your-brain-stimulants-part-2-types-stimulants

81. Chung H. Some socio-economic impacts of toll roads in rural China. J Transp Geogr. 2002 Jun 1;10(2):145–56.

82. Jun X, Bensman D. The heart of the problem: trucking in China's logistics sector. Proceedings of the 62nd Annual Meeting of the Labor and Employment Relations Association (LERA); 2018; Atlanta, GA, USA.

83. Jiang C, Lu L, Lu JJ. Socioeconomic factors affecting the job satisfaction levels of self-employed container truck drivers: a case study from Shanghai Port. Marit Pol Manag. 2017 Jul 4;44(5):641–56.

84. Internal Revenue Service. Publication 463 (2019): Travel, gift, and car expenses [Internet]. n.d. [cited 2020 Jul 13]. Available from: https://www.irs.gov/publications/p463

85. Canada Revenue Agency. Responsibilities, benefits and entitlements for employees and self-employed workers [Internet]. 2014 [cited 2020 Jul 13]. Available from: https://www.canada.ca/en/revenue-agency/services/tax/canada-pension-plan-cpp-employment-insurance-ei-rulings/cpp-ei-explained/employees-self-employed-workers-responsibilities-benefits-entitlements.html

86. Baglioni C, Riemann D. Is chronic insomnia a precursor to major depression? Epidemiological and biological findings. Curr Psychiatry Rep. 2012 Oct;14(5):511–8.

87. National Institute of Mental Health. Chronic illness & mental health [Internet]. [cited 2020 May 28]. Available from: https://www.nimh.nih.gov/health/publications/chronic-illness-mental-health/index.shtml

88. Habibi E, Poorabdian S, Shakerian M. Job strain (demands and control model) as a predictor of cardiovascular risk factors among petrochemical personnel. J Educ Health Promot [Internet]. 2015 Mar 26 [cited 2020 Jun 27];4. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4389361/

89. Battams S, Roche AM, Fischer JA, Lee NK, Cameron J, Kostadinov V. Workplace risk factors for anxiety and depression in male-dominated industries: a systematic review. Health Psychol Behav Med. 2014 Jan 1;2(1):983–1008.

90. Stansfeld SA, Shipley MJ, Head J, Fuhrer R. Repeated job strain and the risk of depression: longitudinal analyses from the Whitehall II study. Am J Public Health. 2012 Dec;102(12):2360–6.

91. Melchior M, Caspi A, Milne BJ, Danese A, Poulton R, Moffitt TE. Work stress precipitates depression and anxiety in young, working women and men. Psychol Med. 2007 Aug;37(8):1119–29.

92. Madsen IEH, Nyberg ST, Magnusson Hanson LL, Ferrie JE, Ahola K, Alfredsson L, et al. Job strain as a risk factor for clinical depression: systematic review and meta-analysis with additional individual participant data. Psychol Med. 2017 Jun;47(8):1342–56.

93. Canadian Centre for Occupational Health and Safety. Mental health - psychosocial risk factors in the workplace: OSH answers [Internet]. 2020 [cited 2020 May 31]. Available from: https://www.ccohs.ca/

94. Wang J, Lloyd-Evans B, Giacco D, Forsyth R, Nebo C, Mann F, et al. Social isolation in mental health: a conceptual and methodological review. Soc Psychiatry Psychiatr Epidemiol. 2017;52(12):1451–61.

95. Cacioppo JT, Hughes ME, Waite LJ, Hawkley LC, Thisted RA. Loneliness as a specific risk factor for depressive symptoms: cross-sectional and longitudinal analyses. Psychol Aging. 2006;21(1):140–51.

96. Matthews T, Danese A, Wertz J, Odgers CL, Ambler A, Moffitt TE, et al. Social isolation, loneliness and depression in young adulthood: a behavioural genetic analysis. Soc Psychiatry Psychiatr Epidemiol. 2016;51:339–48.

97. Wijngaards I, Hendriks M, Burger MJ. Steering towards happiness: an experience sampling study on the determinants of happiness of truck drivers. Transp Res Part A Policy Pract. 2019 Oct 1;128:131–48.

98. Mood Disorders Society of Canada. What is depression? [Internet]. 2019. Available from: https://mdsc.ca/docs/MDSC_What_is_Depression.pdf

99. Zhou X, Yan Z, Therese H. Depression and aggression in never-married men in China: a growing problem. Soc Psychiatry Psychiatr Epidemiol. 2012 Dec 12;48.

100. St John PD, Montgomery PR. Marital status, partner satisfaction, and depressive symptoms in older men and women. Can J Psychiatry. 2009 Jul 1;54(7):487–92.

101. Wilson CM, Oswald AJ. How does marriage affect physical and psychological health? A survey of the longitudinal evidence [Internet]. Rochester, NY: Social Science Research Network; 2005 Jun [cited 2020 Sep 12]. Available from: https://papers.ssrn.com/abstract=735205

102. Caldwell JE, Swan SC, Woodbrown VD. Gender differences in intimate partner violence outcomes. Psychol Violence. 2012;2(1):42–57.

103. Anderson DG. Workplace violence in long haul trucking: occupational health nursing update. AAOHN Journal. 2004 Jan 1;52(1):23–7.

104. Babyak MA. What you see may not be what you get: a brief, nontechnical introduction to overfitting in regression-type models. Psychosom Med. 2004 Jun;66(3):411–21.

105. Hege A, Lemke MK, Apostolopoulos Y, Sönmez S. Occupational health disparities among U.S. long-haul truck drivers: the influence of work organization and sleep on cardiovascular and metabolic disease risk. PLoS One. 2018 Nov 15;13(11):e0207322.

Chapter 5: Lack of Association between Driving Duration and Depressive Symptoms in Long-haul Truck Drivers

5.1. *Abstract*

Background: Long-haul truckers have a higher risk of depression than other occupations. The number of hours they spend driving could have an association with depression. The objective of this study was to determine if driving duration was associated with depression and if so, if this association differs by a trucker's country of work.

Methods: Canadian and U.S. long-haul truckers voluntarily participated in a web-based, cross-sectional survey which was distributed online. The exposure was a trucker's weekly duration of driving measured in hours. The outcome, depressive symptoms, was measured continuously using the 10-item Center for Epidemiological Studies Depression scale (CES-D-10). We performed univariate and bivariate analyses on all variables. The univariate analyses were also stratified by the country that a trucker drives in and the outcome. All variables were then included into a multiple linear regression model with driving duration as the exposure. The final model tested for significant interactions between the exposure and driving country, marital status, and sex.

Results: A total of 355 truckers participated in the survey. There were 303 truckers who met the eligibility criteria and who were included in the univariate and bivariate analyses. We later dropped three truckers who indicated that they were of other sex and one trucker who drove in Canada, U.S., and Mexico due to scarce numbers in these categories for testing for interactions. This left us with 299 truckers for our modelling. The crude association between driving duration and depression was statistically significant (unstandardized b = 0.10 95% CI: 0.03, 0.17) prior to adjusting for confounders. However, after controlling for country of residence, country of work,

type of trucker, general health, sleep quality, fatigue, stimulant use, age, being a recent immigrant, and the stressors of: tight delivery deadlines, poor road conditions, social isolation, and violence at work, the association disappeared (unstandardized b = 0.02, 95% CI: -0.04, 0.08). None of the interactions we tested were significant ($p < .05$) in the final model.

Conclusion: Driving duration is not associated with depression in long-haul truck drivers. Other factors seem to explain the crude relationship between driving duration and depression in long-haul truckers. Future studies should use a stronger study design and random sampling to examine whether these other factors have significant associations with depression in long-haul truckers.

5.2. *Introduction*

Depression is one of the most common mental health disorders (MHD) among the general population. Although several types of depression exist—including post-partum depression and seasonal affective disorder (SAD), the latter being a discrete type of seasonal depression—major or clinical depression is the most prevalent type of depression [1]. Major depression affected 4.7% of Canadians 15 years of age or older in 2012 and 6.0-8.1% of American adults between 2001 and 2017 [1–5].

Certain demographics are at an increased risk of depression. These include young adults (those aged 15 to 24 years old) and women, both of whom experience depression more frequently than any other demographic [1,6]. Women have a higher risk of depression than men [7]. Other vulnerable demographics include those who are financially strained and recent immigrants who are not yet citizens of their respective countries [8,9].

Long-haul truck drivers have recently been found to be commonly afflicted with higher levels of depression. The prevalence of depression among Canadian truckers was recently found to be 19% [10]. Among U.S. truckers, this prevalence was found to range between 14.6% and 26.9% [8,11]. The risk of depression in truckers has also been shown to be higher than 18 other types of occupations (OR = 6.18, 95% CI: 2.52-15.16) [11].

5.2.1. Driving as a Lifestyle and its association with Depression in Long-haul Truckers

Driving comprises most of a long-haul truck driver's day to day tasks and work hours [12]. Truckers in Canada can drive for up to 13 hours per day while in the U.S. this limit is 11 hours per day [13,14]. Likewise, truckers in Canada can work (in which, most of this time could consist of driving) for up to 70 hours per week while in the U.S. this limit is capped at 60 hours per week [13,14]. Many truckers often drive for longer than the legal limits in order to meet the

tight delivery deadlines of their industry [15]. Truckers are also often remunerated by the distance or load, which encourages longer durations of driving [15].

Driving duration has been associated with many negative outcomes in long-haul truck drivers. These outcomes include a greater risk of fatigue, crashing, falling asleep at the wheel, and being in a near-miss incident [16–20]. Similar associations have been found with short-haul truck drivers who typically work a "9am to 5pm" shift on workdays, five days a week, and are typically home each night [21]. Long hours of work, generally defined as working more than eight hours in one day, have been positively associated with both low job satisfaction and fatigue in previous studies involving non-trucking workers [17,22–24]. Fatigue and poor job satisfaction have both been linked to a greater risk of future depression [23,25].

High job stress is a risk factor for depression [8,26,27]. Many long-haul truck drivers have reported feeling stressed due to the tight delivery deadlines of long-haul trucking; poor road conditions, such as due to construction, ice, or poor weather, on their routes; and poor driving behaviours from the general public (referred to as "four-wheelers") [26]. Furthermore, truckers have reported dealing with abuse, violence, crime, and harassment while on their shifts [8,24,26]. Abuse, whether at work or at home, is a well-known risk factor for depression [8,26,27].

5.2.2. Other Elements of Trucking associated with Depression

Long-haul truckers are also often on the road for days at a time [12]. Their long and irregular shifts (which may involve driving overnight) can make it difficult for them to maintain adequate social relationships [12,24]. One study found that nearly two thirds of truckers were widowed, divorced, or separated [8]. Social isolation can be a risk factor for depression [28–30]. Men who are divorced are also more likely to be suicidal than non-divorced men [31]. Suicidal thoughts are a symptom of severe depression [32]. Those who drive for longer periods of time

may be at greater risk for social isolation, given their separation from their peers and relationships for long periods of time.

Poor sleep, such as when sleep is disturbed or short, and fatigue occur often in trucking [26,33]. This may be due to the long, erratic, and sometimes overnight shifts of many truck drivers [24,26,33]. Poor sleep and fatigue have both been shown to increase one's risk of developing depression [25,34–36]. Insomnia, as a result of consuming caffeinated products or stimulants to stay awake while on the job, has also been associated with depression [34,36]. Long durations of driving are associated with fatigue and truckers who drive for longer periods of time are prone to obtaining fewer hours of sleep [33].

Lastly, chronic pain and disability, which may occur as a result of low back pain due to trucking, has been positively associated with depression [37,38]. Nearly 60% of long-haul truck drivers experience chronic low back pain [37]. Chronic back pain can occur as a result of sitting for prolonged periods of time [37].

5.2.3. Rationale for the Current Study

The objective of this study is to determine if there is an association between long durations of driving and depression in long-haul truck drivers. To the best of our knowledge, no study to date has yet examined if such an association exists. We hypothesize that driving duration will have a positive association with depression, given that long durations of driving have been positively associated with fatigue, as well as long working hours. Long working hours have been positively associated depression particularly if one's job satisfaction is low [23]. We hypothesize that job satisfaction would decrease the longer a trucker spends driving on the road, given that truckers who drive for long periods would be at an increased risk for developing fatigue and poor sleep, be socially isolated for longer periods of time, and may be more likely to

encounter stressors while on the job. The method of renumeration of trucking may also encourage those who are financially strained to drive for longer, given that truckers are often remunerated by the distance travelled or the number of loads delivered. Financial strain is a risk factor for depression [8].

We will also examine whether the association between driving duration and depression differs by working country (Canada versus the U.S.) [24]. To the best our knowledge, no study has yet examined whether working country could be an effect modifier in the association between driving duration and depression, even though some countries (i.e., Canada and the U.S.) differ in their working environments. We hypothesize that driving in Canada would be associated with greater depressive symptoms than driving in the U.S. This belief is based on the colder climate, shorter durations of daylight, and sparser population of Canada relative to the U.S. [39–41]. A colder climate could result in more dangerous weather and road conditions (e.g., ice, freezing rain, loss of traction) which could lead to lower job satisfaction in truckers [39]. Poor job satisfaction is a risk factor for depression [23]. A lack of exposure to sunlight results in lower serotonin levels in the brain and greater melatonin production, a neurochemical process which may cause depression [42]. Finally, most of Canada is uninhabited, except near the U.S. border [40]. This may translate to a greater risk for social isolation, in addition to fewer truck stops on the road [43]. A lack of truck stops could result in greater unmet needs and fewer opportunities for rest or to take breaks. Driving in these conditions for a prolonged period of time could lead to lower job satisfaction and a greater risk of depression among those who drive in Canada relative to the U.S.

As a secondary objective, we will also examine whether certain demographic factors (i.e., sex and marital status) could modify the association between driving duration and depression. It

is possible that truckers without a current partner (e.g., widowed) could be more vulnerable to social isolation while on the road. A trucker's sex could also be a moderating factor as female truckers have reported facing disrespect, gender bias, and poor treatment as a result of their sex at work [44]. Females in other male-dominated (≥ 70% male) occupations, such as policework, have similarly reported facing discrimination and sexual harassment on the job [45,46]. Finally, women tend to experience worse health outcomes (such as more injuries, more post-traumatic stress) as a result of violence than men [47]. These issues could result in a more positive association between driving duration and depression in female truckers if their risk of exposure to these issues is higher the longer they are driving on the road for.

5.3. *Methods*

5.3.1. Study Design

An online, cross-sectional survey was used to collect the data. We used the online program Qualtrics (Provo, Utah: Qualtrics) to develop both an online consent form (Appendix A) and survey (Appendix B). Participants were required to provide consent prior to being permitted to access the survey.

We distributed the link to the consent form through a variety of offline and online methods. Only the link to the consent form was distributed both offline and online, as participants would be automatically redirected to the main survey upon completing the form and providing their informed consent. We used a combination of posters (Appendix C) put up at physical locations for truck drivers as well as promotions over radio, TV, and on social media to encourage truckers to voluntarily participate in the study. For a complete list of these individuals and locations contacted, please refer to Appendix D.

Participants could select that they would like to be entered in a draw to receive a $100 CAD prepaid gift card at the end of the study, in the consent form. The draw included those who selected that they would like to be entered in the draw, and who had completed the consent form. We ran our survey from January 15, 2020 to April 16, 2020.

Ethics approval was granted by the ethics board of Lakehead University (Appendix E).

5.3.2. Participants

Eligible participants were those whose primary country of residence was Canada or the U.S. and who were 18 years of age or older. We only included drivers who had slept away from home for at least one day over the past 30 days. We used the last condition as an attempt to screen out individuals who may not be long-haul truck drivers (such as short-haul truck drivers), as long-haul truckers are typically on the road for multiple days at a time. Truckers who did not fulfil these criteria were excluded.

5.3.3. Measures

We measured the outcome, depressive symptoms, continuously, using the 10-item Center for Epidemiological Studies Depression scale (CES-D-10). The CES-D-10 consists of 10 items which measure the severity of one's symptoms of depression. Each item is scored from 0 to 3 [48]. Higher scores denote more severe symptoms [48]. The scores of all items are summed in the CES-D-10, with a range of 0 to 30. A summed score of 10 or more is considered an indicator for depression [49]. The measure has been validated among adolescents, the elderly, and ethnic groups in Africa but not with long-haul truck drivers [50–52]. The Cronbach's alpha of the CES-D-10 has been previously found to be 0.86 [53].

Driving duration was our exposure of interest. We used a question from the U.S. National Institute for Occupational Safety and Health's (NIOSH) National Survey of Truck Driver Injury

and Health: Main Questionnaire, to measure this variable. The item asks respondents to estimate the number of hours they had spent driving their truck over the last week; or, if they had not driven over the last week, to estimate the number of hours they drive in a typical work week. Driving duration was measured continuously in hours per week.

Variables assessed as potential confounders included: age and sex (male, female, other), education (high school or less, some trade/college/university, completed a trade/college/university, some post-graduate, completed post-graduate) and marital status (now married, widowed, divorced, separated, never married, living with partner). Questions from the NIOSH National Survey of Truck Driver Injury and Health: Main Questionnaire, were used to measure sex and marital status [54]. We later dichotomized the variable for education into the levels "some post-secondary or less" and "completed post-secondary or more", in addition to collapsing some categories of marital status (i.e., widowed, separated, and divorced were grouped into one category) to increase the sample size in these categories.

We also assessed a trucker's primary country of residence (Canada, U.S.A, other) and legal status in Canada and the U.S. (Canadian or U.S. citizen, permanent resident of Canada or the U.S., work permit for Canada or the U.S., student or visiting visa for Canada or the U.S., other, don't know) as potential confounders. We used the measure for legal status by Srirangson, Thavorn, Moon and Noh (2013) [55]. The levels for legal status were later collapsed into: non-citizen/other, citizen, and don't know. In addition, we looked at whether participants were recent immigrants to Canada or the U.S. by asking participants, "have you immigrated to the USA or Canada within the past five years?" with the response options "yes" and "no". Finally, financial strain was measured by using the same measure as Dijkstra-Kersten, Biesheuvel-Leliefeld, van der Wouden, Penninx and van Marwijk (2015). We asked participants, "in general, how is your

financial status at the end of each month?". Participants responded with: usually have money left at the end of each month, just enough to get by at the end of each month, and not enough to get by at the end of each month [56].

The type of truck driver a participant was (company, owner-operator and leased to a motor carrier, owner operator and operating own truck, working for a temporary employment or personnel agency, don't know), the country they last drove in (Canada, U.S.A., Mexico, other), the number of years they have driven a truck, the number of days they have slept away from home in the past 30 days (due to work), and the number of days a trucker has slept away from home were also assessed as confounders. We used questions from NIOSH's National Survey of Truck Driver Injury and Health: Main Questionnaire to measure the type of truck driver, the number of years driving a truck for work, and the number of days a trucker has slept away from home [54]. The number of years driving a truck was later dichotomized into the levels "less than 5 years" and "5 years or more" to increase the sample size of its categories. We also measured the presence of any formal training beyond having a truck driver's licence (yes, no, don't know).

Low-back pain (yes, no, don't know) and self-perceived general health (poor, fair, good, every good, excellent, don't know) were other potential confounders we examined. We used questions from the NIOSH survey to measure low-back pain and general health, respectively. The levels for general health were later collapsed into "poor / fair", "good, very good, or excellent", and "don't know" due to a small number of truckers in certain categories.

Sleep quality was measured using the instrument used by Hege, Lemke, Apostolopoulos, Whitaker and Sönmez (2019) [57]. The measure consists of two items, which ask participants to describe how often they get a good night's sleep on workdays, followed by non-workdays. We initially split the response choices for the items into four levels (never, rarely, almost every night,

every night) but later dichotomized these into never/rarely and almost every night/every night categories to reduce collinearity. Fatigue was measured using a question from the NIOSH questionnaire and asked respondents to indicate the number of days they felt fatigued over the past seven days. We measured stimulant use by asking participants, "How often do you use stimulants other than coffee or tea (such as energy drinks, cocaine or amphetamines) to stay awake while on the job?". Response options were: never, less than once a month, one or more times a month, one or more times a week, every one or two days, and don't know. The levels were later collapsed into "never", "less than once a month or more (used at least once)", and "don't know". Finally, stress was measured by asking participants to indicate how much stress they experienced from various factors at work and outside of work. We used the same response options as those used in a similar measure for stress by Hege, Lemke, Apostolopoulos, Whitaker and Sönmez (2019) [57]. The reliability of this measure is unknown. At-work factors included stress due to tight delivery times and pressures, poor driving behaviours from the public ("four-wheelers"), poor road conditions, being away from social relationships, poor sleep (on workdays) and violence (at work). Off-work factors were poor sleep (on non-workdays) and violence (outside of work). Violence was also measured as a sub-scale within the measure for stress, using the two violence-related items. Both the stress and violence variables were later dichotomized into "none / mild / moderate" and "high / extreme / chronic" levels of stress.

5.3.4. Data Analysis

Stata SE/15.2 (College Station, TX: StataCorp LP). was used for all analyses. We first removed respondents with 3 or more missing responses to the CES-D-10. We then performed descriptive analyses on all variables, stratified by depression status, (depressed / non-depressed) according to a participant's CES-D-10 score, and the country they last drove in over the past

week (or a typical week) for work. We considered those with a score of less than 10 in the CES-D-10 as being non-depressed, while those with a score of 10 or more were considered to be depressed. Depression status was only dichotomized briefly for descriptive purposes and was not used as a categorical variable beyond the univariate analyses. We computed the mean and standard deviation for continuous variables and performed frequency counts for categorical ones.

Truck drivers with less than 3 missing responses in the CES-D-10 had their mean CES-D-10 score imputed into their missing responses. We conducted a sensitivity analysis to determine if there would be any noticeable changes in the results from doing so. The sensitivity analysis consisted of performing univariate analyses on all variables and a bivariate analysis between each variable (exposure and confounders) with depression, with and without imputation. For the bivariate analyses, we ran simple linear regression between each continuous variable (including the exposure) and depression while ANOVA was used to analyze the differences between levels of each categorical variable and depression. Dummy variables were made for all levels of our categorical variables. Simple linear regression was used to analyze all bivariate associations with depression.

We then ran a full multiple linear regression with driving duration forced in, along with all of our potential confounders against depression. This selection of variables formed our full model. We then used the backwards deletion method by Greenland, Daniel and Pearce (2016) to select which confounders to remove from our full model [58]. Interaction terms between driving duration and sex (referent: male), driving duration and marital status (referent: currently married), and driving duration with the country a trucker last worked in (referent: Canada) were added to the regression once a final model was developed. Interactions which were not significant ($p > .05$) were removed from the final model.

5.4. *Results*

There were 355 truckers who participated in the study. There were 18 truckers who did not meet the eligibility criteria and 34 truck drivers with three or more missing responses in the CES-D-10. This left us with 303 truck drivers (85.4%) for our analyses. The mean age of the truckers was 47.0 (SD = 11.8; Table 1). Males made up 76.6% of the truck drivers while females made up 17.8%. The mean driving duration of the sample was 62.4 (SD = 10.5) hours per week.

Nearly 60% of the sample was depressed, using the CES-D-10 cut-off point of ten for depression. Depressed truckers had a higher frequency of financial strain, poor/ fair health, low back pain, poor sleep quality, and indicated greater fatigue than non-depressed ones. Depressed truck drivers also reported a greater frequency of high, extreme, or chronic levels of stress relative to non-depressed truckers. The weekly driving durations of depressed and non-truckers were similar (M = 63.3, SD = 9.6; and M = 61.1, SD = 11.7, respectively).

Table 1. Characteristics of the long-haul truck drivers by depression status

		Depression status (CES-D-10)	
Variable	Total	Depressed	Non-depressed
N	303	179 (59.1%)	124 (40.9%)
Age (SD)	47.0 (11.8)	45.8 (12.4)	48.8 (10.6)
Sex			
Male	232 (76.6%)	136 (76.0%)	96 (77.4%)
Female	54 (17.8%)	30 (16.8%)	24 (19.4%)
Other	3 (1.0%)	2 (1.1%)	1 (0.8%)
Missing	14 (4.6%)	0	3 (2.4%)
Marital status			
Married now	147 (48.5%)	84 (46.9%)	63 (50.8%)
Widowed/divorced/separated	49 (16.2%)	25 (14.0%)	24 (19.4%)
Never married	39 (12.9%)	28 (15.6%)	11 (8.9%)
Living with a partner	54 (17.8%)	31 (17.3%)	23 (18.6%)
Missing	14 (4.6%)	11 (6.2%)	3 (2.4%)
Education			

Some post-secondary or less	197 (65.0%)	119 (66.5%)	78 (62.9%)
Completed post-secondary or higher	92 (30.4%)	49 (27.4%)	43 (34.7%)
Missing	14 (4.6%)	11 (6.2%)	3 (2.4%)
Legal status			
Non-citizen/other	26 (8.6%)	13 (7.3%)	13 (10.5%)
Canadian or U.S. citizen	263 (86.8%)	155 (86.6%)	108 (87.1%)
Don't know	0	0	0
Missing	14 (4.6%)	11 (6.2%)	3 (2.4%)
Financial strain			
Usually have money left	138 (45.5%)	60 (33.5%)	78 (62.9%)
Just enough to get by	125 (41.3%)	83 (46.4%)	42 (33.9%)
Not enough to get by	26 (8.6%)	25 (14.0%)	1 (0.8%)
Don't know	0	0	0
Missing	14 (4.6%)	11 (6.2%)	3 (2.4%)
Immigrated within past 5 years			
No	282 (93.1%)	163 (91.1%)	119 (96.0%)
Yes	6 (2.0%)	4 (2.2%)	2 (1.6%)
Missing	15 (5.0%)	12 (6.7%)	3 (2.4%)
Days away from home over last 30 days (SD)	22.1 (6.2)	22.2 (5.8)	21.9 (6.7)
Primary country of residence			
Canada	187 (61.7%)	113 (63.1%)	74 (59.7%)
U.S.	116 (38.3%)	66 (36.9%)	50 (40.3%)
Missing	0	0	0
Countries driven in, over last week			
Canada	85 (28.1%)	60 (33.5%)	25 (20.2%)
U.S.	127 (41.9%)	66 (36.9%)	61 (49.2%)
Mexico	0	0	0
Canada, U.S.	84 (27.7%)	46 (25.7%)	38 (30.7%)
Canada, U.S., Mexico	1 (0.3%)	1 (0.6%)	0
U.S., Mexico	0	0	0
Missing	6 (2.0%)	6 (3.4%)	0
Type of truck driver			
Company employee	220 (72.6%)	135 (75.4%)	85 (68.6%)
Owner-operator, truck leased to motor carrier	66 (21.8%)	35 (19.6%)	31 (25.0%)
Owner-operator, operates own truck	15 (5.0%)	8 (4.5%)	7 (5.7%)
Temporary employment/ personnel agency	1 (0.3%)	0	1 (0.8%)
Don't know	0	0	0
Missing	1 (0.3%)	1 (0.6%)	0
Years employed as a truck driver			

< 5 years	84 (27.7%)	57 (31.8%)	27 (21.8%)
5 years or more	218 (72.0%)	121 (67.6%)	97 (78.2%)
Missing	1 (0.3%)	1 (0.6%)	0
Professional training as trucker			
No	101 (33.3%)	57 (31.8%)	44 (35.5%)
Yes	201 (66.3%)	122 (68.2%)	79 (63.7%)
Don't know	1 (0.3%)	0	1 (0.8%)
Missing	0	0	0
Driving duration, in hours per week (SD)	62.4 (10.5)	63.3 (9.6)	61.1 (11.7)
CES-D-10 score (SD), without imputation	11.5 (6.4)	15.9 (4.4)	5.3 (2.5)
CES-D-10 score (SD), with imputation	11.6 (6.4)	15.9 (4.4)	5.3 (2.5)
General health			
Poor/ fair	95 (31.4%)	71 (39.7%)	24 (19.4%)
Good, very good or excellent	208 (68.7%)	108 (60.3%)	100 (80.7%)
Don't know	0	0	0
Missing	0	0	0
Low back pain			
No	135 (44.6%)	62 (34.6%)	73 (58.9%)
Yes	166 (54.8%)	116 (64.8%)	50 (40.3%)
Don't know	1 (0.3%)	1 (0.6%)	0
Missing	1 (0.3%)	0	1 (0.8%)
How often do you feel you get a good night's sleep…			
On workdays?			
Never/ rarely	167 (55.12%)	132 (73.7%)	35 (28.2%)
Almost every night/ every night	128 (42.2%)	40 (22.4%)	88 (71.0%)
Missing	8 (2.6%)	7 (3.9%)	1 (0.8%)
On non-workdays?			
Never/ rarely	96 (31.7%)	73 (40.8%)	23 (18.6%)
Almost every night/ every night	188 (62.1%)	93 (52.0%)	95 (76.6%)
Missing	19 (6.3%)	13 (7.3%)	6 (4.8%)
Days fatigued, over past week (SD)	3.5 (2.3)	4.5 (2.1)	2.0 (1.7)
Stimulant use			
Never	202 (66.7%)	108 (60.3%)	94 (75.8%)
< once a month or more	91 (30.0%)	61 (34.1%)	30 (24.2%)
Don't know	4 (1.32%)	4 (2.2%)	0
Missing	6 (1.98%)	6 (3.4%)	0
Stress…			
At work			
Tight delivery times and pressures			
None/ mild/ moderate	208 (68.7%)	103 (57.5%)	105 (84.7%)

High/ extreme/ chronic	86 (28.4%)	69 (38.6%)	17 (13.7%)
Missing	9 (3.0%)	7 (3.9%)	2 (1.6%)
Poor driving behaviours from 4-wheelers			
None/ mild/ moderate	131 (43.2%)	57 (31.8%)	74 (59.7%)
High/ extreme/ chronic	163 (53.8%)	115 (64.3%)	48 (38.7%)
Missing	9 (3.0%)	7 (3.9%)	2 (1.6%)
Poor road conditions (e.g., weather, ice)			
None/ mild/ moderate	197 (65.0%)	93 (52.0%)	104 (83.9%)
High/ extreme/ chronic	97 (32.0%)	79 (44.1%)	18 (14.5%)
Missing	9 (3.0%)	7 (3.9%)	2 (1.6%)
Being away from family, friends, other social relationships			
None/ mild/ moderate	179 (59.1%)	77 (43.0%)	102 (82.3%)
High/ extreme/ chronic	114 (37.6%)	94 (52.5%)	20 (16.1%)
Missing	10 (3.3%)	8 (4.5%)	2 (1.6%)
Poor sleep, on workdays			
None/ mild/ moderate	185 (61.1%)	80 (44.7%)	105 (84.7%)
High/ extreme/ chronic	108 (35.6%)	92 (51.4%)	16 (12.9%)
Missing	10 (3.3%)	7 (3.9%)	3 (2.4%)
Violence (e.g., being mugged, harassment)			
None/ mild/ moderate	269 (88.8%)	150 (83.8%)	119 (96.0%)
High/ extreme/ chronic	25 (8.3%)	22 (12.3%)	3 (2.4%)
Missing	9 (3.0%)	7 (3.9%)	2 (1.6%)
Outside of work			
Poor sleep, on non-workdays			
None/ mild/ moderate	250 (82.5%)	133 (74.3%)	117 (94.4%)
High/ extreme/ chronic	42 (13.9%)	37 (20.7%)	5 (4.0%)
Missing	11 (3.6%)	9 (5.0%)	2 (1.6%)
Violence			
None/ mild/ moderate	284 (93.7%)	165 (92.2%)	119 (96.0%)
High/ extreme/ chronic	6 (2.0%)	5 (2.8%)	1 (0.8%)
Missing	13 (4.3%)	9 (5.0%)	4 (3.2%)

Note: Standard Deviation (SD)

Stratifying the truckers by depression status and country of work (Table 2) revealed that those with depression had similar mean CES-D-10 scores irrespective of their country of work.

A similar trend was observed in the non-depressed group. There was a higher proportion of truckers who were driving in Canada who were depressed (33.7%) as opposed to non-depressed (20.2%). In contrast, there was a higher proportion of truckers who were driving in the U.S., or across both Canada and the U.S., who were not depressed group as opposed to depressed.

Among the depressed group, more than half (54.2%) of the truckers in Canada reported that they experienced high, extreme, or chronic levels of stress due to poor road conditions. High, extreme, or chronic levels of stress as a result of being away from social relationships, violence at work, and poor sleep on workdays was also reported more frequently among the truckers in Canada than any other country of work, irrespective of depression status.

The mean driving durations of those with depression, versus those without depression, did not differ greatly across the three different countries of work.

Table 2. Descriptive statistics of the long-haul truck drivers (N = 303) stratified by depression status and the countries they drove in during their last week (or a typical week) of work

	Depressed (CES-D-10 ≥ 10)				Non-depressed (CES-D-10 < 10)			
	Countries driven in over the past week (or a typical week) of work[a]							
Variable	Total[b]	Canada only	U.S. only	Canada and U.S.	Total	Canada only	U.S. only	Canada and U.S.
N = 303	179 (59.1%)	60 (33.5%)	66 (36.9%)	46 (25.7%)	124 (41.1%)	25 (20.2%)	61 (49.2%)	38 (30.6%)
Driving duration, in hours per week (SD)	63.3 (9.6)	64.7 (11.1)	63.1 (8.3)	62.7 (7.8)	61.1 (11.7)	63.0 (15.4)	59.6 (11.5)	62.4 (8.9)
Age (SD)	45.8 (12.4)	45.7 (12.7)	45.3 (12.8)	46.4 (12.2)	48.8 (10.6)	45.3 (12.8)	50.5 (10.0)	48.4 (9.7)
Sex								
Male	136 (76.0%)	53 (88.3%)	43 (65.2%)	34 (73.9%)	96 (77.4%)	22 (84.0%)	44 (72.1%)	31 (81.6%)
Female	30 (16.8%)	5 (8.3%)	18 (27.3%)	6 (13.0%)	24 (19.4%)	3 (12.0%)	15 (24.6%)	6 (15.8%)
Other	2 (1.1%)	1 (1.7%)	0	1 (2.2%)	1 (0.8%)	0	1 (1.6%)	0
Missing	11 (6.2%)	1 (1.7%)	5 (7.6%)	5 (10.9%)	3 (2.4%)	1 (4.0%)	1 (1.6%)	1 (2.6%)
Marital status								
Married now	84 (46.9%)	28 (46.7%)	31 (47.0%)	21 (45.7%)	63 (50.8%)	11 (44.0%)	35 (58.3%)	17 (44.7%)
Widowed/divorced/separated	24 (14.0%)	10 (16.6%)	10 (15.2%)	3 (6.5%)	24 (19.4%)	5 (20.0%)	12 (20.0%)	7 (18.4%)
Never married	28 (15.6%)	5 (8.3%)	15 (22.7%)	8 (17.4%)	11 (8.9%)	2 (8.0%)	5 (8.3%)	4 (10.5%)
Living with a partner	31 (17.3%)	16 (26.7%)	5 (7.6%)	9 (19.6%)	23 (18.6%)	6 (24.0%)	7 (11.7%)	9 (23.7%)
Missing	11 (6.2%)	1 (1.7%)	5 (7.6%)	5 (10.9%)	3 (2.4%)	1 (4.0%)	1 (1.7%)	1 (2.6%)
Education								
Some post-secondary or less	119 (66.5%)	47 (78.3%)	35 (53.0%)	32 (69.6%)	78 (62.9%)	18 (72.0%)	40 (65.6%)	20 (52.6%)
Completed post-secondary or higher	49 (27.4%)	12 (20.0%)	26 (39.4%)	9 (19.6%)	43 (34.7%)	6 (24.0%)	20 (32.8%)	17 (44.7%)
Missing	11 (6.2%)	1 (1.7%)	5 (7.6%)	5 (10.9%)	3 (2.4%)	1 (4.0%)	1 (1.6%)	1 (2.6%)
Legal status								
Non-citizen/other	13 (7.3%)	4 (6.7%)	8 (12.1%)	0	13 (10.5%)	3 (12.0%)	5 (8.2%)	5 (13.2%)
Canadian or U.S. citizen	155 (86.6%)	55 (91.7%)	53 (80.3%)	41 (89.1%)	108 (87.1%)	21 (84.0%)	55 (90.2%)	32 (84.2%)
Don’t know	0	0	0	0	0	0	0	0
Missing	11 (6.2%)	1 (1.7%)	5 (7.6%)	5 (10.9%)	3 (2.4%)	1 (4.0%)	1 (1.6%)	1 (2.6%)
Financial strain								

Usually have money left	60 (33.5%)	14 (23.3%)	32 (48.5%)	13 (28.3%)	78 (62.9%)	12 (48.0%)	43 (70.5%)	23 (60.5%)
Just enough to get by	83 (46.4%)	34 (56.7%)	23 (34.9%)	23 (50.0%)	42 (33.9%)	12 (48.0%)	17 (27.9%)	13 (34.2%)
Not enough to get by	25 (14.0%)	11 (18.3%)	6 (9.1%)	5 (10.9%)	1 (0.8%)	0	0	1 (2.6%)
Don't know	0	0	0	0	0	0	0	0
Missing	11 (6.2%)	1 (1.7%)	5 (7.6%)	5 (10.9%)	3 (2.4%)	1 (4.0%)	1 (1.6%)	1 (2.6%)
Immigrated within past 5 years								
No	163 (91.6%)	57 (95.0%)	60 (90.9%)	40 (87.0%)	119 (96.0%)	23 (92.0%)	60 (98.4%)	36 (94.7%)
Yes	4 (2.2%)	2 (3.3%)	0	1 (2.2%)	2 (1.6%)	1 (4.0%)	0	1 (2.6%)
Missing	12 (6.7%)	1 (1.7%)	6 (9.1%)	5 (10.9%)	3 (2.4%)	1 (4.0%)	1 (1.6%)	1 (2.6%)
Days away from home over last 30 days (SD)	22.2 (5.8)	20.6 (4.4)	23.8 (6.1)	21.7 (6.2)	21.9 (6.7)	15.9 (8.0)	23.7 (6.2)	22.7 (4.2)
Primary country of residence								
Canada	113 (63.1%)	59 (98.3%)	7 (10.6%)	44 (95.7%)	74 (59.7%)	25 (100.0%)	12 (19.7%)	37 (97.4%)
U.S.	66 (36.9%)	1 (1.7%)	59 (89.4%)	2 (4.4%)	50 (40.3%)	0	49 (80.3%)	1 (2.6%)
Missing	0	0	0	0	0	0	0	0
Countries driven in, over last week								
Canada	60 (33.5%)	-	-	-	25 (20.2%)	-	-	-
U.S.	66 (36.9%)				61 (49.2%)			
Mexico	0				0			
Canada, U.S.	46 (25.7%)				38 (30.7%)			
U.S., Mexico	1 (0.6%)				0			
Missing	6 (3.4%)				0			
Type of truck driver								
Company employee	135 (75.4%)	48 (80.0%)	52 (78.8%)	32 (69.6%)	85 (68.6%)	23 (92.0%)	38 (62.3%)	24 (63.2%)
Owner-operator, truck leased to motor carrier	35 (19.6%)	8 (13.3%)	12 (18.2%)	13 (28.3%)	31 (25.0%)	1 (4.0%)	16 (26.2%)	14 (36.8%)
Owner-operator, operates own truck	8 (4.5%)	3 (5.0%)	2 (3.0%)	1 (2.2%)	7 (5.7%)	1 (4.0%)	6 (9.8%)	0
Temporary employment/ personnel agency	0	0	0	0	1 (0.8%)	0	1 (1.6%)	0
Don't know	0	0	0	0	0	0	0	0
Missing	1 (0.6%)	1 (1.7%)	0	0	0	0	0	0
Years employed as a truck driver								
< 5 years	57 (31.8%)	17 (28.3%)	25 (37.9%)	14 (30.4%)	27 (21.8%)	6 (24.0%)	15 (25.0%)	6 (15.8%)

5 years or more	121 (67.6%)	43 (71.7%)	41 (62.1%)	32 (69.6%)	97 (78.2%)	19 (76.0%)	45 (75.0%)	32 (84.2%)
Missing	1 (0.6%)	0	0	0	0	0	0	0
Professional training as trucker								
No	57 (31.8%)	15 (25.0%)	26 (39.4%)	15 (32.6%)	44 (35.5%)	14 (56.0%)	19 (31.2%)	11 (29.0%)
Yes	122 (68.2%)	45 (75.0%)	40 (60.6%)	31 (67.4%)	79 (63.7%)	10 (40.0%)	42 (68.9%)	27 (71.1%)
Don't know	0	0	0	0	1 (0.8%)	1 (4.0%)	0	0
Missing	0	0	0	0	0	0	0	0
CES-D-10 score (SD), without imputation	15.9 (4.4)	16.5 (5.0)	15.3 (4.2)	16.1 (4.0)	5.3 (2.5)	5.4 (2.9)	5.0 (2.4)	5.6 (2.5)
CES-D-10 score (SD), with imputation	15.9 (4.4)	16.5 (5.0)	15.3 (4.2)	16.1 (4.0)	5.3 (2.5)	5.4 (2.9)	5.0 (2.5)	5.6 (2.5)
General health								
Poor/ fair	71 (39.7%)	24 (40.0%)	24 (36.4%)	19 (41.3%)	24 (19.4%)	5 (20.0%)	9 (14.8%)	10 (26.3%)
Good, very good or excellent	107 (60.3%)	36 (60.0%)	42 (63.6%)	27 (58.7%)	100 (80.7%)	20 (80.0%)	52 (85.3%)	28 (73.7%)
Don't know	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0
Low back pain								
No	62 (34.6%)	21 (35.0%)	27 (40.9%)	12 (26.1%)	73 (58.9%)	13 (52.0%)	41 (67.2%)	19 (50.0%)
Yes	116 (64.8%)	39 (65.0%)	39 (59.1%)	33 (71.7%)	50 (40.3%)	12 (48.0%)	20 (32.8%)	18 (47.4%)
Don't know	1 (0.6%)	0	0	1 (2.2%)	0	0	0	0
Missing	0	0	0	0	1 (0.8%)	0	0	1 (2.6%)
How often do you feel you get a good night's sleep…								
On workdays?								
Never/ rarely	132 (73.7%)	48 (80.0%)	43 (65.2%)	35 (76.1%)	35 (28.2%)	8 (32.0%)	16 (26.2%)	11 (29.0%)
Almost every night/ every night	40 (22.4%)	11 (18.3%)	19 (28.8%)	9 (19.6%)	88 (71.0%)	17 (68.0%)	44 (72.1%)	27 (71.1%)
Missing	7 (3.9%)	1 (1.7%)	4 (6.1%)	2 (4.4%)	1 (0.8%)	0	1 (1.6%)	0
On non-workdays?								
Never/ rarely	73 (40.8%)	24 (40.0%)	28 (42.4%)	19 (41.3%)	23 (18.6%)	3 (12.0%)	12 (19.7%)	8 (21.1%)
Almost every night/ every night	93 (52.0%)	33 (55.0%)	32 (48.5%)	24 (52.2%)	95 (76.6%)	20 (80.0%)	47 (77.1%)	28 (73.7%)
Missing	13 (7.3%)	3 (5.0%)	6 (9.1%)	3 (6.5%)	6 (4.8%)	2 (8.0%)	2 (3.3%)	2 (5.3%)

Number of days fatigued over past week (SD)	4.5 (2.1)	4.5 (2.1)	4.5 (2.1)	4.5 (2.1)	2.0 (1.7)	2.1 (1.6)	2.0 (1.7)	2.0 (1.8)
Stimulant use								
Never	108 (60.3%)	34 (56.7%)	40 (60.6%)	31 (67.4%)	94 (75.8%)	17 (68.0%)	51 (83.6%)	26 (68.4%)
< once a month or more	61 (34.1%)	22 (36.7%)	22 (33.3%)	13 (28.3%)	30 (24.2%)	8 (32.0%)	10 (16.4%)	12 (31.6%)
Don't know	4 (2.2%)	3 (5.0%)	1 (1.5%)	0	0	0	0	0
Missing	6 (3.4%)	1 (1.7%)	3 (4.6%)	2 (4.4%)	0	0	0	0
Stress…								
At work								
Tight delivery times and pressures								
None/ mild/ moderate	103 (57.5%)	36 (60.0%)	37 (56.1%)	26 (56.5%)	105 (84.7%)	22 (88.0%)	51 (83.6%)	32 (84.2%)
High/ extreme/ chronic	69 (38.6%)	23 (38.3%)	26 (39.4%)	17 (37.0%)	17 (13.7%)	2 (8.0%)	9 (14.8%)	6 (15.8%)
Missing	7 (3.9%)	1 (1.7%)	3 (4.6%)	3 (6.5%)	2 (1.6%)	1 (4.0%)	1 (1.6%)	0
Poor driving behaviours from 4-wheelers								
None/ mild/ moderate	57 (31.8%)	17 (28.3%)	25 (37.9%)	12 (26.1%)	74 (59.7%)	13 (52.0%)	36 (59.0%)	25 (65.8%)
High/ extreme/ chronic	115 (64.3%)	42 (70.0%)	38 (57.6%)	31 (67.4%)	48 (38.7%)	11 (44.0%)	24 (39.3%)	13 (34.2%)
Missing	7 (3.9%)	1 (1.7%)	3 (4.6%)	3 (6.5%)	2 (1.6%)	1 (4.0%)	1 (1.6%)	0
Poor road conditions (e.g., weather, ice)								
None/ mild/ moderate	93 (52.0%)	27 (45.0%)	37 (56.1%)	25 (54.4%)	104 (83.9%)	22 (88.0%)	51 (83.6%)	31 (81.6%)
High/ extreme/ chronic	79 (44.1%)	32 (53.3%)	26 (39.4%)	18 (39.1%)	18 (14.5%)	2 (8.0%)	9 (14.8%)	7 (18.4%)
Missing	7 (3.9%)	1 (1.7%)	3 (4.6%)	3 (6.5%)	2 (1.6%)	1 (4.0%)	1 (1.6%)	0
Being away from family, friends, other social relationships								
None/ mild/ moderate	77 (43.0%)	23 (38.3%)	32 (48.5%)	18 (39.1%)	102 (82.3%)	18 (72.0%)	49 (80.3%)	35 (92.1%)
High/ extreme/ chronic	94 (52.5%)	36 (60.0%)	30 (45.5%)	25 (54.4%)	20 (16.1%)	6 (24.0%)	11 (18.0%)	3 (7.9%)
Missing	8 (4.5%)	1 (1.7%)	4 (6.1%)	3 (6.5%)	2 (1.6%)	1 (4.0%)	1 (1.6%)	0
Poor sleep, on workdays								
None/ mild/ moderate	80 (44.7%)	24 (40.0%)	35 (53.0%)	18 (39.1%)	105 (84.7%)	18 (72.0%)	51 (83.6%)	36 (94.7%)
High/ extreme/ chronic	92 (51.4%)	35 (58.3%)	28 (42.4%)	25 (54.4%)	16 (12.9%)	5 (20.0%)	9 (14.8%)	2 (5.3%)
Missing	7 (3.9%)	1 (1.7%)	3 (4.6%)	3 (6.5%)	3 (2.4%)	2 (8.0%)	1 (1.6%)	0

Violence (e.g., being mugged, harassment)								
None/ mild/ moderate	150 (83.8%)	48 (80.0%)	57 (86.4%)	38 (82.6%)	119 (96.0%)	22 (88.0%)	59 (96.7%)	38 (100.0%)
High/ extreme/ chronic	22 (12.3%)	11 (18.3%)	6 (9.1%)	5 (10.9%)	3 (2.4%)	2 (8.0%)	1 (1.6%)	0
Missing	7 (3.9%)	1 (1.7%)	3 (4.6%)	3 (6.5%)	2 (1.6%)	1 (4.0%)	1 (1.6%)	0
Outside of work								
Poor sleep, on non-workdays								
None/ mild/ moderate	133 (74.3%)	44 (73.3%)	50 (75.8%)	34 (73.9%)	117 (94.4%)	23 (92.0%)	58 (95.1%)	36 (94.7%)
High/ extreme/ chronic	37 (20.7%)	14 (23.3%)	13 (19.7%)	9 (19.6%)	5 (4.0%)	1 (4.0%)	2 (3.3%)	2 (5.3%)
Missing	9 (5.0%)	2 (3.3%)	3 (4.6%)	3 (6.5%)	2 (1.6%)	1 (4.0%)	1 (1.6%)	0
Violence								
None/ mild/ moderate	165 (92.2%)	55 (91.7%)	61 (92.4%)	43 (93.5%)	119 (96.0%)	24 (96.0%)	57 (93.4%)	38 (100.0%)
High/ extreme/ chronic	5 (2.8%)	3 (5.0%)	2 (3.0%)	0	1 (0.8%)	0	1 (1.6%)	0
Missing	9 (5.0%)	2 (3.3%)	3 (4.6%)	3 (6.5%)	4 (3.2%)	1 (4.0%)	3 (4.9%)	0

Note: Standard Deviation (SD); [a] Data was not stratified for the one trucker who drove in Canada, U.S., and Mexico combined; [b] Counts and frequencies may not sum to row total due to some truckers with depression not indicating which country they drove in, as well as the lack of a column for the one trucker who drove in Canada, U.S., and Mexico combined

The Cronbach's alpha for the CES-D-10 remained consistently high at 0.86 with and without imputation. The measures for poor sleep (alpha = 0.67), stress including stress due to violence (alpha = 0.77), and violence using the two violence-related items only (alpha = 0.58) showed stable to acceptable levels of internal reliability.

The sensitivity analyses did not show any significant difference between imputing the mean CES-D-10 scores (for missing responses) versus using a complete-case analysis. We thus continued to use the imputed data to increase the sample size of our models. Table 3 shows the results of the bivariate analyses and thus, the crude associations between variables.

Table 3. Crude association between each variable with depression

Variable	Unstandardized regression coefficient (b)	95% Confidence interval
Driving duration	0.09	0.02, 0.16
Age	-0.10	-0.16, -0.04
Sex		
Male (ref)	-	-
Female	-0.98	-2.91, 0.94
Other	1.11	-6.31, 8.53
Marital status		
Married now (ref)	-	-
Widowed/divorced/separated	-0.36	-2.37, 1.64
Never married	1.91	-0.28, 4.10
Living with a partner	0.17	-1.76, 2.10
Education		
Some post-secondary or less (ref)	-	-
Completed post-secondary or higher	-0.92	-2.53, 0.69
Legal status*		
Non-citizen/other (ref)	-	-
Canadian or U.S. citizen	1.48	-1.15, 4.10
Financial strain*		
Usually have money left (ref)	-	-
Just enough to get by	2.33	0.84, 3.82

Not enough to get by	5.80	3.26, 8.34
Immigrated within past 5 years		
No (ref)	-	-
Yes	0.28	-5.00, 5.56
Number of days away from home	0.04	-0.08, 0.16
Primary country of residence		
Canada (ref)	-	-
U.S.	-0.87	-2.37, 0.63
Country last driven in		
Canada (ref)	-	-
U.S.	-1.97	-3.45, -0.49
Canada, U.S.	-0.19	-1.84, 1.45
Canada, U.S., Mexico	4.52	-8.25, 17.29
Type of truck driver		
Company employee (ref)	-	-
Owner-operator, truck leased to motor carrier	-0.47	-2.24, 1.29
Owner-operator, operates own truck	-0.67	-4.03, 2.68
Temporary employment/ personnel agency	-2.53	-15.22, 10.16
Years employed as a truck driver		
< 5 years (ref)	-	-
5 years or more	-1.76	-3.38, -0.14
Professional training as trucker		
No (ref)	-	-
Yes	0.78	-0.76, 2.32
Don’t know	-11.60	-24.25, 1.06
General health*		
Poor/ fair (ref)	-	-
Good, very good or excellent	-3.14	-4.67, -1.60
Low back pain		
No (ref)	-	-
Yes	3.75	2.34, 5.16
Don’t know	7.45	-5.26, 20.16
Sleep quality: workdays		
Never/ rarely (ref)	-	-
Almost every night/ every night	-6.51	-7.79, -5.22
Sleep quality: non-workdays		
Never/ rarely (ref)	-	-
Almost every night/ every night	-4.36	-5.89, -2.83

Number of days fatigued	1.55	1.26, 1.84
Stimulant use		
Never (ref)	-	-
< once a month or more	1.74	0.15, 3.32
Don't know	4.63	-1.74, 11.00
Stress: tight deadlines		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	4.71	3.17, 6.25
Stress: public driving behaviours		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	4.18	2.77, 5.60
Stress: poor road conditions		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	5.03	3.56, 6.50
Stress: away from social relationships		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	6.67	5.36, 7.99
Stress: due to poor sleep, on workdays		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	6.48	5.13, 7.83
Stress: violence at work		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	4.67	2.06, 7.27
Stress: due to poor sleep, on non-workdays		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	5.99	3.98, 8.01
Stress: violence outside of work		
None/ mild/ moderate (ref)	-	-
High/ extreme/ chronic	2.58	-2.69, 7.84

*Note: *The levels "Don't know" were not displayed as these contained no observations*

The crude association between driving duration and depression was statistically significant (unstandardized b = 0.09 95% CI: 0.02, 0.16). We decided to remove the three individuals of "other sex" and the one trucker who drove in "Canada, U.S., and Mexico" from the data at this point, due to too few truckers in these categories to be able to test for the potential

modifying effects of these two categories. The crude association between driving duration and depression was still significant (unstandardized b = 0.10 95% CI: 0.03, 0.17) prior to adjusting for confounders.

5.4.1. Regression Modelling

All remaining variables were put into the full regression model. Table 4 shows the results of the full and final multivariable linear regression models. The final model includes only those important confounders, based on the change in mean squared error. As described in Greenland et al. [58], potential confounders were eliminated one by one if the change in mean squared error (ΔMSE) of the model was negative upon their removal. The full model contained 202 observations and had an adjusted-R^2 of 0.536 and p-value of < .01. The final model contained 226 observations and had an adjusted-R^2 of 0.546 and p-value of < .01.

Table 4. Full and reduced models of the association between driving duration and depression

	Full model*		Final model±	
Exposure variable	Unstandardized regression coefficient (b)	95% Confidence interval	Unstandardized regression coefficient (b)	95% Confidence interval
Driving duration	0.05	-0.02, 0.13	0.02	-0.04, 0.08

* *Full model includes the following confounders: days away from home, country of residence, type of trucker, country last driven in, driving experience, professional training, general health, low back pain, sleep quality (both on work and non-workdays), fatigue, stimulant use; stress due to tight delivery deadlines, poor driving behaviours from the public, poor road conditions, being away from social relationships, poor sleep on workdays and non-workdays, violence at work and outside of work; age, sex, marital status, education, citizenship status, financial strain, and being a recent immigrant*

± *Final model includes the following confounders: country of residence, country last driven in, type of trucker, general health, sleep quality (both on work and non-workdays), fatigue, stimulant use; stress due to tight delivery deadlines, poor road conditions, being away from social relationships, violence at work; age, and being a recent immigrant*

The interaction terms (and their main effects, if removed) were then added into the final model to test for effect modification. Table 5 shows that none of the interaction terms we tested were statistically significant ($p > .05$). These interaction terms were ultimately dropped from the model and the final model from Table 4 was thus kept. The final model shows that driving duration was not significantly associated with depression after controlling for confounders (unstandardized b = 0.02, 95% CI: -0.04, 0.08).

Table 5. Interaction terms when added to the final model

Variable	Unstandardized regression coefficient (b)	P-value	[95% CI]
Sex			
Female × driving duration	-0.12	0.18	-0.30, 0.06
Country last drove in			
U.S. × driving duration	0.06	0.41	-0.08, 0.21
Canada, U.S. × driving duration	-0.02	0.81	-0.20, 0.15
Marital status			
Widowed/ divorced/ separated × driving duration	-0.03	0.70	-0.21, 0.14
Never married × driving duration	0.18	0.08	-0.02, 0.38
Living with partner × driving duration	0.03	0.77	-0.18, 0.25

Note: Confidence Interval (CI)

5.5. *Discussion*

5.5.1. Primary Objective

The primary objective of this study was to determine if driving duration is associated with depression in long-haul truck drivers. We observed a statistically significant, positive association in our crude bivariate model between driving duration and depression. However, this association became non-significant after controlling for other extraneous variables. This finding seems to contradict with previous findings by Useche S, Cendales B, Montoro L, and Esteban C

(2018) who conducted a study on 222 Colombian city bus drivers. Interestingly, they found a very small, but statistically significant association between higher driving duration and lower psychological distress scores even after controlling for confounders [59]. However, their model only controlled for two variables: age and gender [59]. Indeed, their model only explained 7.1% of the variance in their association. Some potentially important confounders such as income, education, and heath were also not controlled for. It is possible that the direction of their association could have changed had they accounted for some of these factors. Driving duration could have also had a negative association with distress if these drivers felt that they had more disposable income as a result of their work hours. The poverty rate in Colombia was approximately 28% in 2017 while the poverty rate of Canada and the U.S. were 9.4% and 15.1%, respectively, in 2008 and 2010 [60]. Furthermore, civil conflict in Colombia from 1964 to 2017 could have made it difficult for much of the population to work [61]. In fact, 15% of Colombians today have registered themselves as victims of conflict [61]. Thus, those who could now work to earn an income could have had more positive feelings towards their work hours.

We also expected a significant association between driving duration and depression after controlling for confounders given that one study by Wang, Rodríguez, Sarmiento and Guaje (2019) found a positive association between an individual's time spent commuting and depressive symptoms. Their association remained significant even after controlling for the commuters' mode of transportation, demographics and neighbourhood characteristics (e.g., the number of hospitals and schools within a 10-minute walk, the number of abandoned buildings within three blocks) [62]. However, they also did not report an adjusted-R^2, thus it is hard to say how well their model was able to account for the variance in their outcome and whether other factors could have still which explained their association. Their measure for neighbourhood

characteristics may have also not been valid, thus, they might not have properly controlled for the commuters' environments. Finally, long commuting times may not necessarily be generalizable to long durations of driving in truckers.

A third reason we expected to see a significant association between driving duration and depression is that people who work long hours (> 10 hours a day) have been found to be more depressed than those who work fewer hours (6 to 8 hours a day) [22,23]. This association has been significant even after adjusting for confounders (demographics, type of industry, job stressors, and other factors) [23,63]. One other major reason why we might not have observed a significant association between driving duration and depression could be due to low variation in our sample's durations of driving, which could have reduced the magnitude (and statistical significance) of the association between our exposure and outcome. Most of the truckers in this study were driving very close to their legal limits. Though this actually appears to match with the literature, such that truckers in the U.S. have been found to work for a mean of 60 to 65.0 hours per week (the mean number of hours driven per week are to the best of our knowledge, unknown in the literature) [15,64–67]. We likely observed low variation in the truckers' durations of driving due to the pressures of their industry: Truckers are often remunerated based on how far they drive and how much freight they deliver [12]. This would then mean, however, that there may be other factors which are more strongly associated with depression in truckers. Indeed, we did find that there were several confounders which explained the relationship between driving duration and depression instead of our exposure alone. We could have also had a slight under-sample of truckers with extremely high durations of driving if these truckers were less likely to have the free time to voluntarily participate in a survey. This type of selection bias could have

reduced the variation in our exposure and biased our association between driving duration and depression towards the null.

We recorded a frequency of depression which was much higher in our sample than any prevalence found in either Canadian or U.S. truckers. It is worth noting, however, that we did not compute a prevalence of depression due to our use of voluntary sampling. We may have recruited a higher number of truckers with depression due to these individuals' interest in participating in a study related to mental health. The saliency (relevance) of a topic is one of the most important factors in a participant's decision to respond to a survey [68]. People are also keen to participate in studies if they believe that they would have knowledge to contribute [69]. Truckers with depression, overall, likely had greater motivations for participating. The literature supports the above-average participation rates we observed: people with depression tend to have higher participation rates than the general public in studies involving MHD [70–72].

5.5.2. Secondary Objective

Our secondary objective sought to determine if a trucker's working country could modify the association between driving duration and depression. To the best of our knowledge, no previous studies have examined whether country of work (specifically, Canada versus U.S.) could moderate the association between driving duration and depression in truck drivers, nor in other types of drivers. We did not observe a significant interaction between country of work and driving duration in our main association. This could be due to the lack of an association between the main effect of driving duration and depression to begin with. However, we expected that those who drove in Canada would have had a more positive association between driving duration and depression for two reasons: i) the colder and less sunny climate, in general, of Canada relative to the U.S. [39]; ii) the sparser population of Canada as compared to the U.S. [40].

Though cold temperatures have not been associated with depression in the general public, sunlight is known to regulate serotonin and melatonin, which both play a role in mood and depression [73,74]. People who live in poorly-lit dwellings are also more likely to be depressed, even after controlling for confounders (e.g., health, age, income, employment, city) [73]. Most of Canada, furthermore, obtains significantly fewer annual hours of sunshine than the U.S. [41]. Snow and ice could have also resulted in more challenging road conditions and more stress. It is possible, however, that most of the truckers in Canada in this study could have simply been driving near Southern Ontario, or between Canada's major cities, near the U.S. border. This could be a natural reflection of the proportion of truckers who work in Northern versus Southern Canada; though this proportion is, to the best of our knowledge, unknown. Another possibility is that we could have obtained an oversample of truckers from Southern Canada, if these individuals were more likely to have the internet or cellphone access to participate in our survey relative to those in more Northern parts of Canada [43]. Truckers near the border, however, would have likely experienced more similar climates, levels of daylight, and road conditions to those in the U.S. [39]. This could have eliminated part of the modifying effect of country of work.

We also expected that the sparser population of Canada could have translated to greater social isolation and fewer truck stops among the truckers in Canada, relative to the U.S. [43]. Fewer truck stops could lead to more unmet needs and lower job satisfaction. Social isolation is then, a risk factor of depression [29,75]. However, if most of the truckers in Canada were simply driving near the U.S. border, then most of them might not have experienced these conditions; the population density of Canada near the border is quite high [40]. Consequently, we might have eliminated part of the moderating effect of country of work, if again, we had a sample which was

mostly driving in urban areas, near the U.S. border [43]. A final possibility is that country of work might simply not be an effect modifier at all in the (lack of) association between driving duration and depression. However future studies may want to verify this.

We also examined whether other characteristics of truck drivers (i.e., marital status, sex) could modify the association between driving duration and depression. Marital status was not found to be a significant effect modifier. One study involving over 16,000 Japanese employees from nine manufacturing companies found a positive association between work hours and depression and similarly, found no interaction between marital status and work hours [76]. Our findings seem to corroborate with theirs, such that marital status might not strongly interact with driving duration in truckers. This could be the case even if a general employee's work hours are not comparable to the hours spent driving a long-haul truck. A second explanation why we might have not seen a significant modifying effect, however, could be due to the lack of an association between the main effect of driving duration and depression to begin with. Sparse numbers in some categories of marital status could have also made it harder to observe an effect.

We did not observe a significant interaction between driving duration and sex, even though we believed that women with longer durations of driving could have had a greater risk of encountering one of their sex-based hazards (such as sexual harassment) while at work. This finding appears to contradict the literature, such that females have been shown to have a more positive association between their work hours and depression than males even after adjusting for confounders (e.g., demographics, job seniority, blue/white/pink collar work, sleep) [76,77]. One possible explanation for our findings is that the female truckers could have had different reasons for entering the industry than males (Carson J, personal communication, February 2020). Female truckers tend to enter the industry after their childbearing years, which is not necessarily true of

male ones [44]. They may be doing so as a way to re-enter the workforce, spend time with their spouse, supplement their spouse's income, or travel the country for leisure (Carson J, personal communication, February 2020) [44]. As the females tend to be joining later in life, they may have also had another career prior to trucking [44]. These characteristics could make it easier for more females who dislike driving, or who develop depression, to simply leave the industry relative to men, particularly if they no longer had children to raise or if their spouse was already earning much of the household's income. Consequently, the females who remain in trucking could be more likely to be those who enjoy the work, and/or those who are not depressed. This in turn, could have reduced the modifying effect of female sex in this study. Alternatively, as with country of work, female sex may simply not be an effect modifier in the association between driving duration and depression in long-haul truckers.

5.5.3. Limitations & Strengths

A major limitation of this study is that we were not able to establish any cause-and-effect relationships. This was due to our use of a cross-sectional study. Thus, any findings from this study should be interpreted as only associative and not causal in nature.

A second limitation of this study was in our use of voluntary recruitment. As such, we could not calculate a prevalence of depression. It is also possible that there could have been a bit of a healthy worker effect among our sample such that those with the most severe symptoms of depression could have already quit trucking. Thus, we could have missed these individuals. This selection bias would have biased our findings towards the null.

Similarly, those who currently have depression could have also been those who are more likely to be temporarily off work. As such, truckers with depression could have been more likely to provide us with their *typical* durations of driving and not their durations of driving over the

last week. Statistics Canada, however, reports that a person's self-estimates of their typical work hours in a week are usually higher (by up to 0.6 hours) than their true number of hours worked over the last week [78]. There is thus, the risk for differential measurement error in this study, which—if present—could have biased our association between driving duration and depression slightly away from the null.

There is the risk that we could have had selection bias in the driving durations we sampled, such that truckers who drove for fewer hours could have had an easier time participating. Although, our mean durations of driving actually did not differ from the mean number of hours worked each week for U.S. truckers (60 to 65.0 work hours per week, between 1997 and 2010) [15]. Thus, we did not appear to have below-average durations of driving. Still, it is possible that we could have recruited fewer drivers with extremely high durations of driving, which would have resulted in lower variation in our truckers' durations of driving. This increases the risk that we could have had a type II error in this study.

The use of a web-based survey may have also limited who could participate in the study, such that those with regular internet and cellphone service would have had an easier time in participating. As such, we may have had an oversample of truckers in Canada who drove near the U.S. border if this region tended to have more frequent truck stops and better internet or cellphone service. An oversample of truckers driving near the U.S.-Canadian border could have led to few regional differences between the trucking environments of Canada and the U.S. and thus, eliminated the modifying effect of country of work.

We were unable to examine age as an effect modifier due to the sample size limitations of this study. In addition, we did not examine a trucker's primary country of residence as an effect modifier. It is possible that country of residence could have been a more accurate measure for

assessing differences between the Canadian and U.S. truckers. The country that was driven in over the last week (for those who were not on a leave of absence) may have not been a country that a trucker typically drives in, and thus, not a good variable for comparing between truckers from the two countries.

One strength of our study is that we included a large sample size of long-haul truck drivers. This allows for our study's findings to be more powerful. We were also able to perform descriptive statistics on different countries of work (Canada versus U.S.; those who drove in both countries), which, to the best of our knowledge, has not previously been examined before in truckers. The modifying effects of country of work, sex, and marital status on depression were also investigated and we do not believe that these variables have been previously assessed as potential effect modifiers in any sort of association involving truck drivers. Finally, though our survey was short, we also controlled for many confounders in our models.

5.6. *Conclusion*

Driving duration had a small positive crude association with depression in long-haul truck drivers. However, this association disappeared after controlling for important extraneous factors. Similarly, the country that a trucker has driven in over their last week (or a typical week) of work, their marital status, and their sex did not modify the association between the number of hours driven per week and depression.

The findings of this study addressed a previously unknown gap in the literature. Our findings suggest that there may be other factors, other than weekly driving duration alone, which could be associated with depression in long-haul truckers. Future studies should use a stronger study design and random sampling to investigate some of these other factors in long-haul truck drivers.

5.7. *References*

1. Public Health Agency of Canada. What is depression? [Internet]. 2009 [cited 2019 Jul 4]. Available from: https://www.canada.ca/en/public-health/services/chronic-diseases/mental-illness/what-depression.html

2. Weinberger AH, Gbedemah M, Martinez AM, Nash D, Galea S, Goodwin RD. Trends in depression prevalence in the USA from 2005 to 2015: widening disparities in vulnerable groups. Psychol Med. 2018 Jun;48(8):1308–15.

3. Brody DJ, Pratt LA, Hughes JP. Prevalence of depression among adults aged 20 and over: United States, 2013–2016 [Internet]. Centers for Disease Control and Prevention; 2018. Available from: https://www.cdc.gov/nchs/data/databriefs/db303.pdf

4. Pilon D, Joshi K, Sheehan JJ, Zichlin ML, Zuckerman P, Lefebvre P, et al. Burden of treatment-resistant depression in Medicare: a retrospective claims database analysis. PLoS One [Internet]. 2019 Oct 10 [cited 2020 Sep 12];14(10). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6786597/

5. Centers for Disease Control and Prevention. Current depression among adults --- United States, 2006 and 2008. U.S. Department of Health and Human Services. 2010 Oct 1;59(38):1229–35.

6. Statistics Canada. Mental and substance use disorders in Canada [Internet]. 2013 [cited 2019 Jul 4]. Available from: https://www150.statcan.gc.ca/n1/pub/82-624-x/2013001/article/11855-eng.htm

7. Van de Velde S, Bracke P, Levecque K. Gender differences in depression in 23 European countries. Cross-national variation in the gender gap in depression. Soc Sci Med. 2010 Jul;71(2):305–13.

8. Shattell M, Apostolopoulos Y, Collins C, Sönmez S, Fehrenbacher C. Trucking organization and mental health disorders of truck drivers. Issues Ment Health Nurs. 2012 Jun 29;33(7):436–44.

9. Singh S, Schulz AJ, Neighbors HW, Griffith DM. Interactive effect of immigration-related factors with legal and discrimination acculturative stress in predicting depression among Asian American immigrants. Community Ment Health J. 2017 Aug;53(6):638–46.

10. Bigelow P, Myers AM, Crizzle AM, Shubair M, Thiffault P. Health and wellness of commercial motor vehicle drivers in Canada: literature review, discussion and directions for further research [Internet]. Transport Canada; 2014. Available from: https://buyandsell.gc.ca/cds/public/2014/09/24/cf03ae960e86303a593693298995bcfc/final_tc_report_cmv_health_and_wellness.pdf

11. Fan ZJ, Bonauto DK, Foley MP, Anderson NJ, Yragui NL, Silverstein BA. Occupation and the prevalence of current depression and frequent mental distress, Washington Behavioral Risk Factor Surveillance System 2006 and 2008. Am J Ind Med. 2012 Oct;55(10):893–903.

12. Statistics Canada. Perspectives on labour and income: on the road again [Internet]. 2006 [cited 2019 May 11]. Available from: https://www150.statcan.gc.ca/n1/pub/75-001-x/10106/9061-eng.htm

13. Federal Motor Carrier Safety Administration. Interstate truck driver's guide to Hours of Service [Internet]. 2015 p. 27. Available from: https://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/Drivers%20Guide%20to%20HOS%202015_508.pdf

14. Government of Yukon. Driving commercial vehicles: a guide for professional drivers. In Whitehorse, Yukon; 2014 [cited 2019 May 9]. p. 129–40. Available from: https://yukon.ca/sites/yukon.ca/files/hpw-yukon-commercial-vehicle-handbook-web.pdf

15. Belzer MH, Sedo SA. Why do long distance truck drivers work extremely long hours? Econ Labour Relat Rev. 2018 Mar 1;29(1):59–79.

16. Chen C, Xie Y. Modeling the safety impacts of driving hours and rest breaks on truck drivers considering time-dependent covariates. J Safety Res. 2014 Dec;51:57–63.

17. Williamson A, Feyer A-M, Friswell R, Sadural S. Driver fatigue: a survey of long distance heavy vehicle drivers in Australia [Internet]. 2001. Available from: https://www.infrastructure.gov.au/roads/safety/publications/2001/pdf/Fatig_Trans_6.pdf

18. Heaton K, Browning S, Anderson D. Identifying variables that predict falling asleep at the wheel among long-haul truck drivers. AAOHN journal. 2008 Oct 1;56:379–85.

19. Hanowski RJ, Hickman J, Fumero MC, Olson RL, Dingus TA. The sleep of commercial vehicle drivers under the 2003 Hours-of-Service regulations. Accid Anal Prev. 2007 Nov;39(6):1140–5.

20. Health P on RM and SA to UDFF in MCS and D, Statistics C on N, Integration B on H-S, Education D of B and SS and, Board TR, National Academies of Sciences E. Hours-of-Service regulations [Internet]. National Academies Press (US); 2016 [cited 2019 Jul 13]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK384967/

21. Martins AJ, Martini LA, Moreno CRC. Prudent diet is associated with low sleepiness among short-haul truck drivers. Nutrition. 2019;63(Complete):61–8.

22. Bannai A, Tamakoshi A. The association between long working hours and health: a systematic review of epidemiological evidence. Scand J Work Environ Health. 2014 Jan;40(1):5–18.

23. Nakata A. Long working hours, job satisfaction, and depressive symptoms: a community-based cross-sectional study among Japanese employees in small- and medium-scale businesses. Oncotarget. 2017 May 23;8(32):53041–52.

24. Apostolopoulos Y, Sönmez S, Hege A, Lemke M. Work strain, social isolation and mental health of long-haul truckers. Occup Ther Ment Health. 2016 Jan 2;32(1):50–69.

25. Addington AM, Gallo JJ, Ford DE, Eaton WW. Epidemiology of unexplained fatigue and major depression in the community: the Baltimore ECA follow-up, 1981-1994. Psychol Med. 2001 Aug;31(6):1037–44.

26. Shattell M, Apostolopoulos Y, Sönmez S, Griffin M. Occupational stressors and the mental health of truckers. Issues Ment Health Nurs. 2010 Aug;31(9):561–8.

27. Montesó-Curto P, Aguilar C, Lejeune M, Casadó-Marin L, Casanova Garrigós G, Ferré-Grau C. Violence and depression in a community sample. J of Clin Nurs. 2017 Aug;26(15–16):2392–8.

28. Calati R, Ferrari C, Brittner M, Oasi O, Olié E, Carvalho AF, et al. Suicidal thoughts and behaviors and social isolation: a narrative review of the literature. J Affect Disord. 2019 15;245:653–67.

29. Wang J, Lloyd-Evans B, Giacco D, Forsyth R, Nebo C, Mann F, et al. Social isolation in mental health: a conceptual and methodological review. Soc Psychiatry Psychiatr Epidemiol. 2017;52(12):1451–61.

30. Cacioppo JT, Hughes ME, Waite LJ, Hawkley LC, Thisted RA. Loneliness as a specific risk factor for depressive symptoms: cross-sectional and longitudinal analyses. Psychol Aging. 2006;21(1):140–51.

31. Kposowa A. Marital status and suicide in the National Longitudinal Mortality Study. J Epidemiol Community Health. 2000 Apr;54(4):254–61.

32. Melhem NM, Porta G, Oquendo MA, Zelazny J, Keilp JG, Iyengar S, et al. Severity and variability of depression symptoms predicting suicide attempt in high-risk individuals. JAMA Psychiatry. 2019 Jun;76(6):603–13.

33. Mitler MM, Miller JC, Lipsitz JJ, Walsh JK, Wylie CD. The sleep of long-haul truck drivers. N Engl J Med. 1997 Sep 11;337(11):755–61.

34. Hawes NJ, Wiggins AT, Reed DB, Hardin-Fanning F. Poor sleep quality is associated with obesity and depression in farmers. Public Health Nurs. 2019 May;36(3):270–5.

35. Khurshid KA. Comorbid insomnia and psychiatric disorders. Innov Clin Neurosci. 2018 Apr 1;15(3–4):28–32.

36. Li L, Wu C, Gan Y, Qu X, Lu Z. Insomnia and the risk of depression: a meta-analysis of prospective cohort studies. BMC Psychiatry. 2016 Nov 5;16(1):375.

37. Andrusaitis SF, Oliveira RP, Barros Filho TEP. Study of the prevalence and risk factors for low back pain in truck drivers in the state of São Paulo, Brazil. Clinics (Sao Paulo). 2006 Dec;61(6):503–10.

38. Konietzny K, Chehadi O, Streitlein-Böhme I, Rusche H, Willburger R, Hasenbring MI. Mild depression in low back pain: the interaction of thought suppression and stress plays a role, especially in female patients. Int J Behav Med. 2018 Apr;25(2):207–14.

39. Government of Canada. Land and climate [Internet]. 2009 [cited 2020 Jul 4]. Available from: https://www.canada.ca/en/immigration-refugees-citizenship/services/new-immigrants/learn-about-canada/land-climate.html

40. Statistics Canada. Canadian demographics at a glance: provinces and regions [Internet]. n.d. [cited 2020 Jun 22]. Available from: https://www150.statcan.gc.ca/n1/pub/91-003-x/2007001/4129908-eng.htm

41. de Jong S, Auping WL, Oosterveld WT, Usanov A, Abdalla M, van de Bovenkamp A. The geopolitical impact of climate mitigation policies [Internet]. The Hague Centre for Strategic Studies; 2017. Available from: https://hcss.nl/sites/default/files/files/reports/HCSS_Energytransition.pdf

42. Kent ST, McClure LA, Crosson WL, Arnett DK, Wadley VG, Sathiakumar N. Effect of sunlight exposure on cognitive function among depressed and non-depressed participants: a REGARDS cross-sectional study. Environ Health. 2009 Jul 28;8:34.

43. Smart Trucking. A quick guide to the state of truck driving in Canada [Internet]. 2019 [cited 2020 Jul 1]. Available from: https://www.smart-trucking.com/truck-driving-in-canada/

44. Reed DB, Cronin JS. Health on the road: issues faced by female truck drivers. AAOHN Journal. 2003 Mar 1;51(3):120–5.

45. Somvadee C, Morash M. Dynamics of sexual harassment for policewomen working alongside men. Policing. 2008;31(3):485–98.

46. Battams S, Roche AM, Fischer JA, Lee NK, Cameron J, Kostadinov V. Workplace risk factors for anxiety and depression in male-dominated industries: a systematic review. Health Psychol Behav Med. 2014 Jan 1;2(1):983–1008.

47. Caldwell JE, Swan SC, Woodbrown VD. Gender differences in intimate partner violence outcomes. Psychol Violence. 2012;2(1):42–57.

48. Andresen EM, Byers K, Friary J, Kosloski K, Montgomery R. Performance of the 10-item Center for Epidemiologic Studies Depression scale for caregiving research. SAGE Open Med [Internet]. 2013 Dec 2 [cited 2019 Apr 30];1. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4687763/

49. Zhang W, O'Brien N, Forrest JI, Salters KA, Patterson TL, Montaner JSG, et al. Validating a shortened depression scale (10 Item CES-D) among HIV-positive people in British Columbia, Canada. PLoS One. 2012 Jul 19;7(7):e40793.

50. Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). Am J Prev Med. 1994 Apr;10(2):77–84.

51. Bradley KL, Bagnell AL, Brannen CL. Factorial validity of the Center for Epidemiological Studies Depression 10 in adolescents. Issues Ment Health Nurs. 2010 Jun;31(6):408–12.

52. Baron EC, Davies T, Lund C. Validation of the 10-item Centre for Epidemiological Studies Depression Scale (CES-D-10) in Zulu, Xhosa and Afrikaans populations in South Africa. BMC Psychiatry. 2017 09;17(1):6.

53. Miller WC, Anton HA, Townson AF. Measurement properties of the CESD scale among individuals with spinal cord injury. Spinal Cord. 2008 Apr;46(4):287–92.

54. National Institute for Occupational Safety and Health. National survey of truck driver injury and health main questionnaire. U.S. Department of Health & Human Services; 2011.

55. Srirangson A, Thavorn K, Moon M, Noh S. Mental health problems in Thai immigrants in Toronto, Canada. Int J Cult Ment Health. 2013 Aug;6(2):156–69.

56. Dijkstra-Kersten SMA, Biesheuvel-Leliefeld KEM, van der Wouden JC, Penninx BWJH, van Marwijk HWJ. Associations of financial strain and income with depressive and anxiety disorders. J Epidemiol Community Health. 2015 Jul;69(7):660–5.

57. Hege A, Lemke MK, Apostolopoulos Y, Whitaker B, Sönmez S. Work-life conflict among U.S. long-haul truck drivers: influences of work organization, perceived job stress, sleep, and organizational support. Int J Environ Res Public Health. 2019 19;16(6).

58. Greenland S, Daniel R, Pearce N. Outcome modelling strategies in epidemiology: traditional methods and basic alternatives. Int J Epidemiol. 2016 Apr 1;45(2):565–75.

59. Useche SA, Cendales B, Montoro L, Esteban C. Work stress and health problems of professional drivers: a hazardous formula for their safety outcomes. PeerJ [Internet]. 2018 Dec 20 [cited 2020 May 30];6. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6304262/

60. Central Intelligence Agency. Field listing: population below poverty line [Internet]. n.d. [cited 2020 Jun 30]. Available from: https://www.cia.gov/library/publications/the-world-factbook/fields/221.html

61. Congressional Research Service. Colombia: background and U.S. relations [Internet]. 2019. Available from: https://fas.org/sgp/crs/row/R43813.pdf

62. Wang X, Rodríguez DA, Sarmiento OL, Guaje O. Commute patterns and depression: Evidence from eleven Latin American cities. J Transp Health. 2019 Sep 1;14:100607.

63. Yoon Y, Ryu J, Kim H, Kang C won, Jung-Choi K. Working hours and depressive symptoms: the role of job stress factors. Ann Occup Environ Med [Internet]. 2018 Jul 13

[cited 2020 Jun 30];30. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6043993/

64. Belman DL, Monaco KA, Brooks TJ. Sailors of the concrete sea: a portrait of truck drivers' work and lives. East Lansing: Michigan State University Press; 2004.

65. Roetting M, Huang Y-H, McDevitt JR, Melton D. When technology tells you how you drive—truck drivers' attitudes towards feedback by technology. Transp Res Part F Traffic Psychol Behav. 2003 Dec 1;6(4):275–87.

66. Chen GX, Sieber WK, Lincoln JE, Birdsey J, Hitchcock EM, Nakata A, et al. NIOSH national survey of long-haul truck drivers: injury and safety. Accid Anal Prev. 2015 Dec;85:66–72.

67. Federal Motor Carrier Safety Administration, U.S. Department of Transportation. FMCSA field HOS survey: motor carrier industry implementation and use of the April 2003 Hours of Service regulations. FMCSA, U.S. Department of Transportation.; 2005.

68. Fan W, Yan Z. Factors affecting response rates of the web survey: a systematic review. Comput Hum Behav. 2010 Mar 1;26(2):132–9.

69. Möller-Leimkühler AM. Barriers to help-seeking by men: a review of sociocultural and clinical literature with particular reference to depression. J Affect Disord. 2002 Sep;71(1–3):1–9.

70. Brown JSL, Murphy C, Kelly J, Goldsmith K. How can we successfully recruit depressed people? Lessons learned in recruiting depressed participants to a multi-site trial of a brief depression intervention (the 'CLASSIC' trial). Trials [Internet]. 2019 Dec [cited 2019 Jul 17];20(1). Available from: https://trialsjournal.biomedcentral.com/articles/10.1186/s13063-018-3033-5

71. Tallon D, Mulligan J, Wiles N, Thomas L, Peters TJ, Elgie R, et al. Involving patients with depression in research: survey of patients' attitudes to participation. Br J Gen Pract. 2011 Apr;61(585):134–41.

72. National Health Service Patient Survey Programme. Response rates for the community mental health survey [Internet]. Care Quality Commission; 2016. Available from: http://www.nhssurveys.org/Filestore/Community_mental_health_response_rates.pdf

73. Brown MJ, Jacobs DE. Residential light and risk for depression and falls: results from the LARES study of eight European cities. Public Health Rep. 2011;126(Suppl 1):131–40.

74. Huibers MJH, de Graaf LE, Peeters FPML, Arntz A. Does the weather make us sad? Meteorological determinants of mood and depression in the general population. Psychiatry Res. 2010 Dec 30;180(2):143–6.

75. Leigh-Hunt N, Bagguley D, Bash K, Turner V, Turnbull S, Valtorta N, et al. An overview of systematic reviews on the public health consequences of social isolation and loneliness. Public Health. 2017;152(Complete):157–71.

76. Tsuno K, Kawachi I, Inoue A, Nakai S, Tanigaki T, Nagatomi H, et al. Long working hours and depressive symptoms: moderating effects of gender, socioeconomic status, and job resources. Int Arch Occup Environ Health. 2019 Jul 1;92(5):661–72.

77. Weston G, Zilanawala A, Webb E, Carvalho LA, McMunn A. Long work hours, weekend working and depressive symptoms in men and women: findings from a UK population-based study. J Epidemiol Community Health. 2019 May;73(5):465–74.

78. Statistics Canada. Average usual and actual hours worked in a reference week by type of work (full- and part-time), annual [Internet]. 2018 [cited 2019 Jul 17]. Available from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410004301

Chapter 6: Discussion

6.1. *Overview of Findings*

The primary objective of this study was to determine factors associated with depressive symptoms in long-haul truck drivers. It was found that being in good, very good or excellent health, having good quality sleep almost every day or every day on workdays, and having good quality sleep almost every day or everyday on non-workdays were associated with a significantly lower risk of depression. In particular, good quality sleep on workdays and good health both had the most negative associations with depressive symptoms. Meanwhile, being fatigued and having high, extreme, or chronic levels of stress due to tight delivery deadlines, poor road conditions, or being away from social relationships were associated with a significantly higher risk of depression. In particular, high stress due to being away from social relationships and fatigue both had the most positive associations with depression.

The secondary objective of this study was to determine the association between driving duration and depression. It was found that driving duration had a positive, statistically significant crude association with depression. This association, however, was no longer statistically significant after adjusting for confounders.

The tertiary objective of this study was to determine the moderating effect of a long-haul truck driver's country of work on the association between driving duration and depression. We found no evidence of effect modification due to a truck driver's country of work.

6.2. *Main Findings*

6.2.1. Factors Associated with Depressive Symptoms in Long-haul Truck Drivers

In Chapter Four, we hypothesized that all of the predictors presented in the introduction would have been factors associated with depression. However, only some of the factors were

significantly associated with depression. Consequently, our hypothesis was rejected. We observed that good, very good, or excellent health had the second greatest negative association with depressive symptoms (standardized β = -0.17, 95% CI: -0.27, -0.07), relative to all other factors. Good, very good, or excellent health was associated with a two-point decrease in a trucker's CES-D-10 score (unstandardized b = -2.13, 95% CI: -3.35, -0.91), relative to poor or fair health. Good quality sleep almost every day, or every day on workdays had the most negative association with depressive symptoms out of all other factors (standardized β = -0.17, 95% CI: -0.27, -0.07). The association between good quality sleep on non-workdays and depressive symptoms was slightly less positive (standardized β = -0.14, 95% CI: -0.23, -0.04). Regardless, good quality sleep on workdays and non-workdays were both associated with a nearly two-point decrease in a trucker's CES-D-10 score (unstandardized b = -2.23, 95% CI: -3.59, -0.87 and unstandardized b = -1.86, 95% CI: -3.15, -0.57 respectively), relative to poor sleep quality on these days. Truckers who were in good health, and who had good sleep on an average given day, were thus, less likely to be depressed. Alternatively, those who were not depressed were more likely to be those in good health, or who slept well on an average given day.

Our findings that poor sleep and poor health were positively associated with depression are supported by the literature. It is well-known that poor sleep is a symptom of depression [1]. Those with depression are also more likely to develop poor health [2]. However, poor sleep and poor health can both increase one's risk of depression [3,4]. These bidirectional relationships likely explain why good sleep quality (on workdays) and good health both had the most negative associations with depression in our final model. It is also worth noting that good sleep quality on workdays could have had a more negative association with depressive symptoms than good sleep

quality on non-workdays if the truckers with depression ended up sleeping for longer periods of time, or slept more frequently, on their days off [1]. Fatigue, a lack of energy (lethargy), and trouble sleeping are all symptoms of depression [1]. Truckers with depressive symptoms could have thus, wanted to sleep more during the week, or could have experienced poor sleep quality during the week (i.e., on workdays) due to their symptoms. However, the long and irregular hours of trucking could have made it difficult for those with depression to obtain this sleep on a workday, thus, some truckers could have chosen to pursue this sleep on non-workdays instead. Consequently, some individuals with depressive symptoms could have ended up with better sleep quality on their days off, while still experiencing poor sleep quality on their workdays. This phenomenon might explain why poor sleep quality on workdays had a slightly more positive association with depression than poor sleep quality on non-workdays.

A recent case-control study by Crizzle, McLean, and Malkin (2020) found that broken sleep (their measure of poor sleep) was positively associated with depressive symptoms in 107 Canadian long-haul truckers but interestingly, not poor health [5]. However, their results should be interpreted with caution (see Section 2.4.1. for details). We believe that our associations between sleep quality and depressive symptoms, and between general health and depressive symptoms were overall, sensible.

Fatigue had the second greatest positive association with depression (standardized β = 0.26, 95% CI: 0.16, 0.36), relative to all other factors. Each additional day of fatigue during the week was associated with a (unstandardized b) 0.74-point (95% CI: 0.45, 1.04) increase in a trucker's CES-D-10 score. Thus, truckers with more days of fatigue throughout week are more likely to be depressed. There is some cohort evidence that fatigue may be a risk factor of depression, although the authors only controlled for age and sex [6]. Thus, they may have missed

some confounders and their results should be interpreted with caution [6]. Fatigue, however, is also a well-known symptom of depression [1]. Thus, another interpretation of our association is that the truckers with higher CES-D-10 scores could have also been those who felt more frequently fatigued throughout the week. Either way, the highly positive relationship between fatigue and depression is likely due to fatigue being both a symptom and risk factor of depression. Interestingly, Crizzle, McLean, and Malkin (2020) did not observe an association between fatigue and depressive symptoms [5]. However, there were also some methodological concerns with their study (refer to Section 2.4.1). The association we found between fatigue and depression appears to be reasonable, based on the literature regarding depression.

High stress due to tight delivery deadlines (unstandardized b = 2.14, 95% CI: 0.84, 3.44) and poor road conditions (unstandardized b = 1.81, 95% CI: 0.56, 3.07) were each associated with a nearly two-point increase in a trucker's CES-D-10 score as opposed to those who did not experience high stress from these factors. High stress due to being away from social relationships (unstandardized b = 3.54, 95% CI: 2.28, 4.80) was then associated with a nearly four-point increase in a truck driver's CES-D-10 score. High stress due to being away from social relationships was, in fact, the factor with the most positive association with depression (standardized $\beta = 0.27$, 95% CI: 0.18, 0.36) across the full sample. Truckers who experience high stress at work due to tight delivery deadlines and driving on poor roads are thus, more likely to be depressed. Those who experience high stress due to social isolation are especially vulnerable to having depressive symptoms.

To the best of our knowledge, stress due to tight and unrealistic delivery timelines is a factor which has not yet been studied for its association with depression in truckers, nor in other types of commercial drivers. Crizzle, McLean, and Malkin (2020) did find that severe job-related

stress was positively associated with symptoms of depression in their study on truckers [5]. However, they did not specify what stressors they were looking at, nor what tool they used to measure job stress [5]. Regardless, we believe that our association could have been due to those with tight delivery deadlines experiencing high job strain (high job demands and a lack of control at work) and job overload (high amounts of work in little time) [7,8]. A systematic review of male and female workers from male-dominated industries (≥ 70% male) found that job overload and high job demands (work requiring high levels of physical or mental effort) both had positive associations with depression [8]. Two longitudinal studies found that job overload and job strain also increased one's risk of depression, even after controlling for various factors (e.g., socioeconomics, demographics, job grade, drug use) [9,10]. Job strain and low job satisfaction have been previously associated with depression [9,11,12]. We believe that the association between tight delivery deadlines and depression was thus, reasonable in this study.

To the best of our knowledge, stress due to poor road conditions has also not been previously tested for its association with depression in long-haul truckers (though Crizzle, McLean, and Malkin (2020) found a positive association between severe job-related stress and symptoms of depression) [5]. We believe that poor road conditions could have resulted in greater stress towards meeting delivery deadlines (a factor which was associated with depression). Unsafe roads and weather could have also resulted in poor job satisfaction [13]. Low job satisfaction was associated with a greater odds of depression even after adjusting for multiple confounders (demographics, lifestyle factors such smoking and alcohol intake, type of industry, and other factors) in a study of over 2,000 general workers [12]. Stress due to poor road conditions could have thus, led to higher stress in meeting delivery deadlines and lower job satisfaction in this study, which are both associated with depression.

Though stress due to social isolation has not been previously examined for its association with depression in truckers, we know from Chapter Two that social isolation is a risk factor of depression in the general public [14–15]. Social isolation can lead to loneliness, a feeling which can lead to depression [15]. Furthermore, our finding that stress due to being away from social relationships had the most positive association with depression was supported by the literature in Chapter Four: loneliness was found to have the most positive association with depression in a study of over 2,000 adults from the general U.S. population [15]. It is thought that the strong association between social isolation/ loneliness and depression in humans is due to either evolutionary reasons (i.e., humans evolved to feel intense pain from social isolation, which would encourage them to rejoin a group. Group living was key to survival) or genetic ones (those who tend to feel lonely also tend to be those with "negative" attribution styles—i.e., they think pessimistically or self-blame. This negative thinking style is a risk factor for depression) [16]. Overall, we believe that the positive association we observed between stress due to being away from social relationships and depression was sensible, based on the literature.

Other sex lacked an association with depression due to sparse numbers in this category (three truckers). Sparse numbers also likely explained the lack of association between being a recent immigrant and depression, as well as citizenship status with depression. It is possible that we would have observed a positive association between other sex and depression if we had more truckers, given that those who are sexual minorities are more likely to be depressed than their heterosexual counterparts [17,18]. The same trend is true between those who are gender-nonconforming versus those who are cis-gender [17,18]. We did find that recent immigrants and non-citizens were also more likely to be depressed than those individuals who did not belong to

these categories, in Chapter Two [19,20]. Thus, it is possible that we could have also observed these trends had we had more truckers in these categories.

The lack of an association between financial strain and depression does not match the literature. To the best of our knowledge, this variable has not previously been tested in truckers. However, financial strain is known to be associated with depression in the general public, even after adjusting for various confounders (e.g., demographics, income, employment/ unemployment, having insurance) [21,22]. It is also considered to be a risk factor of depression in the general population [22]. Some research has suggested that certain personality traits or disorders, MHDs, and health issues may be risk factors for both financial strain and depression, however, and explain the association between these two variables in the general public [22]. Trucking, however, could have selectively removed some of these people, especially given that truck drivers must pass a biennial medical exam to retain their licence [23]. People who can fail this exam include those who abuse drugs; people with neurological, psychiatric, or musculoskeletal disorders; people with a loss of sensory abilities; and people with physical or mental disabilities [24]. Another explanation for the lack of association between financial strain and depression could be that as everyone is working as a trucker, their differences in wealth and socioeconomic status could have been smaller relative to the general public, resulting in smaller differences between the disadvantages/benefits afforded to truckers of high/low financial strain. Consequently, low financial strain might not be as protective against depression in truckers when compared to high financial strain.

The non-significant association we found between female sex and depression does not corroborate with the literature. Female sex is a risk factor of depression based on multiple biological, psychological and social factors [25]. Crizzle, McLean, and Malkin (2020) similarly

did not find that female sex was associated with depressive symptoms in truckers, though only four out of 107 of their truckers were female (4.4%), raising the concern for a type II error [5]. They also had other methodological issues (see Section 2.4.1.), thus, their results should be interpreted with caution. Regardless, one large case-control study of working adults in the U.S. population did find that female sex was associated with a greater odds of depression relative to men, even after controlling for confounders (e.g., age, age upon entry in workforce, education, occupation) [26]. Although, interestingly, the magnitude of this association decreased (but remained significant) when the women were found to make equal or greater incomes relative to the men [26]. Thus, one explanation for our findings is that we could have reduced the association between female sex and depression after controlling for financial strain (which could have controlled for women in the workforce—including in trucking—making lower incomes than men) [26,27]. A second explanation for our findings lies in the reasons why men and women may join trucking: as mentioned in Chapter Four, women tend to enter trucking after they are done raising their children [28]. Some women may begin trucking as a way to re-enter the workforce, spend time with a partner, supplement their spouse's income, or explore the country for leisure (Carson J, personal communication, February 2020) [28]. Some may have had a career prior to trucking [28]. We did find that the completion of post-education or higher was more frequent among the female than male truckers in this study, a finding which is supported by the literature [27,28]. It is possible that these characteristics could have made it easier for more women than men to be able to leave trucking if they felt depressed, or disliked their jobs. This could have been particularly true if the women no longer had children to support at home, or if their spouse was already a significant contributor to their household's income. The females who remain in trucking could in turn, be more likely to be those who work in good workplaces and/or

who are not depressed [12]. This tendency might explain the rest of the lack of association we found between female sex and depression.

We did not observe a negative association between education and depression, even though a previous study on Brazilian truckers found that completing less than high school, versus completing a high school education, was positively associated with depression [29]. This association was significant even after controlling for confounders (e.g., age, stimulant use, self-employed/ company driver) [29]. However, one study on Chinese truck drivers did find that this association disappeared when comparing between truckers with a less than high school education, versus those who had a college education (although they did not control for confounders) [30]. Crizzle, McLean, and Malkin (2020) similarly found that education (post-secondary versus less than high school) was not associated with depressive symptoms in truckers, although they also may have had some methodological issues in their study (see Section 2.4.1.) [5]. Regardless, the lack of a protective effect from higher education in this study could have been due to overeducation [31–34]; truckers with a post-secondary education may have not needed their current levels of education for their work and derived few benefits in having their current levels of education [31–34]. In contrast, in the study in Brazil, a high school education could have afforded the truckers increased health literacy while also not making them overeducated for their jobs [35]. We believe that these reasons may explain why higher education was not associated with lower CES-D-10 scores in this study.

Company driving (as compared to being self-employed) was associated with depression in a study by da Silva-Júnior, de Pindo, de Mello, VM de Bruin and PFD de Bruin (2009) [29]. However, we did not observe this association in our study. This may be due to the previous study taking place in Brazil [29]. Brazil did not have legal rights for truck drivers at the time of their

study [36,37]. Their company drivers could have been at a greater risk for poor working conditions and treatment than the self-employed drivers and consequently, had a higher risk of depression. Federal laws for truckers in Canada and the U.S. could mean that company drivers and self-employed drivers experience similar work conditions. Crizzle, McLean, and Malkin (2020) similarly, did not find that type of trucker (company employee, owner-operator leased to carrier, owner-operator who owns own truck) was associated with depressive symptoms in Canadian truckers, which corroborates with our findings. Although once again, there could have been some issues with their study (refer to Section 2.4.1.) [5].

Our lack of association between stimulant use and depression contradicts with the findings of da Silva-Júnior, de Pindo, de Mello, VM de Bruin and PFD de Bruin (2009). The authors found that stimulant use was positively associated with depression in truckers, even after controlling for confounders such as demographics, minimum or above minimum wage, and working ten or more hours a day [29]. However, it is unclear if their drivers were using licit or illicit stimulants; amphetamine and cocaine are the two most commonly-consumed illicit drugs by truckers in Brazil [36–38]. Illicit stimulants, however, can be a risk factor of depression, whereas the same is not necessarily true of licit stimulants [39–41]. Licit stimulants—mainly energy drinks—have only been significantly associated with depression in high school students and young adults (e.g., college students) [40]. It is possible that da Silva-Júnior, de Pindo, de Mello, VM de Bruin and PFD de Bruin (2009) could have had a greater proportion of truckers who were using illicit stimulants than those in our study, which could have explained their positive association [42]. Licit stimulant use is popular among U.S. truckers [40,41,43]. Although one study in Australia found that only 18% of the truckers consumed a caffeinated product within the past month to stay awake while on the job (approximately 9.5% to 13% of

U.S. truckers consume illicit stimulants at least once a month at work), thus differences in the frequency of licit versus illicit use may have not been that large in our sample [44–46]. However we could have had a high enough number of licit users to eliminate the association between stimulant use and depression.

Large social, economic, and geographic disparities between people in Brazil—as well as a lack of mental health facilities—as compared to Canada and the U.S. could have also led to some of the truckers in Brazil with depression to self-medicate with stimulants [47]. Approximately 80% of Brazilians with depression, in fact, never receive treatment for their MHD [47]. Stimulants, however—mainly illicit ones—release dopamine, a neurochemical which temporarily incites feelings of pleasure [39,48]. People who frequently use of stimulants, however (such as through addiction), may experience increasingly intense emotional "crashes", wherein they experience increasingly severe feelings of depression [39]. Thus da Silva-Júnior, de Pindo, de Mello, VM de Bruin and PFD de Bruin (2009) could have observed their positive association either due to some of their truckers with depression using stimulants to self-medicate, or, some truckers becoming dependent on stimulants (e.g., addicted) and then experiencing increasingly severe emotional "crashes" and thus, depressive symptoms. Overall, there might not be a significant association between stimulant use and depression in Canadian and U.S. truckers or, alternatively, this association may only be present for those who use illegal stimulants.

Years of driving experience was not associated with depression, even though a positive association was previously found between these two factors in a study on Chinese truckers. Shen et al. (2013) found that 3-4 years, 5-6 years, and eight years or more of driving experience (relative to less than one year of experience) were negatively associated with depression [30]. Although they did not control for confounders thus, it is possible that factors such as age, or

income could have explained these associations. Those with greater driving experience could have had more seniority and thus, better incomes, relative to those with low driving experience. However, China also frequently employs toll roads (both legal and illegal ones) to pay for the costs of building new highways and roads [49]. Heavy fines may also be given for real, minor, or imagined misdeeds by traffic police [50]. It is possible that those with low driving experience may not have yet known how to avoid these hazards. Consequently, drivers with low experience could have experienced greater losses in income, which could have been particularly devastating given that over 85% of truckers in China are self-employed, and most come from relatively poor, rural farmer backgrounds [51]. Self-employed truckers in China also do not receive social insurance [51]. This could have exacerbated the effect of losses in income; again, the positive association that Shen et al. (2013) found did not control for any confounders, thus there could have other factors (such as poor health, income) which explained their positive association between driving experience and depression [50–53].

We did not observe a positive association between stress due to poor driving behaviours from the public and truckers' CES-D-10 scores. This finding might contradict with the current literature: one study by Crizzle, McLean, and Malkin (2020) on Canadian truckers found a positive association between severe job-related stress and symptoms of depression in Canadian truckers [5]. However, it is unclear what stressors they were measuring, their measure of stress, and how many truckers could have felt stressed due to the public's driving behaviours. One study by Wijngaards, Hendriks and Burger (2019) on Dutch transport truck drivers did find a negative association between road congestion and feelings of momentary happiness in the past hour [54]. Momentary happiness was measured on a scale from 0 ("very unhappy") to 10 ("very happy") [54]. However, traffic congestion and poor driving behaviours from the public might not

necessarily elicit symptoms of depression but rather, feelings of frustration [44]. Thus, the truckers in their study could have felt unhappy out of frustration and not necessarily out of feeling more depressed [44]. It is possible that there might not be a significant association between stress due to poor driving behaviours from the public and depression in truckers, though future studies should confirm this.

Though poor sleep was positively associated with depression in this study, we did not observe a positive relationship between stress due to poor sleep on work/ outside of work and depression. We could have eliminated these associations by already controlling for poor sleep. Poor sleep could have explained most of the relationship between stress due to poor sleep on workdays/ non-workdays due to it already being a symptom of depression.

There was no association between high stress due to violence at work/ outside of work and depression. This finding contradicts with the literature from Chapter Two; victims of violence (whether at work/ outside of work) may experience post-traumatic stress or injury, which can make them at risk of developing depression [1,55]. Our lack of association could have been due to sparse numbers in the "high stress due to violence" category. Another possibility is that some of the truckers could have experienced acts such as racism, discrimination, or sexual harassment work, but might not have considered these incidents as acts of violence due to the examples we provided. Our item for stress due to violence at work listed mugging, verbal abuse, and harassment as examples of violence at work. Some truckers could have felt confused, however, if their experiences were not listed as one of the examples in this item. Consequently, some truckers could have indicated that they did not experience (or experience low) stress due to violence at work, which could have resulted in some non-differential measurement bias towards the null. More information on this potential bias is in section 6.3.1. Regardless, this could have

been another explanation for the lack of association between stress due to violence at work and depression. There could have been some non-differential measurement error in stress due to violence outside of work as well (such as if some truckers felt confused because they experienced violence outside of their work hours, but still at the workplace). Some truckers could have indicated low/no stress, or skipped this question, if they felt confused on whether their experience counted as an incident at work or outside of work. More explanation as to why stress due to violence outside of work might not have been associated with depression in study are found in the section below (6.2.2) and in section 6.3.1.

6.2.2. Factors Associated with Depressive Symptoms in Truckers, by Sex

A secondary objective of the study described in Chapter Four was to examine if there could be factors which are associated depression which differ by sex. We found that men had many of the same predictors as in the main sample, due to men comprising 77% of the sample (although high stress due to tight delivery deadlines was dropped from their model). High stress due to being away from social relationships remained as the factor which had the most positive association with depression (standardized $\beta = 0.30$, 95% CI: 0.21, 0.40), relative to all other factors. High stress due to due to poor road conditions had the second highest positive association with depression (standardized $\beta = 0.20$, 95% CI: 0.10, 0.30). However, being never married was a factor which was exclusive to the male demographic. Being never married had a slightly positive association with depression (standardized $\beta = 0.10$, 95% CI: 0.01, 0.20) and was associated with a (unstandardized b) 2.08-point (95% CI: 0.02, 4.14) increase in a trucker's CES-D-10 score, relative to being married. Thus, male truckers who were never married were more likely to be depressed than their married counterparts.

Fatigue had the most positive association with depressive symptoms in the model for women (standardized β = 0.62, 95% CI: 0.47, 0.77). Each additional day of fatigue during the week was associated with a (unstandardized b) 1.65-point (95% CI: 1.09, 2.21) increase in a female trucker's CES-D-10 score. Meanwhile, high stress due to violence outside of was a factor which was exclusive to their demographic. Women who experienced high stress from this factor had a (unstandardized b) 5.83-point (95% CI: -0.41, 11.24) increase in their CES-D-10 scores as opposed to women with low stress from this factor.

We expected that men who were separated / divorced / widowed would also score higher on the depression scale given that the literature indicates that men from these categories show a greater risk of later committing suicide, an outcome of severe depression [56]. However, we found no association between this category of marital status and depression. It is possible that male truckers who are separated / divorced / widowed might not experience as many marital or relationship problems as a result of being absent for days at a time (due to work) than the truckers who currently have a partner and thus, could have been slightly less likely to be depressed. This could have resulted in men who are separated / divorced / widowed and men who are married having similar likelihoods of being depressed. Meanwhile, there is some evidence that men who are never married are more likely to be depressed than men who are married [57,58]. Men who are never married can develop low-self esteem and may feel depressed over their marital status [57]. Although one study by da Silva-Júnior, de Pindo, de Mello, VM de Bruin and PFD de Bruin (2009) did not find that being never married was positively associated with depression in Brazilian truck drivers [29]. However, it is worth pointing out that most of their sample was significantly younger than ours, thus most of the truckers might not have yet had negative feelings about being never married.

High stress due to poor road conditions was found to have the second greatest positive association with depression in the male model, instead of fatigue in the model across all truckers. This could have been due to the removal of high stress due to tight delivery deadlines in the male model, in Chapter Four. High stress in this factor could have accounted for some of the association between high stress due to poor road conditions and depression, if truckers driving in poor road conditions were also more likely to feel stressed about meeting their delivery deadlines. High stress due to tight delivery deadlines likely disappeared from the male model due to the slight reduction in sample size (as a result of sampling only males, instead of all truckers) when stratifying the truckers by sex.

No studies, to the best of our knowledge, have examined the association between violence (whether at work, or outside of work) with depression in female truckers, nor in other types of drivers. However, women are more likely to experience injuries, fear and post-traumatic stress as a result of domestic violence than men [59,60]. Victims of domestic violence often experience depression [59,60]. The higher risk for negative outcomes as a result of domestic violence in women could have explained why violence outside of work was positively associated with depression for their demographic only.

Fatigue had a very high beta coefficient in the female-only model (standardized $\beta = 0.62$, 95% CI: 0.47, 0.77). This was likely due to the absence of other factors in their model (some of which, could have accounted for part of the association between fatigue and depression, such as poor sleep on non-workdays, other stressors, and poor health). Some of these other factors were likely missing from the female-only model due to the small number of female truckers. Meanwhile, the absence of high stress due to social isolation in the female-only model could be due to women being less affected by loneliness: the relationship between loneliness and

depression has been found to be lower in magnitude (less positive) in females than males [16]. Women may be less likely to feel lonely due to their tendency of forming more meaningful and emotionally supportive social relationships than men [16,18]. This tendency, and the small sample size of women in our study, might explain why stress due to being away from social relationships was not significant in (and thus, dropped from) the female-only model.

To the best of our knowledge, there have only been three studies thus far (other than our own) which have specifically looked at female truck drivers [27,28,60]. However, one study was only a review of the literature and the other two studies only performed descriptive statistics [27,28,60]. The latter two studies also only measured demographics, access to care, and current medical conditions in the truck drivers, thus, very few (if any) workplace factors were measured. Interestingly, one of these studies reported that the prevalence of depression in the female truckers was 8%. This seems to suggest that female truckers are indeed, not more likely to be more depressed than their male counterparts [28]. However, they also distributed and collected their surveys in person, at a public truck show [28]. Thus, there is the risk for desirability bias, such that those with depression might have not wanted to indicate that they have a MHD while at a public event. Our study is thus, one of the few studies to date on female truckers.

6.2.3. Lack of Association between Driving Duration and Depressive Symptoms in Long-haul Truck Drivers

Chapter Five sought to determine the association between driving duration and depression in long-haul truck drivers. We hypothesized that longer durations of driving would increase the risk of depression. We observed a statistically significant, positive association between these two variables in a crude model. This finding allowed us to partly accept our hypothesis. The findings of the crude model also matched with some of the literature, such that

depression has been observed as an outcome of long commuting times in the general public and long work hours in general workers. Our association, however, become non-statistically significant after adjusting for confounders. The literature does not support the latter finding as they have reported that this association is still statistically significant after controlling for confounders. Furthermore, one study on city bus drivers reported a small but inverse relationship between driving duration and psychological distress scores, even after controlling for confounders [61].

Our final model contained more confounders and explained more of the variance in depression (54.6%) than the study involving city bus drivers, however (7.1%) [61]. This could be one reason why they still observed a significant, negative association even after controlling for confounders. The study on bus drivers also took place in Columbia, however, which has a poverty rate higher (28%) than that of Canada (9.4%) and the U.S. (15.1%) [62]. Colombia also had civil conflict from 1964 to 2017 which could have made it difficult for many people to work [63]. The city bus drivers could have consequently, felt less distress in working and being able to earn an income. This could be a reason why their association was overall negative, regardless of controlling for confounders.

Though the study on commuters found a positive association between commuting times and depression, even after controlling for confounders (mode of transportation, demographics and neighbourhood characteristics), the authors also did not report an adjusted R-squared, thus it is hard to say whether other factors could have still explained much of their association. Our model could have explained more of the variance between driving duration (which, in addition, may not be analogous to long commuting times) and depression. Their measure for

neighbourhood characteristics might have also not been valid, thus there might still be other confounders which they did not properly control for in the commuters' environments.

Long working hours (> 10 hours a day) was associated with more depressive symptoms even after controlling for confounders (demographics, type of industry, job stressors, and other factors) in studies involving general workers [12,64]. However long-haul truckers are often encouraged to drive for as long as possible, due to the method of renumeration of the industry [65]. They are often paid by the distance they travel, or how much freight they deliver [65]. Most of the truckers in this study were driving close to their legal limits. Though the mean driving durations we found actually appear to match with the literature, such that truckers in the U.S. have been found to work for a mean of 60 to 65.0 hours per week (the mean number of hours driven per week are to the best of our knowledge, unknown in the literature) [66–70]. If most truckers are driving near or at their legal limits, however, then this would mean that there may be other factors which are more strongly associated with depression in the general trucking population. Indeed, we did find that confounders explained the relationship between these two variables instead of driving duration alone in Chapter Five.

It is also possible that we could have had some under-sampling of truckers who were driving for very high numbers of hours each week. These individuals could have been less likely to have the free time to respond to a survey. Low variation in our truckers' durations of driving could have biased the association between driving duration and our outcome towards the null.

6.2.4. Country of Work as an Effect Modifier in the Association between Driving Duration and Depressive Symptoms

Another primary objective of Chapter Five was to determine if a trucker's country of work could modify the effect between driving duration and depression. To the best of our

knowledge, no previous studies have looked at whether country of work (specifically, Canada versus U.S.) could moderate the association between driving duration and depression in truck drivers, nor in other types of drivers. We did not observe a significant interaction between country of work and driving duration in our main association. This could have been due to the lack of an association between the main effect of driving duration and depression to begin with. We expected that those who drove in Canada would have had a more positive association between driving duration and depression, however, for two reasons: i) the colder and less sunny climate, in general, of Canada relative to the U.S. [71]; ii) the sparser population of Canada as compared to the U.S. [72].

Though cold temperatures and weather have not been associated with depression in the general public, sunlight is known to regulate neurochemicals which are responsible for improved mood [73,74]. The proper regulation of these chemicals (serotonin and melatonin) may prevent the onset of depression [73,74]. In fact, people who live in poorly-lit dwellings have been found to have a greater odds of being depressed, even after controlling for confounders (e.g., health, age, income, employment, city) [73]. Most of Canada, however, obtains fewer annual hours of sunshine than the U.S. [75]. Thus, we expected to see a positive association between driving in Canada and depression. It is possible, however, that climate could have lost its modifying effect in this study if most of the truckers in Canada were driving near Southern Ontario, or between Canada's major cities, near the U.S. border. We could have had more truckers from Southern Ontario (oversampling) if these individuals were more likely to have internet and cellphone service, and more frequent truck stops, than those in Northern Canada [76]. Alternatively, this could simply be a natural reflection of the proportion of truckers who work in Northern versus Southern Canada; however, this proportion is, to the best of our knowledge, unknown.

Regardless, this could have eliminated part of the modifying effect of country of work. A higher proportion of truckers driving in Southern versus Northern Canada—where there might be more truck stops and more heavily populated cities—could have also resulted in many of the truckers in Canada not feeling socially isolated, further reducing the modifying effect of country of work [76]. A final explanation for the lack of interaction could simply be that country of work (Canada versus U.S., versus working in both countries) might not be an effect modifier at all in the association between driving duration and depression.

6.2.5. Marital Status and Sex as Effect Modifiers in the Association between Driving Duration and Depressive Symptoms

A secondary objective of Chapter Five was to examine if other characteristics—such as marital status and sex—could be effect modifiers in the association between driving duration and depression. We expected that female sex and marital status could have had an interacting effect with our main association of interest, given that women are more likely to become depressed than men, and that those of certain marital designations (e.g., widowed/ separated/ divorced) could have been more at risk for social isolation while driving. However, neither sex nor marital status were found to have any significant modifying effects.

To the best of our knowledge, neither of these interactions have been previously examined in truckers. The lack of interaction between female sex with driving duration and depression, however, does not appear to be supported by the literature. Female sex has been associated with higher levels of depression relative to men, over the course of increasing work hours in general workers [77,78]. The association remained true even after adjusting for confounders (e.g., demographics, job seniority, blue/white/pink collar work, sleep) [77,78]. One explanation why we may not have observed a significant interaction could be due to the lack of

an association between the main effect of our exposure and depression, to begin with. Another possibility is that we could have reduced some of the association between female sex and depression after controlling for financial strain. As mentioned previously, in section 6.2.1, the magnitude of the association between female sex and depression in general workers was reduced (but remained significant) when the women made equal or greater incomes relative to men, even after controlling for confounders (e.g., age, education, occupation) [26]. A third factor which could have contributed to the lack of interaction could be that perhaps, more women than men in trucking could have had an easier time in leaving the industry if they disliked the work. As mentioned previously, women tend to join trucking after they have raised their children. Many might have had a prior career to trucking (as evidenced by the higher proportion of female than male truckers which tend to have post-secondary education in the industry, as well as women's tendency to have fewer years of experience relative to men in the industry; we found this trend as well) [27,28]. Some women also choose to join trucking to supplement a spouse's income, spend time with their spouse, re-enter the workforce, or travel (Carson J, personal communication, February 2020) [28]. A lack of children to support at home, the possession of previous work experience, and the presence of a spouse who was already earning much of the household's income could have made it easier for more women than men to be able to quit trucking if they disliked their jobs, or became depressed. This, in turn, could have left more women who enjoy driving, or who are not depressed, behind in the industry, removing the modifying effect of sex.

One study on general workers from Japan also did not pick up a significant interaction between marital status and the employee's work hours, even though the main association they tested between work hours and depression was significant [78]. They controlled for confounders such as demographics, type of work (blue/pink/white collar), job seniority and sleep [78].

Though general work hours may not be fully comparable to the time spent driving a truck, it is possible that marital status may simply not significantly interact with driving hours. Other possibilities are that there could have been a modifying effect, but we might not have seen this due to the lack of an association between the main effect of our exposure and depression to be begin with, or sparse number in some categories of marital status.

6.3. *Epidemiological Implications*

6.3.1. Internal Validity

Internal validity refers to the extent that the results we observed are a representation of the truth within a studied population, and how much our results were not the result of methodological errors [79]. These methodological errors generate bias [80]. Bias decreases the internal validity of a study [81]. Our major sources of bias were selection bias, bias from differential measurement error, bias from non-differential measurement error, and bias from uncontrolled confounders.

Selection Bias

We could have had a healthy worker effect among our sample such that those who were severely depressed could have already quit trucking. Consequently, we could have missed some of these individuals. Fewer cases of severe depression could have biased our findings from chapters Four and Five towards the null.

We could have also had an under-sample of truckers who drove for very high durations of driving in this study, if these individuals were less likely to have the free time to participate in a survey. An under-sample of high durations of driving could have resulted in poorer variation in our exposure in Chapter Five. Lower variation in our truckers' durations of driving could have biased our association between driving duration and depression towards the null.

Finally, we could have obtained an oversample of Canadians who were driving in urban areas, very close to the U.S.-Canadian border, if these individuals were more likely to have had the internet and cellphone service needed to participate in our survey [72]. Alternatively, this could also just be a natural reflection of the proportion of truckers who are driving in Southern Canada relative to Northern Canada (this proportion is, to the best of our knowledge, unknown). Regardless, truckers driving in Southern Canada could have been less likely to be socially isolated, have better access to truck stops (resulting in fewer unmet needs), and could have experienced better climate, more hours of sunlight, and better road conditions than those driving in the rest of Canada [76]. Some of these factors (such as social isolation) are known risk factors of depression [14,16]. Consequently, it is possible that the truckers in Canada we sampled could have encountered fewer risk factors of depression at work and been less likely to be depressed than the general trucking population of Canada. An oversampling of truckers from Southern Canada could have biased the association between country of work and depression towards the null in Chapter Four and biased the modifying effect of country of work towards the null in Chapter Five.

Differential Measurement Error

People with depression are more likely to be off work [82]. Consequently, truckers with depression could have been more likely to report their typical durations of driving, instead of their number of hours driven over the past week. However, an individual's self-estimates of their typical work hours each week are usually higher (by 0.6 hours over the week) than the true hours they worked for over the past week [83]. Thus, the differential measurement error in this study, if present, would have likely biased the association between driving duration and depression away from the null in chapters Four and Five.

Non-differential Measurement Error

Another area of concern was in the measures we chose. Most of our measures were unvalidated and those with multiple items had unknown internal consistency—including the CES-D-10—in long-haul truckers. The CES-D-10 had the benefit of being validated in other studies and has showed high internal reliability (> 0.80) in non-truckers [84–86]. Validation of the CES-D was also tested in rural people and in non-English speakers [84–87]. Indeed, we found that the CES-D-10 had high internal reliability as well (0.86). Thus, there was likely little measurement error in our outcome in this study.

We obtained our measures for sex, marital status, type of trucker, the number of years employed as a trucker, driving duration, the number of days away from home in the past 30 days, the number of days of fatigue in the past week, general health, and low back pain from a national survey on long-haul trucker health by NIOSH [88]. The validities of these measures are unknown. However, we believe that these measures would have been valid for our sample given that they were specifically designed for use in U.S. long-haul truckers themselves (the Canadian drivers would have also likely been able to interpret their questions). The contents of these measures were also relatively short and simple (e.g., "in general, how is your overall health?"; over the past 30 days, how many days have you slept away from home due to work?"), thus limiting the risk for confusion, errors, and biased associations towards the null.

The measure for poor sleep, which consisted of two items, had previously unknown internal consistency. We recorded fair reliability for this measure (0.67). These low scores increase the risk for misclassification in our measure of sleep quality. This misclassification could have biased the association between sleep quality and depression towards the null. Although, these scores are likely low due to fact that our measures used only two items. The

Groningen Sleep Quality Scale is a measure for sleep quality which contains 15 items [89]. It has content that is nearly identical to ours and had Cronbach's alphas of over 0.85 in multiple clinical and non-clinical samples of people [89–91]. This scale has also been validated as a measure which correlates strongly with measures of objective (biological) sleep quality [92]. Given that our measure for sleep quality has similar content and face validity as the Groningen Sleep Quality Scale, we thus expect that our measure for poor sleep had adequate validity and would have had higher internal consistency had we simply added more items. Thus, we do not believe that our associations between poor sleep and depression were biased towards the null. In addition, each item for sleep quality was assessed individually for its association with depression, thus, any lack of internal consistency (if present) would have likely not affected each of the individual items' associations with our outcome.

The measures for financial strain and citizenship came from previous studies and have unknown validity [21,93]. Although the validities of these measures are unknown, both measures seem to show adequate content and face validity. These measures are also relatively easy to interpret ("what is your current legal status in Canada or the U.S.?" "Don't know" as a response was also possible; "in general, how is your financial status at the end of each month?" "Don't know" also possible). In combination with their brevity, we believe that these measures would not have resulted in much misclassification among the participants. Consequently, we do not believe that either of these measures (financial strain and citizenship status) would have resulted in associations which were biased towards the null.

Our measure for stress was based on a similar measure for stress which was used on U.S. long-haul truck drivers [94]. However, instead of having one item which asked participants to rate their level of perceived stress at work (none, mild, moderate, high, extreme, chronic), we

included several items which were previously reported as stressors by long-haul truckers themselves and then, had the truckers rate these stressors using this same none-to-chronic rating system. Our measure for stress had fairly good internal reliability (0.77). Though our measure for stress also had unknown validity. To the best of our knowledge, however, there is currently no validated measure for occupational stress in long-haul truckers, nor in other types of commercial drivers. Thus, it is difficult to compare the validity of our measure to a comparable measure. There are some measures for stress among members of the general public who commute and several of these measures have included poor driving behaviours from the public as a stressor [95,96]. These scales have been validated in commuters and have good internal reliability [95,96]. Furthermore, in a qualitative study of 60 long-haul truckers in the U.S., several of the truckers reported that dealing with poor driving behaviours from the public was a stressor [44]. Thus, we do have confidence that stress due to poor driving behaviours from the public was a valid stressor to measure. In combination with the brevity in language used for this item, we do not believe that stress due to poor driving behaviours from the public had an association which was strongly biased towards the null.

We believe that the other items in our measure for stress were also valid to include. Stress due to tight delivery deadlines was a commonly-reported stressor by truckers themselves in several qualitative interviews of American long-haul truckers from the literature [37,44,60,97]. Stress due to tight delivery deadlines was also often reported by the Canadian and U.S. truckers themselves at the end of our survey (Makuto N, survey, April 2020). Social isolation, poor road conditions, and violence were then, identified as some of the most significant stressors for truck drivers in a conference report sponsored by NIOSH [98]. This conference involved the participation of over 60 experts in truck driver safety from the government, universities,

employers, industry associations, and trucker labour unions from Canada, the U.S., Europe, and Australia [98]. In a qualitative interview of over 60 U.S. truckers, several of the drivers themselves also brought up social isolation, poor road conditions, and violence as some of their most common occupational stressors [44,97,99]. Thus, we believe that these stressors were reasonable items to include in a measure for stress in long-haul truckers. We also believe that the items were relatively easy to interpret and that we provided many response options. Consequently, we do not believe that most of these stressors would have had biased associations with depression towards the null. One problem, however, was in our item measuring stress due to violence at work. This item could have been phrased too vague. Our examples of violence at work included: being mugged, verbal abuse, and harassment. However, we did not explicitly list bullying, racism/ discrimination, or sexual harassment (or sexual assault) as other examples of violence at work [100]. It is possible that our examples could have given some truckers the impression that these behaviours did not count as acts of violence at work [100]. Consequently, we could have observed fewer truckers who indicated that violence at work was a high stressor for them (misclassification). This could have biased the association between stress due to violence at work and depression towards the null.

Unfortunately, there is little data on the prevalence of violence and harassment in the workforce, particularly with respect to truckers. One study on 60 U.S. truckers found that 5.1% reported being a victim of violence (i.e., shot at, assaulted, arrested, incarcerated) [44]. Our frequently of high stress due to violence at work (8.3%) was slightly higher than the 5.1% reported in this study, confirming that some people did indeed consider verbal abuse, harassment and possibly other actions as acts of violence at work. However one report by Statistics Canada found that 13% and 19% of men and women, respectively, experienced an act of violence (i.e.,

physical assault, verbal abuse, threats, sexual harassment) at work in 2016 [101]. Threats were experienced by 3% of men and women each, and less than 1% of men and 4% of women, respectively, experienced sexual harassment at work [101]. The lower frequency of high stress due to violence at work in this study (8.3%), relative to the frequency of violence at work reported by Statistics Canada (13% and 19% of men and women, respectively), suggests that we might have, indeed, missed some of the truckers who could have experienced these other acts of violence at work (e.g., racism, sexual harassment). Although, we are also only comparing the literature to our category of high/extreme/chronic stress due to violence at work, and not the category of none/mild/moderate levels of stress. It is possible that some of the truckers that we missed could have simply felt that they experienced no/mild/moderate levels of stress due to violence at work. Regardless, the association between stress due to violence at work and depression could have been slightly biased towards the null.

Though the overall reliability of the measure for violence was fairly low (0.58), we believe that the individual items within violence were still fairly valid on their own, and that this score was simply suggesting that the scale could have been broken down into two constructs (i.e., one scale for violence at work, another for violence outside of work). The items in this measure were also assessed individually for their association with depression, thus we do not believe that this reliability would have biased their individual associations towards the null. The item which measured stress due to violence outside of work was furthermore, still able to show a significant association between this stressor and depression in the female truck drivers. This association appears to match with the literature, such that women are more likely to experience worse outcomes (e.g., worse injuries) as a result of domestic violence than men [59]. We also believe that the wording of this item was easy to interpret and did not leave much room for error.

One problem is, however, that some truckers could have experienced violence from a domestic partner at their workplace, while on/off their work hours. The Canadian Labour Congress estimates that 54% of domestic abuse victims also experience violence at work from their partner [102]. It is possible that some truckers who experienced high stress due to violence outside of work could have become confused and indicated that they had low stress in this factor, while indicating that they experience high stress due to violence while at work instead, resulting in some misclassification of the individuals. This could have biased some of the association between stress due to violence outside of work and depression towards the null. Meanwhile, more truckers indicating that they had high stress due to violence at work could have biased the association between high stress due to violence at work and depression away from the null.

Finally, the measure for being a recent immigrant had unknown validity in this study. This measure had adequate face and content validity however it is possible that five years may have not been a suitable cut-off point for defining who is (or isn't) a recent immigrant. Statistics Canada defines a recent immigrant as someone who has been in Canada for less than five years [103]. The U.S. government similarly defines recent immigrants as those who have been in the U.S. for less than five years [104]. Thus, our cut-off point for a recent immigrant appears to be valid. It is possible, however, that some immigrants might not have remembered if they came to Canada or the U.S. within the past five years, in which case, they could have skipped the question instead of indicating "yes". This could have resulted in an association which was slightly biased towards the null.

Bias from Measuring Symptoms of Depression as Exposures

Poor sleep and fatigue were both included as exposures during our modeling in Chapter Four. The CES-D-10 however, also measures these factors as symptoms of depression. Thus, it is

possible that any (or all) of the associations we picked up between poor sleep and fatigue with the CES-D-10 could have been slightly biased away from the null in Chapter Four. The inclusion of poor sleep and fatigue as exposures—and as items within the measure of our outcome—could have also slightly inflated the adjusted-R^2 of our models in this Chapter.

Bias from Uncontrolled Confounders

Job satisfaction could have been a possible confounder which we did not control for in this study. In Chapter Four, we expected that female sex would have had a positive association with depression in truckers, due to the possibility that the women could have experienced sexual harassment, gender bias, and discrimination as a result of working in a male-dominated industry [27]. However, female sex was not associated with depression. As mentioned previously, one explanation for this finding could have been that male and female truckers could have been joining trucking for different reasons, or with different characteristics [28]. Women may join trucking after they are done raising children, they may have had another career prior to trucking, they may be joining to supplement their spouse's income, and some may be joining for leisure (e.g., to travel) [28]. These characteristics, however—including a lack of children—could have made it easier for those women who worked in poor workplaces, or who became depressed from work, to be able to leave their jobs. Consequently, the women who remain in trucking could have been more likely to be those with good, or neutral, job satisfaction and lower CES-D-10 scores. We did not measure job satisfaction, however, thus we cannot test whether the job satisfaction of those women who tend to stay in trucking could have been higher than that of men. Job satisfaction is protective of depression [12]. A lack of accounting for this factor could have biased the association between female sex and depression towards the null, and removed the association (if present) between female sex and depression.

We also did not control for the region that a trucker drives in. The truckers in Canada could have been more likely to be those who drove in urban areas, between major cities, close to the U.S. border, if these areas were more likely to have the cellphone and internet service needed to complete our survey. Most major cities (and frequent truck stops) are located close to the U.S. border [72,76]. The lack of association between working in Canada and depression could be due to most truckers in Canada driving in urban areas, near the border, either as a result of an oversampling of these individuals, or as a natural reflection of the proportion who drive in Southern Canada versus Northern Canada. Unfortunately, to the best of our knowledge, this proportion is unknown in the literature. Regardless, if most truckers in Canada were from the Southern region, they could have experienced similar climates and similar levels of social isolation as those in the U.S. A lack of controlling for region of work, within Canada as a working country, could have biased the association between country of work and depression towards the null.

We did not control for obesity either. A lack of literature on the diets (and risk of obesity) of truckers prior to conducting this study, in combination with the need to keep the survey short, meant that we did not measure this factor. The survey was kept short to maximize the number of truckers who would want, or be able, to participate. Chapter Two suggested that there may be an association between obesity and depression. Although the association appears to be due to either reverse causality (depression leading to obesity), or confounding [105]. Thus, it is possible that some of our factors could have already explained part of the association between obesity and depression [106]. Regardless, obesity could have explained some of the association between general health and depression. A lack of adjusting for obesity could have biased some of the association between these two factors away from the null.

Poor diet and a lack of physical activity were also not controlled for. Although one study by Crizzle, McLean, and Malkin (2020) did not find that diet and physical activity were significantly associated with depressive symptoms in long-haul truckers (though their results should be interpreted with caution, as noted in Section 2.4.1.). Fruit and vegetable consumption, however, has anti-inflammatory and neuroprotective effects, two factors which may be protective of depression [107]. Physical activity improves brain function, decreases hormonal stress in the body, and can promote good self-esteem, which may also be protective of depression [108]. It is possible that a lack of controlling for diet and physical activity could have biased some of the association between health and depression away from the null.

We did not measure non-stimulant drug use. Some of these drugs could have been associated with depression in Chapter Four. Narcotics (such heroin and fentanyl), hallucinogens, and steroids are drugs which are risk factors of depression [109]. Unfortunately, there is a lack of literature on which of these drugs (if any) could be more predictive of depression over the other(s). A lack of controlling for some of these drugs, however, could have biased some of the association between stimulant use and depression away from the null, such that some truckers who were consuming illicit stimulants could have also been consuming some of these other illegal drugs [110]. Although we did not find a significant association between stimulant use and depression in this study. Thus, even if there was bias due to not controlling for other "hard" drugs, it did not appear to affect our overall findings.

Smoking and alcohol consumption have not been associated with depression in two studies involving truckers, even after controlling for several factors (e.g., demographics, type of trucker, history of accidents/crashes, sleep quality, fatigue) [5,29]. One caveat is that these studies were relatively poor in quality, thus their findings should be interpreted with caution. It is

possible that smoking could have also biased the association between stimulant use and depression away from the null. However up to 51% of U.S. truckers are current smokers (the prevalence of current smoking in the general U.S. population is 19%) [111]. Smoking is thought to be common in truckers due to most being older in age (i.e., a reflection of their generation) [112]. It may also be a reflection of many truckers having relatively low levels of education; education has an inverse relationship with smoking [112]. If everyone smokes, however, then there is likely not a significant association between smoking and depression in truckers. Meanwhile, one study on truckers found that marijuana use was only associated with depressive symptoms prior to controlling for potential confounders (e.g., poor sleep, fatigue, severe job-related stress) [5]. It is possible that some of the truckers with depression could have been self-medicating, which could explain why this association disappeared after accounting for poor sleep and fatigue (i.e., symptoms of depression) [113]. Indeed, marijuana use and alcohol consumption have only been associated with depression in cases of dependency (e.g., addiction), but not from general or casual use [113]. There is some possibility that a lack of controlling for marijuana use (or even alcohol consumption) could have biased some of our association between stimulant use and depression away from the null, as up to 29% of U.S. truckers who use stimulants (licit or illicit) also use alcohol or marijuana [114]. Though again, we did not find an association between stimulant use and depression in this study; thus, even if there were bias away from the null, it did not appear to impact our overall findings.

Finally, a history of crashes was also not accounted for. We did not measure these factors for two reasons: one being limitations in the length of our survey; the second being that no studies on truckers thus far have found that the number of crashes, and a history of incidents, have positive associations with depression, even after controlling for multiple factors (e.g.,

demographics, type of trucker, alcohol use, smoking) [5,29]. The number of road crashes was similarly, not correlated with psychological distress in a study of over 3,000 Colombian bus and taxi drivers, although correlations do not account for confounders [61]. Regardless, crashes are known to result in negative mental health outcomes (such as post-traumatic stress disorder) in the general public, which may increase their risk of depression [55,115]. A lack of controlling for crashes could have biased the association between stress due to poor road conditions and depression away from the null, such that those regularly driving on poor roads (or in bad weather) could have also tended to be those who had been in an accident/crash. Although one study on 6,341 Australian adults found that those who were at fault of a vehicular crash were 75% less likely to experience psychological distress following the incident than those who were victims of it, even after controlling for many confounders (e.g., role in the crash—driver, passenger, cyclist; injury severity, currently employed, went to hospital, required rehabilitation) [115]. Another study on over 300 U.S. adults similarly, found that being culpable of the crash, as opposed to being the victim of it, had a protective effect on one's likelihood of developing post-traumatic stress disorder post-crash, even after controlling for confounders (e.g., age, gender, whether a fatality occurred in the crash) [116]. It is possible that crashes might lack an association with depression in truckers if they are unlikely to be "victims" during the crash. This could be due to their size advantage and ground clearance (the latter meaning that they often end up on top of other vehicles in crashes) [117]. Furthermore, one study on 193 train operators found that the operators showed fewer symptoms of post-traumatic stress the more "person under train" incidents (i.e. accidentally running over a person) they experienced, suggesting that the operators became desensitized to the incidents [118]. The authors did not control for any potential confounders in this association. However, they also did not find an association between

the time since the incident occurred and an operator's likelihood of still having post-traumatic stress disorder [118]. Crashes are highly common in trucking and it is estimated that 35% of U.S. truckers experience at least one crash during their careers [69]. It is possible that some truckers could have had some desensitization to their crashes. Another possibility is that truckers with severe injuries, or post-traumatic stress after a crash, could have already left the sampling frame. Those who remain could consequently, be those who have not yet experienced a serious crash and/or those who do not suffer from post-traumatic stress. Some combination of not being as severely injured or traumatized post-crash, desensitization, and those in serious crashes already being removed from the sampling frame might explain why crashing have not been associated with depression in truckers thus far. It is possible that our association between stress due to poor road conditions and depression could have ultimately, not been significantly biased away from the null from not controlling for crashes, if crashes are not associated with depression in truckers. More data are needed to confirm that crashes/accidents are not associated with depression in truckers, however.

Unmeasured Factors Associated with Depression

We would also like to mention that all of the unmeasured confounders in this study could have also been factors which were associated with depression in Chapter Four. Thus, the list of factors that were significantly associated with depression in Chapter Four may not be exhaustive. However, we believe that this study still determined several important associations. We also had a large sample size, which gives our study good power and reduces the risk for a type II error.

Some factors which we did not test for their associations with depression include other MHDs: anxiety disorder, attention-deficit/hyperactivity disorder, bipolar disorder, schizophrenia, obsessive-compulsive disorder, and personality disorders [119]. Most of these MHDs may have

associations with depression, as mentioned in the literature in Chapter Two [120,121]. However, we decided not to measure these MHDs, in order to keep our survey appropriately short for truckers who may be on the road or who may be on their breaks and consequently, have little time to voluntarily participate in a study. Some of these MHDs are also highly uncommon in the general public (< 1%), and, in combination with the biennial medical exam in trucking, might mean that very few truckers would belong to these categories [119]. We wanted our survey to be salient for many truckers and limit the risk that truckers would get bored or abandon the survey. We also wanted to include several factors which could be controllable by either truckers themselves, or their employers (salient for them both), thus we chose to mainly focus on demographics and the workplace. The large number of possible anxiety disorders from Chapter Two would have also made it difficult to decide on which anxiety disorders could have been "more important" to include in our survey and which ones would have not, particularly given the lack of literature on MHDs in truckers.

6.3.2. External Validity

We likely obtained an oversample of depressed truck drivers due to the topic of our survey having more relevance for them [122]. People are also keen to respond to surveys if they feel that they would have knowledge to contribute to the survey's topic of interest, which likely would have been true for those with depression [123]. Finally, truckers with depression could have been more likely to be temporarily off work (or even been working fewer hours) than those without depression, thus it could have been easier for them to participate in our survey. These reasons may explain why we observed a high frequency of depressed truckers relative to the literature. An oversampling of depressed truckers could have led to an overestimation of which

variables were significantly associated with depression in Chapter Four. Although we believe that our findings can still be generalized to Canadian and U.S. truckers.

We could have also obtained an oversample of truckers in Canada who were driving near the U.S. border, if these areas were more likely to have the cellphone service and internet access needed to complete our survey. Alternatively, we could have had more Southern Canadian truckers as a reflection of most truckers working/living in this region. Regardless, it is possible that our lack of association between driving duration and depression might not be generalizable to those who work in Northern Canada. Those in Northern Canada might experience worse road conditions, greater social isolation, and fewer hours of annual sunshine than those in Southern Canada, resulting in a positive association between driving duration and depression [75].

We would also like to mention that we obtained a high proportion of Canadian truckers. This was likely due to the social media groups, trucking websites, and personal contacts we knew in Canada. Thus, some of the associations and descriptive statistics we found may be more generalizable to Canadian truckers than American ones.

We likely obtained an oversample of female truckers (17.8%) given that current estimates on the prevalence of women in trucking range from 6% to 10% in the U.S. and 7% to 8% in Canada [28,124]. This oversample was likely due to our survey being promoted within some female-only trucking groups on social media. The frequency of women we observed in this study should not be generalized as the prevalence of women in trucking in Canada and the U.S.

Voluntary sampling could have also resulted in some oversampling of truckers who were driving (working) for fewer hours. Thus, we may have observed lower mean durations of driving in this study than those found in the general trucking populations of Canada and U.S. Voluntary sampling also means that there is the risk that those who were financially strained could have

been more likely to participate given that we included a draw for a monetary reward. However, it appears that the frequency of financial strain we observed was very similar to recent estimates on the prevalence of financial strain in the U.S. population [125]. According to a 2017 report on economic well-being in U.S. households, the Board of Governors of the Federal Reserve System reported that 33% of U.S. adults felt that they were currently living comfortably, 40% said they were currently doing okay, and 7% said they were currently financial insecure [125]. There is a lack of data on the prevalence of financial strain among the general Canadian population. However, the numbers from the U.S. Board of Governors seem comparable to the 45.4%, 41.3%, and 8.6% of low, medium and high levels of financial strain, respectively, that we observed in our sample. Ultimately, the frequencies of financial strain that we observed appear to be reasonable approximations to the prevalence of financial strain in Canadian and U.S. truckers.

We would also like to mention that the time (season) in which we conducted the survey could affect the generalizability of our findings. We ran our survey between January and April 2020. The long-haul truck drivers may not have been as busy during this time of year as compared to summer (waitress at Husky gas station in Thunder Bay, personal communication, March 2020). We could have recorded lower mean durations of driving relative to what would be found in the summer, or the rest of the year in truckers. Although the mean weekly durations of driving we recorded were actually very similar to the mean number of hours worked per week found in other studies of truckers, during other times of the year (i.e., mean of 61.4 work hours per week between July to January [126]; mean of 60 hours per week from October to December [69,126]). Thus, seasonality did not appear to result in lower mean durations of driving among the truckers in this study, and the mean driving durations we recorded should still be generalizable to Canadian and U.S. truckers.

Seasonality also did not appear to affect our truckers' levels of financial strain as these were very similar to the levels of financial strain found in the general U.S. public, as mentioned previously. We did appear to have a slight oversample of truckers who were away for fewer days on the road relative to what was found in random samples of Canadian and U.S. truckers, however [5,127]. Although a trucker's number of days away from home has not been previously associated with depression in a random sample of Canadian truckers [5]. The number of days away has also not been associated with stress and poor sleep in two random samples of U.S. truckers, even after adjusting for confounders (age and length of tenure) [94,127]. These findings indicate that a trucker's number of days away from home appear to lack an association with depression. Ultimately, the number of days away from home in this study should not be generalized as the number of days that most Canadian and U.S. truckers are away for.

Finally, the results of this study may not be generalizable to all truckers globally. We did find some differences in the working conditions of truck drivers in Canada and the U.S. versus other countries such as Brazil and China [36,37,128]. Differences in the regulations and characteristics of truckers between countries—including differences in their provision of breaks and limits on their working and driving hours—could result in differences in the variables which are associated with depression in truckers from other countries. The results of the descriptive statistics on truckers from other countries would also likely differ.

6.3.3. Causation

As our study was cross-sectional, we were not able to establish any causations. Thus, some of the variables associated with depression in Chapter Four could have also been outcomes of having depression, such as poor sleep, fatigue, and poor health. Similarly, long durations of driving may not necessarily cause depression. Though we could not establish any causations, we

felt that this cross-sectional study was a cost-effective way of initiating a study regarding an understudied area of mental health in truck drivers.

6.4. *References*

1. Mood Disorders Society of Canada. What is depression? [Internet]. 2019. Available from: https://mdsc.ca/docs/MDSC_What_is_Depression.pdf

2. National Institute of Mental Health. Chronic illness & mental health [Internet]. n.d. [cited 2020 May 28]. Available from: https://www.nimh.nih.gov/health/publications/chronic-illness-mental-health/index.shtml

3. Li L, Wu C, Gan Y, Qu X, Lu Z. Insomnia and the risk of depression: a meta-analysis of prospective cohort studies. BMC Psychiatry. 2016 Nov 5;16(1):375.

4. Baglioni C, Riemann D. Is chronic insomnia a precursor to major depression? Epidemiological and biological findings. Curr Psychiatry Rep. 2012 Oct;14(5):511–8.

5. Crizzle AM, McLean M, Malkin J. Risk factors for depressive symptoms in long-haul truck drivers. Int J Environ Res Public Health [Internet]. 2020 Jun [cited 2020 Jul 13];17(11). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7312166/

6. Addington AM, Gallo JJ, Ford DE, Eaton WW. Epidemiology of unexplained fatigue and major depression in the community: the Baltimore ECA follow-up, 1981-1994. Psychol Med. 2001 Aug;31(6):1037–44.

7. Habibi E, Poorabdian S, Shakerian M. Job strain (demands and control model) as a predictor of cardiovascular risk factors among petrochemical personnel. J Educ Health Promot [Internet]. 2015 Mar 26 [cited 2020 Jun 27];4. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4389361/

8. Battams S, Roche AM, Fischer JA, Lee NK, Cameron J, Kostadinov V. Workplace risk factors for anxiety and depression in male-dominated industries: a systematic review. Health Psychol Behav Med. 2014 Jan 1;2(1):983–1008.

9. Stansfeld SA, Shipley MJ, Head J, Fuhrer R. Repeated job strain and the risk of depression: longitudinal analyses from the Whitehall II Study. Am J Public Health. 2012 Dec;102(12):2360–6.

10. Melchior M, Caspi A, Milne BJ, Danese A, Poulton R, Moffitt TE. Work stress precipitates depression and anxiety in young, working women and men. Psychol Med. 2007 Aug;37(8):1119–29.

11. Madsen IEH, Nyberg ST, Magnusson Hanson LL, Ferrie JE, Ahola K, Alfredsson L, et al. Job strain as a risk factor for clinical depression: systematic review and meta-analysis with additional individual participant data. Psychol Med. 2017 Jun;47(8):1342–56.

12. Nakata A. Long working hours, job satisfaction, and depressive symptoms: a community-based cross-sectional study among Japanese employees in small- and medium-scale businesses. Oncotarget. 2017 May 23;8(32):53041–52.

13. Canadian Centre for Occupational Health and Safety. Mental health - psychosocial risk factors in the workplace: OSH answers [Internet]. 2020 [cited 2020 May 31]. Available from: https://www.ccohs.ca/

14. Wang J, Lloyd-Evans B, Giacco D, Forsyth R, Nebo C, Mann F, et al. Social isolation in mental health: a conceptual and methodological review. Soc Psychiatry Psychiatr Epidemiol. 2017;52(12):1451–61.

15. Cacioppo JT, Hughes ME, Waite LJ, Hawkley LC, Thisted RA. Loneliness as a specific risk factor for depressive symptoms: cross-sectional and longitudinal analyses. Psychol Aging. 2006;21(1):140–51.

16. Matthews T, Danese A, Wertz J, Odgers CL, Ambler A, Moffitt TE, et al. Social isolation, loneliness and depression in young adulthood: a behavioural genetic analysis. Soc Psychiatry Psychiatr Epidemiol. 2016;51:339–48.

17. Chodzen G, Hidalgo MA, Chen D, Garofalo R. Minority stress factors associated with depression and anxiety among transgender and gender-nonconforming youth. J Adolesc Health. 2019 Apr;64(4):467–71.

18. Hayes-Skelton SA, Pantalone DW. Anxiety and depression in sexual and gender minority individuals [Internet]. n.d. [cited 2020 Jul 13]. Available from: https://adaa.org/sexual-gender-minority-individuals

19. Singh S, Schulz AJ, Neighbors HW, Griffith DM. Interactive effect of immigration-related factors with legal and discrimination acculturative stress in predicting depression among Asian American immigrants. Community Ment Health J. 2017 Aug;53(6):638–46.

20. Foo SQ, Tam WW, Ho CS, Tran BX, Nguyen LH, McIntyre RS, et al. Prevalence of depression among migrants: a systematic review and meta-analysis. Int J Environ Res Public Health. 2018 12;15(9).

21. Dijkstra-Kersten SMA, Biesheuvel-Leliefeld KEM, van der Wouden JC, Penninx BWJH, van Marwijk HWJ. Associations of financial strain and income with depressive and anxiety disorders. J Epidemiol Community Health. 2015 Jul;69(7):660–5.

22. Zimmerman FJ, Katon W. Socioeconomic status, depression disparities, and financial strain: what lies behind the income-depression relationship? Health Econ. 14(12):1197–215.

23. Thiese MS, Moffitt GL, Hanowski RJ, Kales SN, Porter RJ, Hegmann KT. Repeated cross-sectional assessment of commercial truck driver health. J Occup Environ Med. 2015;57(9):1022–7.

24. Federal Motor Carrier Safety Administration. Medical examination report: for commercial driver fitness determination [Internet]. n.d. Available from: https://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/Medical_Examination_Report_for_Commercial_Driver_Fitness_Determination_649-F%286045%29.pdf

25. Van de Velde S, Bracke P, Levecque K. Gender differences in depression in 23 European countries. Cross-national variation in the gender gap in depression. Soc Sci Med. 2010 Jul;71(2):305–13.

26. Platt J, Prins S, Bates L, Keyes K. Unequal depression for equal work? How the wage gap explains gendered disparities in mood disorders. Soc Sci Med. 2016 Jan;149:1–8.

27. Layne DM, Rogers B, Randolph SA. Health and gender comparisons in the long-haul trucking industry: a pilot study. AAOHN Journal. 2009 Oct 1;57(10):405–13.

28. Reed DB, Cronin JS. Health on the road: issues faced by female truck drivers. AAOHN Journal. 2003 Mar 1;51(3):120–5.

29. da Silva-Júnior FP, de Pinho RSN, de Mello MT, de Bruin VMS, de Bruin PFC. Risk factors for depression in truck drivers. Soc Psychiatry Psychiatr Epidemiol. 2009 Feb;44(2):125–9.

30. Shen S, Li Y, Zhou M, Zhang C, Jiang Y, Kang Y. Depression status and associated factors in Chinese occupational truck drivers. Cell Biochem Biophys. 2013;67(3):1497–500.

31. High school grads: the "new" recruits for trucking? [Internet]. 2014 [cited 2020 May 28]. Available from: https://www.fleetowner.com/industry-perspectives/trucks-at-work/article/21698241/high-school-grads-the-new-recruits-for-trucking

32. Ministry of Transportation. Commercial truck driver training standard (Class A) [Internet]. Government of Ontario; 2016. Available from: http://www.mto.gov.on.ca/english/driver/pdfs/commercial-truck-driver-training-standard.pdf

33. Ministry of Transportation. Get a truck driver's licence [Internet]. [cited 2020 May 28]. Available from: http://www.mto.gov.on.ca/english/driver/truck-driver-licence.shtml

34. Infrastructure Health & Safety Association. Fleet Signing Authority - MTO Driver Certification Program [Internet]. n.d. [cited 2020 May 28]. Available from: https://www.ihsa.ca/Training/Courses/Fleet-Signing-Authority-MTO-Driver-Certification.aspx

35. Adler NE, Newman K. Socioeconomic disparities in health: pathways and policies. Health Aff. 2002 Mar;21(2):60–76.

36. Messias J, Cavieres H, Silva R, Facundo G, Lessa R. Being a truck driver in Brazil: from implicit self-stereotypes to system justification. Estudos de Psicologia (Campinas). 2019 Jan 1;36.

37. de Oliveira LG, de Souza LM de A, Barroso LP, Gouvêa MJC, de Almeida CVD, Muñoz DR, et al. Occupational conditions and the risk of the use of amphetamines by truck drivers. Rev Saude Publica [Internet]. 2015 Sep 29 [cited 2019 Jul 14];49. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4617435/

38. Leyton V, Sinagawa DM, Oliveira KCBG, Schmitz W, Andreuccetti G, De Martinis BS, et al. Amphetamine, cocaine and cannabinoids use among truck drivers on the roads in the state of Sao Paulo, Brazil. Forensic Sci Int. 2012 Feb;215(1–3):25–7.

39. Berridge KC, Kringelbach ML. Pleasure systems in the brain. Neuron. 2015 May 6;86(3):646–64.

40. Richards G, Smith AP. A review of energy drinks and mental health, with a focus on stress, anxiety, and depression. J Caffeine Res. 2016 Jun 1;6(2):49–63.

41. Grosso G, Micek A, Castellano S, Pajak A, Galvano F. Coffee, tea, caffeine and risk of depression: a systematic review and dose-response meta-analysis of observational studies. Mol Nutr Food Res. 2016 Jan;60(1):223–34.

42. Australian Government Department of Health. Chapter 4: risks associated with psychostimulant use [Internet]. 2004 [cited 2020 May 28]. Available from: https://www1.health.gov.au/internet/publications/publishing.nsf/Content/drugtreat-pubs-modpsy-toc~drugtreat-pubs-modpsy-2~drugtreat-pubs-modpsy-2-4#men

43. Heaton K, Griffin R. The effects of caffeine use on driving safety among truck drivers who are habitual caffeine users. Workplace Health Saf. 2015 Aug 1;63(8):333–41.

44. Shattell M, Apostolopoulos Y, Sönmez S, Griffin M. Occupational stressors and the mental health of truckers. Issues Ment Health Nurs. 2010 Aug;31(9):561–8.

45. Couper FJ, Pemberton M, Jarvis A, Hughes M, Logan BK. Prevalence of drug use in commercial tractor-trailer drivers. J Forensic Sci. 2002 May;47(3):562–7.

46. Meuleners L, Fraser ML, Govorko MH, Stevenson MR. Obstructive sleep apnea, health-related factors, and long distance heavy vehicle crashes in western Australia: a case control study. J Clin Sleep Med. 2015 Apr 15;11(4):413–8.

47. Lopes CS, Hellwig N, e Silva G de A, Menezes PR. Inequities in access to depression treatment: results of the Brazilian National Health Survey – Pesquisa Nacional de Saúde. Int J Equity Health [Internet]. 2016 Nov 17 [cited 2020 Jun 23];15. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5112732/

48. National Institute on Drug Abuse for Teens. Your brain on stimulants, part 2: types of stimulants [Internet]. 2017 [cited 2020 Jul 10]. Available from: https://teens.drugabuse.gov/blog/post/your-brain-stimulants-part-2-types-stimulants

49. Chung H. Some socio-economic impacts of toll roads in rural China. J Transp Geogr. 2002 Jun 1;10(2):145–56.

50. Jun X, Bensman D. The heart of the problem: trucking in China's logistics sector. Proceedings of the 62nd Annual Meeting of the Labor and Employment Relations Association (LERA); 2018; Atlanta, GA, USA.

51. Jiang C, Lu L, Lu JJ. Socioeconomic factors affecting the job satisfaction levels of self-employed container truck drivers: a case study from Shanghai Port. Marit Pol Manag. 2017 Jul 4;44(5):641–56.

52. Internal Revenue Service. Publication 463 (2019): Travel, gift, and car expenses [Internet]. n.d. [cited 2020 Jul 13]. Available from: https://www.irs.gov/publications/p463

53. Canada Revenue Agency. Responsibilities, benefits and entitlements for employees and self-employed workers [Internet]. 2014 [cited 2020 Jul 13]. Available from: https://www.canada.ca/en/revenue-agency/services/tax/canada-pension-plan-cpp-employment-insurance-ei-rulings/cpp-ei-explained/employees-self-employed-workers-responsibilities-benefits-entitlements.html

54. Wijngaards I, Hendriks M, Burger MJ. Steering towards happiness: an experience sampling study on the determinants of happiness of truck drivers. Transp Res Part A Policy Pract. 2019 Oct 1;128:131–48.

55. Montesó-Curto P, Aguilar C, Lejeune M, Casadó-Marin L, Casanova Garrigós G, Ferré-Grau C. Violence and depression in a community sample. J Clin Nurs. 2017 Aug;26(15–16):2392–8.

56. Kposowa A. Marital status and suicide in the National Longitudinal Mortality Study. J Epidemiol Community Health. 2000 Apr;54(4):254–61.

57. Zhou X, Yan Z, Therese H. Depression and aggression in never-married men in China: a growing problem. Soc Psychiatry Psychiatr Epidemiol. 2012 Dec 12;48.

58. St John PD, Montgomery PR. Marital status, partner satisfaction, and depressive symptoms in older men and women. Can J Psychiatry. 2009 Jul 1;54(7):487–92.

59. Caldwell JE, Swan SC, Woodbrown VD. Gender differences in intimate partner violence outcomes. Psychol Violence. 2012;2(1):42–57.

60. Anderson DG. Workplace violence in long haul trucking: occupational health nursing update. AAOHN Journal. 2004 Jan 1;52(1):23–7.

61. Useche SA, Cendales B, Montoro L, Esteban C. Work stress and health problems of professional drivers: a hazardous formula for their safety outcomes. PeerJ [Internet]. 2018 Dec 20 [cited 2020 May 30];6. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6304262/

62. Central Intelligence Agency. Field listing: population below poverty line [Internet]. n.d. [cited 2020 Jun 30]. Available from: https://www.cia.gov/library/publications/the-world-factbook/fields/221.html

63. Congressional Research Service. Colombia: background and U.S. relations [Internet]. 2019. Available from: https://fas.org/sgp/crs/row/R43813.pdf

64. Yoon Y, Ryu J, Kim H, Kang C won, Jung-Choi K. Working hours and depressive symptoms: the role of job stress factors. Ann Occup Environ Med [Internet]. 2018 Jul 13 [cited 2020 Jun 30];30. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6043993/

65. Statistics Canada. Perspectives on labour and income: on the road again [Internet]. 2006 [cited 2019 May 11]. Available from: https://www150.statcan.gc.ca/n1/pub/75-001-x/10106/9061-eng.htm

66. Belzer MH, Sedo SA. Why do long distance truck drivers work extremely long hours? Econ Labour Relat Rev. 2018 Mar 1;29(1):59–79.

67. Belman DL, Monaco KA, Brooks TJ. Sailors of the concrete sea: a portrait of truck drivers' work and lives. East Lansing: Michigan State University Press; 2004.

68. Roetting M, Huang Y-H, McDevitt JR, Melton D. When technology tells you how you drive—truck drivers' attitudes towards feedback by technology. Transp Res Part F Traffic Psychol Behav. 2003 Dec 1;6(4):275–87.

69. Chen GX, Sieber WK, Lincoln JE, Birdsey J, Hitchcock EM, Nakata A, et al. NIOSH national survey of long-haul truck drivers: injury and safety. Accid Anal Prev. 2015 Dec;85:66–72.

70. Federal Motor Carrier Safety Administration, U.S. Department of Transportation. FMCSA field HOS survey: motor carrier industry implementation and use of the April 2003 Hours of Service regulations. FMCSA, U.S. Department of Transportation.; 2005.

71. Government of Canada. Land and climate [Internet]. 2009 [cited 2020 Jul 4]. Available from: https://www.canada.ca/en/immigration-refugees-citizenship/services/new-immigrants/learn-about-canada/land-climate.html

72. Statistics Canada. Canadian demographics at a glance: provinces and regions [Internet]. n.d. [cited 2020 Jun 22]. Available from: https://www150.statcan.gc.ca/n1/pub/91-003-x/2007001/4129908-eng.htm

73. Brown MJ, Jacobs DE. Residential light and risk for depression and falls: results from the LARES study of eight European cities. Public Health Rep. 2011;126(Suppl 1):131–40.

74. Huibers MJH, de Graaf LE, Peeters FPML, Arntz A. Does the weather make us sad? Meteorological determinants of mood and depression in the general population. Psychiatry Res. 2010 Dec 30;180(2):143–6.

75. de Jong S, Auping WL, Oosterveld WT, Usanov A, Abdalla M, van de Bovenkamp A. The geopolitical impact of climate mitigation policies [Internet]. The Hague Centre for Strategic Studies; 2017. Available from: https://hcss.nl/sites/default/files/files/reports/HCSS_Energytransition.pdf

76. Smart Trucking. A quick guide to the state of truck driving in Canada [Internet]. 2019 [cited 2020 Jul 1]. Available from: https://www.smart-trucking.com/truck-driving-in-canada/

77. Weston G, Zilanawala A, Webb E, Carvalho LA, McMunn A. Long work hours, weekend working and depressive symptoms in men and women: findings from a UK population-based study. J Epidemiol Community Health. 2019 May;73(5):465–74.

78. Tsuno K, Kawachi I, Inoue A, Nakai S, Tanigaki T, Nagatomi H, et al. Long working hours and depressive symptoms: moderating effects of gender, socioeconomic status, and job resources. Int Arch Occup Environ Health. 2019 Jul 1;92(5):661–72.

79. Patino CM, Ferreira JC. Internal and external validity: can you apply research study results to your patients? J Bras Pneumol. 2018;44(3):183.

80. Pannucci CJ, Wilkins EG. Identifying and avoiding bias in research. Plast Reconstr Surg. 2010 Aug;126(2):619–25.

81. Berkman ND, Santaguida PL, Viswanathan M, Morton SC. Table 1, Potential sources of bias in studies (threats to internal validity) and approaches used to address specific biases [Internet]. Agency for Healthcare Research and Quality (US); 2014 [cited 2020 Jul 7]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK253184/table/background.t1/

82. Mental Health Commission of Canada. Making the case for investing in mental health in Canada [Internet]. 2013. Available from: https://www.mentalhealthcommission.ca/sites/default/files/2016-06/Investing_in_Mental_Health_FINAL_Version_ENG.pdf

83. Statistics Canada. Average usual and actual hours worked in a reference week by type of work (full- and part-time), annual [Internet]. 2018 [cited 2019 Jul 17]. Available from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410004301

84. Zhang N, Zhang Y-H, Ma M, Zhang T, Qiu P-Y. [Reliability and construct validity of the center for epidemiological studies depression scale in a rural women population]. Sichuan Da Xue Xue Bao Yi Xue Ban. 2014 Sep;45(5):827–30, 841.

85. Andresen EM, Byers K, Friary J, Kosloski K, Montgomery R. Performance of the 10-item Center for Epidemiologic Studies Depression scale for caregiving research. SAGE Open Med [Internet]. 2013 Dec 2 [cited 2019 Apr 30];1. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4687763/

86. Miller WC, Anton HA, Townson AF. Measurement properties of the CESD scale among individuals with spinal cord injury. Spinal Cord. 2008 Apr;46(4):287–92.

87. Baron EC, Davies T, Lund C. Validation of the 10-item Centre for Epidemiological Studies Depression Scale (CES-D-10) in Zulu, Xhosa and Afrikaans populations in South Africa. BMC Psychiatry. 2017 09;17(1):6.

88. National Institute for Occupational Safety and Health. National survey of truck driver injury and health main questionnaire. U.S. Department of Health & Human Services; 2011.

89. Providence Health Care. The Groningen Sleep Quality Scale [Internet]. n.d. Available from: http://phcthrives.providencehealthcare.org/sites/staffmentalhealth.providencehealthcare.org/files/The%20Groningen%20Sleep%20Quality%20Scale.pdf

90. Simor P, Köteles F, Bódizs R, Bárdos G. A questionnaire based study of subjective sleep quality: The psychometric evaluation of the Hungarian version of the Groningen Sleep Quality Scale. Mentalhigiene es Pszichoszomatika. 2009 Sep 1;10(3):249–61.

91. Leppämäki S, Meesters Y, Haukka J, Lönnqvist J, Partonen T. Effect of simulated dawn on quality of sleep – a community-based trial. BMC Psychiatry. 2003 Oct 27;3(1):14.

92. Kis A, Szakadát S, Simor P, Gombos F, Horváth K, Bódizs R. Objective and subjective components of the first-night effect in young nightmare sufferers and healthy participants. Behav Sleep Med. 2014 Nov 2;12(6):469–80.

93. Srirangson A, Thavorn K, Moon M, Noh S. Mental health problems in Thai immigrants in Toronto, Canada. Int J Cult Ment Health. 2013 Aug;6(2):156–69.

94. Hege A, Lemke MK, Apostolopoulos Y, Whitaker B, Sönmez S. Work-life conflict among U.S. long-haul truck drivers: influences of work organization, perceived job stress, sleep, and organizational support. Int J Environ Res Public Health. 2019 19;16(6).

95. Martinussen LM, Hakamies-Blomqvist L, Møller M, Özkan T, Lajunen T. Age, gender, mileage and the DBQ: The validity of the Driver Behavior Questionnaire in different driver groups. Accid Anal Prev. 2013 Mar;52:228–36.

96. Wickens CM, Wiesenthal DL. State driver stress as a function of occupational stress, traffic congestion, and trait stress susceptibility. J Appl Biobehav Res. 2007 May 4;10(2):83–97.

97. Shattell M, Apostolopoulos Y, Collins C, Sönmez S, Fehrenbacher C. Trucking organization and mental health disorders of truck drivers. Issues Ment Health Nurs. 2012 Jun 29;33(7):436–44.

98. Belzer MH. Truck driver occupational safety and health: 2003 conference report and selective literature review. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health; 2007.

99. Apostolopoulos Y, Sönmez S, Hege A, Lemke M. Work strain, social isolation and mental health of long-haul truckers. Occup Ther Ment Health. 2016 Jan 2;32(1):50–69.

100. Rutherford A, Zwi AB, Grove NJ, Butchart A. Violence: a glossary. J Epidemiol Community Health. 2007 Aug;61(8):676–80.

101. Statistics Canada. Harassment in Canadian workplaces [Internet]. 2018 [cited 2020 Jul 9]. Available from: https://www150.statcan.gc.ca/n1/pub/75-006-x/2018001/article/54982-eng.htm

102. Workers Health & Safety Centre. Domestic violence in the workplace: breaking the silence [Internet]. n.d. Available from: https://www.whsc.on.ca/Files/Resources/Hazard-Resource-Lines/Domestic-Violence-in-the-Workplace-V2-WHSC-Resourc

103. Statistics Canada. Portrait of immigrants in Canada [Internet]. n.d. [cited 2020 Jul 10]. Available from: https://www150.statcan.gc.ca/n1/pub/85f0033m/2008018/findings-resultats/portrait-eng.htm

104. U.S. Citizenship and Immigration Services. Welcome to the United States: a guide for new immigrants [Internet]. Washington, DC: U.S. Department of Homeland Security; 2015. 107 p. Available from: https://www.uscis.gov/sites/default/files/document/guides/M-618.pdf

105. Hung C-F, Rivera M, Craddock N, Owen MJ, Gill M, Korszun A, et al. Relationship between obesity and the risk of clinically significant depression: Mendelian randomisation study. Br J Psychiatry. 2014 Jul;205(1):24–8.

106. Luppino FS, Wit LM de, Bouvy PF, Stijnen T, Cuijpers P, Penninx BWJH, et al. Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. Arch Gen Psychiatry. 2010 Mar 1;67(3):220–9.

107. Firth J, Marx W, Dash S, Carney R, Teasdale SB, Solmi M, et al. The effects of dietary improvement on symptoms of depression and anxiety: a meta-analysis of randomized controlled trials. Psychosom Med. 2019 Apr;81(3):265–80.

108. Kandola A, Ashdown-Franks G, Hendrikse J, Sabiston CM, Stubbs B. Physical activity and depression: towards understanding the antidepressant mechanisms of physical activity. Neurosci Biobehav Rev. 2019 Dec 1;107:525–39.

109. Drug Enforcement Administration. Drugs of abuse [Internet]. U.S. Department of Justice; 2017. Available from: https://www.dea.gov/sites/default/files/drug_of_abuse.pdf

110. United Nations Office on Drugs and Crime. Treatment of stimulant use disorders: current practices and promising perspectives. 2019 p. 59.

111. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. National survey of long-haul truck driver health and injury [Internet]. 2014 Transportation Research Board 93rd Annual Meeting; 2014 Jan 14; Federal Motor Carrier Safety Administration Analysis, Research, and Technology Forum. Available from: https://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/National%20Survey%20of%20Long-Haul%20Truck%20Driver%20Health%20and%20Injury.pdf

112. Jain NB, Hart JE, Smith TJ, Garshick E, Laden F. Smoking behavior in trucking industry workers. Am J Ind Med. 2006 Dec;49(12):1013–20.

113. Konefal S, Gabrys R, Porath A. Clearing the smoke on cannabis: regular use and mental health [Internet]. Canadian Centre on Substance Use and Addiction; 2019. Available from: https://www.ccsa.ca/clearing-smoke-cannabis-regular-use-and-mental-health

114. Lund AK, Preusser DF, Blomberg RD, Williams AF. Drug use by tractor-trailer drivers. J Forensic Sci. 1988 May;33(3):648–61.

115. Guest R, Tran Y, Gopinath B, Cameron ID, Craig A. Psychological distress following a motor vehicle crash: evidence from a statewide retrospective study examining settlement times and costs of compensation claims. BMJ Open [Internet]. 2017 Sep 5 [cited 2020 Jul 16];7(9). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5588945/

116. Ryb GE, Dischinger PC, Read KM, Kufera JA. PTSD after severe vehicular crashes. Ann Adv Automot Med. 2009 Oct 5;53:177–93.

117. Insurance Institute for Highway Safety (IIHS), Highway Loss Data Institute (HLDI). Fatality facts 2018: large trucks [Internet]. IIHS-HLDI crash testing and highway safety. n.d. [cited 2020 Jul 16]. Available from: https://www.iihs.org/topics/fatality-statistics/detail/large-trucks

118. Doroga C, Băban A. Traumatic exposure and posttraumatic symptoms for train drivers involved in railway incidents. Clujul Med. 2013;86(2):144–9.

119. National Institute of Mental Health. Statistics [Internet]. n.d. [cited 2020 Jul 23]. Available from: https://www.nimh.nih.gov/health/statistics/index.shtml

120. Weingarden H, Renshaw KD, Wilhelm S, Tangney JP, DiMauro J. Anxiety and shame as risk factors for depression, suicidality, and functional impairment in body dysmorphic disorder and obsessive compulsive disorder. J Nerv Ment Dis. 2016 Nov;204(11):832–9.

121. Onwuameze OE, Uga A, Paradiso S. Longitudinal assessment of clinical risk factors for depression in schizophrenia spectrum disorders. Ann Clin Psychiatry. 2016;28(3):167–74.

122. Fan W, Yan Z. Factors affecting response rates of the web survey: a systematic review. Comput Hum Behav. 2010 Mar 1;26(2):132–9.

123. Möller-Leimkühler AM. Barriers to help-seeking by men: a review of sociocultural and clinical literature with particular reference to depression. J Affect Disord. 2002 Sep;71(1–3):1–9.

124. Ontario Trucking Association. Survey: number of women in trucking rising [Internet]. 2018 [cited 2020 Jul 11]. Available from: https://ontruck.org/survey-number-of-women-in-trucking-rising/

125. Board of Governors of the Federal Reserve System. Report on the economic well-being of U.S. households in 2017 [Internet]. Washington, DC; 2019 p. 66. Available from: https://www.federalreserve.gov/publications/files/2018-report-economic-well-being-us-households-201905.pdf

126. United States Senate, Subcommittee on Surface Transportation and Merchant Marine Infrastructure, Safety and Security, Committee on Commerce, Science, and Transportation. Oversight of the federal truck driver Hours-of-Service rules and truck safety [Internet]. Washington, DC: U.S. Government Printing Office; 2007. 112 p. Available from: https://babel.hathitrust.org/cgi/pt?id=umn.31951d03523244d&view=1up&seq=7

127. Hege A, Perko M, Johnson A, Yu CH, Sönmez S, Apostolopoulos Y. Surveying the impact of work hours and schedules on commercial motor vehicle driver sleep. Saf Health Work. 2015 Jun;6(2):104–13.

128. Department of Planning, Transport and Infrastructure. Heavy vehicle driver's handbook [Internet]. Government of South Australia; 2019. Available from: http://mylicence.sa.gov.au/__data/assets/pdf_file/0010/174097/MR1566_HV_Drivers_Handbook.pdf

Chapter 7: Ethical Considerations

The consent form, survey, posters and other media, as well as the overall project, were reviewed and approved by the Research Ethics Board of Lakehead University prior to commencing this study (Appendix E). There was the risk that some truckers could have experienced emotional distress in answering some of the questions, including the items related to depression. We provided a list of mental health supports (including not only crisis lines but also some emotional counselling lines) for both Canadian and American truckers, some of which were also exclusive to certain provinces and states only, in the consent form (Appendix A). We did not provide the contact information for support lines across all provinces (and territories) and states due to limitations in space. In particular, we focused on some of the most populous provinces and states, in addition to states which were spread out from each other, in order to make the list of mental health supports relevant to a larger number of truckers. There is the risk that truckers driving in less populous places would have been disadvantaged in their access to mental health supports. However, several national support lines were also made available. In addition, given that the long-haul truckers would likely not be remaining in the same location for long, it would likely not take too long before they could access some of the state- or provincial-specific supports.

We used the "prevent ballot box stuffing" option from Qualtrics, in the consent form, to prevent truckers from accessing the webpage of the survey more than once. We did not tick the same option for the main survey, as access to the main survey was only given to those who completed the consent form (we never distributed the link to the main survey. The main survey checked that respondents came from the same exclusive link—a link which did not differ between participants, and which was presented to only those who agreed to participate in study,

in the consent form). We kept participants' information from the consent form separate from their surveys; thus, the data from the survey could not be linked to any specific names. We also selected for the option to anonymize our main survey responses, in Qualtrics. Anonymity is given by removing participants' IP addresses and location data from their survey data [1].

All electronic data were collected through Qualtrics: a secure, web-based survey platform. All data transmitted in Qualtrics is encrypted [2]. Qualtrics also uses firewalls, scans, and third-party penetration tests to prevent unauthorized access to participants' data [2]. Participants' data were stored onto a password-protected server in the locked office of the principal investigator (Dr. Vicki Kristman) at Lakehead University. This office could only be accessed by the research team of the principal investigator. Participants were made aware of where and how their data would be stored in the survey's consent form. We plan to have the data from this study stored on this password-protected server for a minimum of 5 years after the results of this study have been published.

We included the option for participants to be included in a draw for a $100 prepaid gift card. The draw was conducted after the data collection was completed. We offered this gift as a "thank you" to participants for taking the time to complete our survey. We felt that offering this incentive would have increased the participation rate of long-haul truckers and that the benefits of this incentive would have outweighed the potential risks or cons.

One concern is that the consent form of this study stated that participants could be entered into the draw if they completed both our consent form and survey. However, we ended up running the draw based solely on those who completed the consent forms, due to an unintended consequence of anonymizing the participants' survey responses. The unintended consequence was that although the survey responses did not record any personally identifiable

information—in order to add security to the participants' data—this also meant that we, ourselves, would not be able to link the surveys back to any personally identifiable information in the consent forms, in order to check who had completed both forms.

7.1. *References*

1. Qualtrics. Survey Termination [Internet]. n.d. [cited 2020 Jul 11]. Available from: https://www.qualtrics.com/support/survey-platform/survey-module/survey-options/survey-termination/

2. Qualtrics. Security Statement [Internet]. n.d. [cited 2020 Jun 1]. Available from: https://www.qualtrics.com/security-statement/

Chapter 8: Limitations, Strengths, and Relevance

8.1. *Limitations*

Our findings have some limitations due to our choice in study design, the presence of selection bias, the presence of measurement error (both differential and non-differential), bias from measuring symptoms of depression as exposures, a lack of controlling for some potentially important confounders (e.g., job satisfaction, region of work, crashes/accidents), and other factors which we did not measure but which could have been associated with depression. The limitations of our study design are described in the sub-section directly below. A discussion on the sources and consequences of bias in this study (i.e., selection bias, measurement error, bias from including symptoms of depression as exposures, and bias due to missed confounders), as well as on the factors which we did not test for their association with depression are discussed in the section on *Internal Validity* (6.3.1.) in Chapter Six. Our study also has some limitations on who our findings may be generalizable to. A discussion on the external validity of this study is featured in section 6.3.2.

Study Design

Our study design was cross-sectional, thus were not able to determine any causations, as mentioned previously in section 6.3.3. Our use of voluntary recruitment (non-random sampling) also meant that we could not calculate an unbiased estimate of the prevalence of any characteristic in this population, including depression. Limitations in the sample size of this study also made us unable to stratify the analyses in Chapter Four by age. It is possible that truckers of different age groups could have had different factors associated depression.

Sample size restrictions also meant that some variables were not stable enough to accurately assess for statistical significance or confounding effects. The small number of men

who were separated, widowed, or divorced in this study could have resulted in a non-significant association between this category of marital status and depression in Chapter Four.

8.2. *Strengths*

One major strength of this study is that, to the best of our knowledge, this is the second largest sample of Canadian and U.S. long-haul truck drivers included in a published study. To the best of our knowledge, this is also the largest sample of Canadian long-haul truck drivers taken thus far in a study. Our sample size increases the power of this study. Our sample size also enabled us to control for a large number of confounders in trucking in Chapter Five relative to previous studies on truck drivers [1].

A second strength of this study is that we discovered several factors which are associated with depression which differ by a trucker's sex. No other study, to the best of our knowledge, has looked at whether male and female truckers might differ in their factors which are associated with depression (or poor mental health). There are also very few studies which have looked at female truckers, in general.

A third strength of this study is that we re-tested the associations between certain factors which were previously associated with depression in truck drivers and determined which associations were relevant (or irrelevant) for Canadian and U.S. truckers. Some of the previous associations could have been due to regulatory differences in the trucking industries of China and Brazil relative to Canada and the U.S. Toll roads (both legal and illegal ones) are common in China, traffic police (both legal and illegal) are readily present, and over 85% of truckers in China are self-employed (in contrast, only 29% of Canadian and U.S. truckers are owner-operators), for instance [2–6]. It is possible that truckers with low driving experience (less than one year) in China could have been more prone to encountering these problems/less

knowledgeable in how to avoid them, relative to those with more driving experience (i.e., 3-4 years, 5-6 years, and eight years or more) [7]. Consequently, low driving experience could have been a risk factor for noticeable losses in income, which could have been particularly harmful given that most Chinese truckers are self-employed, lack social insurance, and generally come from poor, rural backgrounds [2]. These same issues may not be relevant for Canadian and U.S. truckers. Consequently, this same association may not be relevant for Canadian and U.S. truckers.

A second study determined several factors which were associated with depression in Brazilian truck drivers. However, Brazil also did not have any legal rights for truck drivers until 2012, which was years after their study [8,9]. This could have resulted in type of trucker having a positive association with depression, such that the company drivers in Brazil could have been more vulnerable to working in poor conditions than the self-employed truckers [1]. In contrast, this same association may not be relevant for Canadian or American truckers (indeed, we found a non-significant association between type of trucker and depression), wherein both types of truckers might have more similar working conditions [8,9]. Stimulant use might also lack a significant association with depression in Canadian and U.S. truckers if most of these truckers are consuming licit products, and if most of these truckers have easier access to MHD treatment or support (which could reduce the risk for self-medication and reduce the risk of becoming dependent on stimulants) relative to Brazilian truckers.

8.3. *Relevance to Health Science or Public Health*

This study addressed three major gaps in the literature. First, it included a larger assessment of potential risk factors for depression in long-haul truck drivers. We tested if there was an association between a trucker's country of residence, country of work, sex, weekly

durations of driving, number of days away from home, general health, sleep quality, fatigue, low back pain, possession of profession training, financial strain, citizenship status (and whether a trucker was a recent immigrant), stressors and exposure to violence with depression. Most of these factors have not previously been tested for their association with depression in long-haul truckers, with the exception of a recent study by Crizzle, McLean, and Malkin (2020). However, the methodology of this study was also poor, and we still included several new factors which were not measured in their study. Thus, we determined multiple previously-unknown associations (and potential risk factors of depression) for this population in the fields of epidemiology and public health, while also retesting some variables using an improved study design (e.g., larger sample size allowing for more power, and a valid measure of depression with valid cut-off points).

Though our study could not make any causal inferences, some of the factors with associations with depression in Chapter Four could also be risk factors of depression in truckers. As such, reducing a trucker's level of exposure to some of these factors (e.g., poor sleep) could potentially decrease their risk of depression. Long-haul truckers may also want to find constructive ways to help manage their stress. This could be through the trucker's initiative, or through an initiative/ workshop/ program that is promoted at the workplace by someone with authority. Those with authority might also want to develop peer support groups for truckers at work, or suggest mental health supports to truck drivers in poor health, with poor sleep, who are frequently fatigued, or who experience high levels of stress at work, in case these truckers are already depressed (or are at risk of becoming depressed). Pro-health workshops or activities (such as meal preparation classes or physical activity workshops) could also be promoted at the workplace. Those with authority or fellow truckers may furthermore, want to consider creating

workshops or peer support groups on how to cope with violence while on the road. Finally, employers may want to create policies which allow for truckers to take breaks more frequently in order to reduce driver fatigue and/or sleepiness.

Second, we also determined that some of these factors which are associated with depression may differ by a trucker's sex. The latter association in particular has not been previously examined in the fields of health science and in epidemiology. We revealed that male truckers who have never been married and female truckers who experience high stress due to violence outside of work are more at risk for depression. These represent unique associations which were previously unknown in the literature and may also represent areas of interest for future public health interventions. Those with authority in trucking may want to consider promoting mental health resources or mental health programs in the workplace for male truckers who have never been married and female truckers who experience domestic violence outside of work. In particular, employers may want to develop wellness programs, workshops, or support groups which are exclusively tailored to men, on the challenges they may experience in maintaining (or developing) their intimate relationships due to the demands of their work. They may also want to develop workshops for women on what they should do, or where they should go if they currently (or later) experience violence outside of work.

Third, the association between driving duration and depression has, to the best of our knowledge, not previously been tested in long-haul truck drivers. We addressed this gap in the literature on whether driving duration may be a risk factor for poor mental health in truckers. We observed a positive, crude association between these variables; however, this association was non-significant after controlling for confounders. These findings inform stakeholders in trucking, other scientists, clinicians, and individuals in public health that there may be other factors which

are more significantly associated with depression in long-haul truckers other than simply the number of hours that they are driving for. However, more studies are needed to confirm this finding, as these were simply the results of our one study.

Employers may also want to encourage, or incentivize truckers to drive with a partner, co-worker, or friend for long trips. One study on female truckers reported that some of the women were driving with a spouse [10]. Some of the grey literature has indicated that some truckers may be driving with a pet [11]. Though some companies may allow for truckers to bring along a companion or co-driver (the percentage which allow this is, to the best of our knowledge, unknown), there could be multiple benefits in encouraging this system [11]: truckers who are allowed to share their driving with a partner may be able to take breaks more frequently and obtain more sleep. A buddy system could also reduce their durations of driving, in case there truly is a positive association between driving duration and depression. A buddy system (or pet) may lastly, prevent truckers from feeling stressed due to social isolation during long drives, and may be a deterrence for crime when truckers are working in isolated or run-down locations.

8.4. *References*

1. da Silva-Júnior FP, de Pinho RSN, de Mello MT, de Bruin VMS, de Bruin PFC. Risk factors for depression in truck drivers. Soc Psychiatry Psychiatr Epidemiol. 2009 Feb;44(2):125–9.

2. Jiang C, Lu L, Lu JJ. Socioeconomic factors affecting the job satisfaction levels of self-employed container truck drivers: a case study from Shanghai Port. Marit Pol Manag. 2017 Jul 4;44(5):641–56.

3. Chung H. Some socio-economic impacts of toll roads in rural China. J Transp Geogr. 2002 Jun 1;10(2):145–56.

4. Jun X, Bensman D. The heart of the problem: trucking in China's logistics sector. Proceedings of the 62nd Annual Meeting of the Labor and Employment Relations Association (LERA); 2018; Atlanta, GA, USA.

5. U.S. Census Bureau. America keeps on truckin' [Internet]. 2019 [cited 2019 Oct 4]. Available from: https://www.census.gov/library/stories/2019/06/america-keeps-on-trucking.html

6. Statistics Canada. Perspectives on labour and income: on the road again [Internet]. 2006 [cited 2019 May 11]. Available from: https://www150.statcan.gc.ca/n1/pub/75-001-x/10106/9061-eng.htm

7. Shen S, Li Y, Zhou M, Zhang C, Jiang Y, Kang Y. Depression status and associated factors in Chinese occupational truck drivers. Cell Biochem Biophys. 2013;67(3):1497–500.

8. Messias J, Cavieres H, Silva R, Facundo G, Lessa R. Being a truck driver in Brazil: from implicit self-stereotypes to system justification. Estudos de Psicologia (Campinas). 2019 Jan 1;36.

9. de Oliveira LG, de Souza LM de A, Barroso LP, Gouvêa MJC, de Almeida CVD, Muñoz DR, et al. Occupational conditions and the risk of the use of amphetamines by truck drivers. Rev Saude Publica [Internet]. 2015 Sep 29 [cited 2019 Jul 14];49. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4617435/

10. Reed DB, Cronin JS. Health on the road: issues faced by female truck drivers. AAOHN Journal. 2003 Mar 1;51(3):120–5.

11. Best Dogs for Trucks Drivers [& How To Travel With Pets] [Internet]. n.d. [cited 2020 Aug 14]. Available from: https://www.cdl.com/trucking-resources/general-resources/best-dogs-for-truck-drivers-and-how-to-travel-with-pets

Chapter 9: Conclusion

9.1. *Summary of Thesis Findings*

The primary objective of this study was to determine common factors which would be significantly associated with depressive symptoms in long-haul truck drivers. We hypothesized that all of the potential risk factors of depression from Chapter Two would have had statistically significant associations with depression. However, this hypothesis was rejected. Being in good, very good, or excellent health, sleeping well almost every night or every night on workdays, and sleeping well almost every night or every night on non-workdays were associated with significantly lower depression scores. In particular, good quality sleep on workdays and good health both had the most negative associations with depression. Fatigue, high stress due to tight delivery deadlines, high stress due to poor road conditions, and high stress due to being away from social relationships were all associated with significantly higher depression scores. In particular, fatigue and high stress due to being away from social relationships both had the most positive associations with depression. An explanation why some of our factors could have lacked an association with depression was presented in Chapter Six.

We also found in Chapter Four that men and women had some factors which were significantly associated with depression which were specific to their demographic. Men had many of the same factors which were associated with depression as in the model across the full sample. However, being never married was a factor which was exclusive to their demographic. Women had significantly fewer variables which were associated with their CES-D-10 scores than either the full sample, or the exclusively male model, likely due to their small sample size. However, high stress due to violence outside of work was a factor which was associated with depression for their demographic only.

The secondary objective of this study was to determine the association between driving duration and depression. We hypothesized that there would be a positive association between these two variables. This hypothesis was partly rejected. There was a positive crude association between driving duration and depression. However, after accounting for confounders, this association was no longer statistically significant.

The tertiary objective of this study was to determine the moderating effect of a long-haul trucker's working country on the association between driving duration and depression. We hypothesized that those who drove in Canada would have a higher risk of depression. However, we did not find that working country had any modifying effect on the association between our main exposure and depression.

We also examined marital status and sex as possible effect modifiers between driving duration and depression in Chapter Five. However, neither marital status, nor sex were found to be statistically significant interaction terms in the association between driving duration and depression.

9.2. *Implications of Thesis Research*

Some of the factors which we found to be associated with depression could be risk factors of depression, or symptoms of depression. As such, truckers should find constructive ways to cope with their work stress in case some of the work stressors we tested could be risk factors of depression. Employers may want to consider developing peer support groups for truckers, or workshops/ programs aimed at improving the health of truckers, such as programs on nutrition, meal preparation, anti-stress workshops and physical activity workshops. Employers may also want to recommend a mental health support to truckers in poor health, who do not sleep well or who are often fatigued at work, or who appear highly stressed at work, in case these

truckers are already (or could become) depressed. Policies may want to be developed so that truckers can take more frequent breaks at work. More frequent breaks could help truckers to reduce their levels of fatigue, obtain more sleep, and reduce their durations of driving, in case there truly is a positive association between driving duration and depression.

Being never married was positively associated with depression in this study. As such, those with authority in trucking may want to consider developing programs or workshops for never married men in trucking, or even workshops and peer support groups on how to cope with the challenges of maintaining an intimate relationship while in trucking. Those with authority may meanwhile, want to develop programs and peer support groups for women on how to cope with (or seek help for) violence outside of the workplace.

Employers may finally, want to encourage a buddy system, or a system/ workplace policy which allows for truckers to take a partner, spouse, or other companion (e.g., pet) while on the road. Though some companies offer this (the percentage is unknown), more employers may want to make a buddy or companion system more common in trucking. The presence of a spouse, or other companion, may help reduce a trucker's feelings of social isolation. Driving with a spouse, companion or pet may also help reduce the risk of a trucker being mugged, assaulted, or targeted for other violent crimes when they travel to isolated or run-down locations. Driving with a co-worker may not only reduce feelings of loneliness but may also, allow for a trucker to switch drivers and obtain more frequent breaks.

9.3. *Future Directions*

Future studies should use more a more robust research design, including cohort studies to assess true risk factors for depression. Larger sample sizes would permit more statistical power to confirm our findings regarding effect modification and expand our findings by assessing age

as a possible effect modifier. Future studies should also use a random sampling approach from a defined sampling frame to assess and potentially reduce selection bias and to estimate the prevalence and incidence of depression in long-haul truck drivers. A targeted sample of female truckers should also be considered to find other factors which are significantly associated with depression which we may have missed. Future studies may also want to consider measuring more items related to stress and violence. Finally, future studies may want to consider running their studies over the course of the year, or in the seasons in which truckers are moderately busy, to reduce the effect that the time of the year could potentially have on their findings.

Appendix A: Consent Form

INFORMATION SHEET AND CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Title	Risk Factors for Depression in Long-haul Truck Drivers: A Cross-sectional Study Design
Principal Investigator	Dr. Vicki Kristman, Lakehead University
Student Investigator	Nyasha Makuto, Graduate Student, Lakehead University

Dear Potential Participant,

You are invited to take part in a research study of long-haul truck drivers. This study is being conducted by researchers at Lakehead University in Thunder Bay, Ontario, Canada. The information that is collected will be used to complete a Masters thesis.

Purpose

This study will examine risk factors for depression among Canadian and U.S. long-haul truck drivers. Risk factors for depression in truckers are currently poorly understood in the literature; this study will allow for us to better understand factors that may influence the risk of depression in truckers. This information can be used by other researchers and stakeholders in the long-haul trucking industry to improve the working environment and conditions of long-haul truckers.

Procedure of Study

This page represents the consent form of the study. If you agree to participate in this study, you will be directed to a confidential web-based survey that should take approximately 10 minutes to

complete. The survey will be administered through Qualtrics, a Canadian-based online survey platform.

This survey will ask if you are currently employed as a long-haul truck driver, followed by your primary country of residence. If you are not currently a long-haul truck driver or do not live in Canada nor the U.S., the survey will end. The next questions will ask about your type of employment as a long-haul trucker (company or owner-operator) and other job-related factors (e.g., your years employed as a long-haul trucker). Data collected from the consent form will be completely unlinked—and kept separate—from the main survey on Qualtrics, so that it will not be possible to identify you and link you to any of the survey responses that are given. Any responses in the survey will be kept strictly confidential by the research team. Names are only collected in this consent form to ensure that informed consent has been given by each participant. The date that you complete the survey will be automatically collected by Qualtrics, so that you will not be required to enter it. E-mails are only collected to 1) allow participants to be sent a copy of the final research results if they so choose, and 2) allow participants to be contacted if they are selected as a winner of a draw (in which their participation is voluntary) that would occur after the data collection period of this project has been completed.

Benefits to being in the study

Benefits of this study are that we will learn about risk factors for depression in truck drivers. Thus, you will contribute to new knowledge that may help us understand why some individuals who work in long-haul trucking may be at risk for poor mental health.

Voluntary Participation

Your participation in this study is completely voluntary. You may decide not to participate in this study after reading the consent form by selecting “No” to the first question on this form.

You may refuse to answer any, and all questions during the survey by skipping questions.

You may leave or withdraw from this study at any point in time without penalty. Surveys that are left partially completed will be automatically closed and saved onto Qualtrics after 1 week of inactivity. You will no longer have access to your partially completed survey once it has been closed. Note that partially completed surveys may be used during the analyses of this study.

Reimbursement

As a thank you for participating in this project, you will also have the option to be included in a random draw to receive a $100 CAD VISA gift card, should you complete both the consent form and survey. You will be notified through e-mail if you are chosen as the recipient of this gift card. The draw will occur after the data collection of this study has been completed.

Confidentiality

All information that is collected in this consent form and the survey will be fully confidential. No personally identifiable information will be shared with anyone outside of the research team. All survey data will be collected using Qualtrics, which is a secure, web-based platform that is based in Canada. Only the research team will have access to the online data. Once your survey and consent form responses are complete, or have been saved onto Qualtrics as a partially completed survey (note that only those who consent to participate in this study will be shown the main survey), all information that you have provided to us will be downloaded from the Qualtrics server and stored onto a secure, password-protected computer in the locked office of the Principal Investigator, Dr. Vicki Kristman, at Lakehead University. The locked office can only be accessed by the research team.

All data that is stored on the Qualtrics server will be completely destroyed once it has been downloaded onto the password-protected computer in the locked office of the Principal

Investigator. Both the consent form and survey data will be erased from Qualtrics. It will not be possible to identify you from your responses in the survey.

All information that is collected during this study, including your personal information on the consent forms, will be kept strictly confidential. You will not be named in any reports, results, publications, or presentations that may come from this study. All data from the surveys will be collected and summed together, then presented as averages or as percentages. Information from the consent form will **not** be shared, analyzed or published in any shape or form.

Data Storage

All data from the consent form and survey will be stored on a secure, password-protected computer in the locked office of the Principal Investigator, Dr. Vicki Kristman, at Lakehead University for a minimum of 5 years after the results of the study have been published. All data from this study will be completely erased off Qualtrics after being downloaded onto the password-protected computer.

Questions about the study

The information in this document and consent form is yours to keep. Please feel free to print this page if you desire. If you have any questions, concerns or would like to speak to the study team for any reason, please contact the student researcher Nyasha Makuto through truckerstudy@gmail.com, her supervisor Dr. Vicki Kristman at +1 (807) 343-8961 (vkristman@lakeheadu.ca). This study has been approved by the Lakehead University Research Ethics Board. If you have any questions related to the ethics of the research and would like to speak to someone outside of the research team, please contact Sue Wright at the Research Ethics Board at +1 (807) 343-8283 or research@lakeheadu.ca.

Consent

I have read and understood the information provided above. I understand the potential risks and benefits of the study. Any data I provide will be securely stored at Lakehead University for a minimum of 5 years following the completion of the project, and I will remain confidential through any publication/presentations which arise from this study. **I consent to take part in this study with the understanding that I can withdraw at any time without penalty. I understand that I can refuse to answer any, and all questions during the study. I understand that partially completed surveys may be analyzed during the study. I voluntarily consent to participate in this study.**

A1.

YES ……..…….……. 1

If you consent to participate, please enter your **first and last name** in the box below.
[_____]

NO ……..……...…… 0 → End survey, do not proceed to main questionnaire

ENTER 1 TO CONTINUE. (Next page)

A2. I would like to receive an e-mail summary of the research findings.

YES ……..…….……. 1 → Enter e-mail address
NO ……..……...…… 0

A2. I would like to be included in a draw to receive a $100 CAD VISA gift card.

Yes; use e-mail address from the last page…..…..…….2
Yes; enter new e-mail address…… 1 → Enter e-mail address
NO ……..……...…… 0

E-mail address:

_____

ENTER 1 TO CONTINUE. (Next page)

If you are using a computer, please print the following sheet, if you would like to keep a physical copy of the mental health resources provided below. If you are using a phone, please take a screenshot, to keep a digital copy of the resources below. You may also click on the following link to open a .pdf of the resources below (on a computer or a phone) which can be downloaded and saved onto your current device, or e-mailed to yourself, to keep and use as you wish. **You will not be able to return to this screen after you proceed to the next page.**

MENTAL HEALTH RESOURCES FOR CANADIANS AND AMERICANS

Canada

TeleHealth (1-866-797-0000)

Crisis Services Canada (1-833-456-4566)

Canadian Crisis Hotline (1-888-353-2273)

Crisis Text Line (smartphones only— text with a crisis counsellor): text HOME to 686868

For First Nations and Inuit

Hope for Wellness Help Line (1-855-242-3310)

Alberta

Alberta Mental Health Help Line (1-877-303-2642)

British Columbia

Fraser Health Crisis Line (1-604-951-8855)

Ontario

2-1-1 Ontario (2-1-1)

Connex Ontario (1-866-531-2600), http://www.mentalhealthhelpline.ca/

Manitoba

Klinic Crisis Line (1-204-786-8686)

Québec

Écoute Entraide (1-514-278-2130)

U.S.

National Alliance on Mental Illness (NAMI) (1-800-950-NAMI)

Project Return Peer Support Network (1-888-448-9777)

SAMHSA Disaster Distress Helpline (1-800-985-5990)

National Suicide Prevention Lifeline (1-800-273-8255)

Crisis Text Line (smartphones only— text with a crisis counsellor): text HOME to 741741

California

California Peer-Run Warm Line (1-855-845-7415)

Florida

Crisis Hotline of Central Florida (1-407-425-2624)

Georgia

Georgia Crisis and Access Line (1-800-715-4225)

Idaho

The Crisis Hotline Idaho (1-208-788-3596)

Illinois

Illinois Warm Line (1-866-359-7953)

Iowa

Iowa Helpline (1-855-800-1239)

Massachusetts

Samaritans Helpline (1-877-870-HOPE)

Michigan

Common Ground (1-800-231-1127)

New York

NYC Well (1-888-NYC-WELL)

North Carolina

NAMI North Carolina Helpline (1-800-451-9682)

Pennsylvania

The Washington County Crisis Line (1-877-225-3567)

Texas

Integral Care (1-512-472-HELP)

Suicide & Crisis Center of North Texas (1-214-828-1000)

ENTER 1 TO CONTINUE. (PROCEED TO SURVEY)

Appendix B: Survey

LONG-HAUL TRUCK DRIVER SURVEY ON RISK OF DEPRESSION

Before we begin, we'd first like to see if you are an eligible participant for our study.

1. As a long-haul truck driver, how many times in the **last 30 days** have you slept away from home due to work?

   DAYS (numbers only)……. |_____|→If 0, END SURVEY
   None, on a temporary leave of absence ……..…...97
   DON'T KNOW…… 99

2. Which of the following is your primary country of residence?

   CANADA ……...…… 1
   U.S.A. ……..…… 2
   OTHER ……..……..……. 3 → END SURVEY

3. In which countries were you driving your truck **over the last week**?
   If you had not driven last week, please indicate which country you typically haul freight in (check all that apply).

   CANADA ……...…… 1
   U.S.A. ……..…… 2
   MEXICO ……...……. 3
   Other country ……..4 → END SURVEY

We'd now like to know more about your work, and your workplace environment, as a long-haul truck driver.

4. What kind of long-haul truck driver are you? Do you consider yourself…

   A company **employee** who does not lease,
   own or make payments on your truck? ……..... 1
   An **owner-operator** who leases, owns or makes
   payments on your truck and is **leased to**
   a motor carrier? ……..…….…….. 2
   An **owner-operator** who leases, owns or makes
   payments on your truck and **operates**
   under your own authority picking up
   your own loads? ……..…….…….. 3

A truck driver who works for a temporary
employment, or personnel agency? ……... 4
DON'T KNOW ……..… 9

5. For how many years have you been **employed** as a long-haul truck driver? Please include employment time at your current, and any previous job.

YEARS (numbers only) …….……... |_____|
DON'T KNOW ……..… 999

6. Have you ever taken professional truck driving lessons, classes, courses, or received additional certification **beyond obtaining your truck driver's licence**?
This may include attending a driving school for long-haul truckers.

Yes ……. 1
No …….. 2
DON'T KNOW ……..9

7. Please **estimate** the total number of hours you spent **driving** your long-haul truck **during the last week** (e.g. 70 hours).
If you had not driven last week, please estimate how many hours you spend **driving** your long-haul truck in a typical work week (numbers only):

|_____|

8. Below is a list of some of the ways you may have felt or behaved. Please indicate how often you have felt this way during the **past week** by rating each question.

	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of the time (3-4 days)	All of the time (5-7 days)
a. I was bothered by things that usually don't bother me.	0	1	2	3
b. I had trouble keeping my mind on what I was doing.	0	1	2	3
c. I felt depressed.	0	1	2	3
d. I felt that everything I did was an effort.	0	1	2	3
e. I felt hopeful about the future.	0	1	2	3
f. I felt fearful	0	1	2	3
g. My sleep was restless.	0	1	2	3
h. I was happy.	0	1	2	3
i. I felt lonely.	0	1	2	3
j. I could not "get going".	0	1	2	3

9. Have you ever been told by a doctor, nurse or other health professional that you have **seasonal affective disorder** (SAD), or **seasonal depression**?
   - Yes, and **still** have seasonal symptoms……...1
   - Yes, but no longer have seasonal symptoms……..…....2
   - No …….. 3
   - DON'T KNOW ……..9

10. In general, you would say your overall health is…
   - Excellent…….....1
   - Very good…….....2
   - Good …….. 3
   - Fair…..…….4
   - Poor……..……...5
   - DON'T KNOW ……..9

11. During the past three months, did you have lower back pain that **lasted a whole day or more**? Do not report aches and pains that are fleeting or minor.
   - Yes……...1
   - No …….. 2

DON'T KNOW ……..9

12. How often do you feel that you get a good night's sleep…

	Never	rarely	almost every night	every night
On workdays?	0	1	2	3
On non-workdays?	0	1	2	3

13. Please indicate how many days, in the period since last _____ **[PROGRAMMER NOTE: INSERT THE DAY OF THE WEEK THAT WAS 7 DAYS AGO]** you felt fatigued for any part of your working period, not including just before sleep.

DAYS (numbers only)…….|_____|
DON'T KNOW…….9

14. How often do you use stimulants **other than coffee or tea** (such as energy drinks, cocaine or amphetamines) to stay awake while on the job?

Never……. 1
Less than once a month …… 2
1 or more times a month…..……...3
1 or more times a week……..……..……..4
Every 1 or 2 days…….. 5
DON'T KNOW……..9

15. Please indicate the level of stress, if any, that you experience due to the following factors…

a. **At work:**

	None	mild	moderate	high	extreme	chronic
Tight delivery times and pressures	0	1	2	3	4	5
Poor driving behaviour from 4-wheelers (e.g., driving slowly, cutting you off)	0	1	2	3	4	5
Poor road conditions (e.g., bad weather, ice, construction)	0	1	2	3	4	5
Being away from family, friends, an intimate partner, or other social relationships	0	1	2	3	4	5
Poor sleep, **on workdays**	0	1	2	3	4	5
Violence (including being mugged, verbal abuse and harassment)	0	1	2	3	4	5

b. **Outside of work:**

None, mild, moderate, high, extreme, chronic

Poor sleep, on **non**-workdays	0	1	2	3	4	5
Violence (such as domestic abuse) outside of work	0	1	2	3	4	5

Thank you for all the information you've provided so far.

In this final section of the questionnaire, we're interested in learning a bit more about you.

We will never provide anyone with your personal information. Instead, this information will be combined with information from everyone else in the survey and will be used to describe how many different people there were in the study.

16. What is your age?

    YEARS (numbers only) ……..……... |_____|

17. Are you male or female?

    MALE ……..……..……..…… 1
    FEMALE ……...…… 2
    OTHER……3
    DON'T KNOW ……..... 9

18. Are you **now** married, widowed, divorced, separated, or never been married, or living with a partner?

    NOW MARRIED……... 1
    WIDOWED…… 2
    DIVORCED……,…..……..…… 3
    SEPARATED……4
    NEVER MARRIED……..……..…… 5
    LIVING WITH A PARTNER……6
    DON'T KNOW…….……...…9

19. What is your current level of education?

    High school or less …… 1
    Some trade, college or university …….. 2
    Completed a trade, college, or university ….…….. 3

20. What is your current legal status in Canada **or** the U.S.?

    Canadian or U.S. citizen ..…….……..1

Permanent resident of Canada or the U.S. ……..……...2
Work permit for Canada or the U.S. …….…… 3
Student or visiting visa for Canada or the U.S. ……..4
Other……5
(SPECIFY) _____
DON'T KNOW ……..... 9

21. In general, how is your financial status **at the end of each month**?

Usually have money left …….……..1
Just enough to get by.……...…….. 2
Not enough to get by.…….…… 3
DON'T KNOW ……..... 9

22. Have you immigrated to the USA or Canada in the past five years?

Yes……1
No…….2
DON'T KNOW …….…..... 9

Thank you for your participation! The survey is now complete.

23. Do you have any additional comments or suggestions for improving the mental health of long-haul truck drivers?

Yes……1 [Allow for text entry]

_____

_____

No, end survey…….2

Appendix C: Trucker Poster

Mental Health of Canadian and U.S. Truck Drivers Study

Lakehead UNIVERSITY

Hello commercial truck drivers!

Lakehead University, a university in Thunder Bay, Ontario, Canada, is currently conducting a survey on the mental health of long-haul truck drivers. **Let us hear your perspectives on your health, mental health, and personal stressors at work and you will be entered in a draw to receive a $100 CAD VISA gift card!**

We believe it is important to understand which factors at work (including being away from home) may be a source of stress for long-haul truck drivers and whether these factors have an impact on their mental health.

- How is your sleep?
- Are you often fatigued?
- Do 4-wheelers stress you out?
- How many days are you away from home?

We want to know!

We are looking to recruit any, and all commercial truck drivers from Canada and the United States of all ages, **with or without any mental health symptoms**, of any years of experience and of any legal residency status (including immigrants).

The survey is strictly confidential and no personally identifiable information you report will be shared. The survey is approximately 10-minutes long and is conducted completely online.

The survey is available at the following link:

https://tinyurl.com/truckstudy

If you have any questions on the study, please contact the survey director at truckerstudy@gmail.com.

Take a tab to do the survey on the go!

Trucker Mental Health Survey | **7-11 min**
https://tinyurl.com/truckstudy

Trucker Mental Health Survey | **7-11 min**
https://tinyurl.com/truckstudy

Trucker Mental Health Survey | **7-11 min**
https://tinyurl.com/truckstudy

Trucker Mental Health Survey | **7-11 min**
https://tinyurl.com/truckstudy

Trucker Mental Health Survey | **7-11 min**
https://tinyurl.com/truckstudy

Trucker Mental Health Survey | **7-11 min**
https://tinyurl.com/truckstudy

Trucker Mental Health Survey | **7-11 min**
https://tinyurl.com/truckstudy

Trucker Mental Health Survey | **7-11 min**
https://tinyurl.com/truckstudy

Trucker Mental Health Survey | **7-11 min**
https://tinyurl.com/truckstudy

Appendix D: List of Organizations Contacted

Joanne's contacts

Organization	Contacted person	Title		Where promoted?	Completed?
Magazines					
Truck News	Abdul Latheef	Associate editor/journalist		Twitter, Truck News	Yes
Truck News	John Smith	Editor		Twitter, Truck News	Yes
The Rear View M	Lisa Richardson	Co-owner,		Rear View Mirror we	Yes
Truck 'N' Roll	Roman Wiktorow	Publisher			
Road Today	Manan Gupta	Editor			Yes
Pro-Trucker Mag	John White	Editor & Publisher			
SiriusXM/Internet Radio					
Trucker Radio Ne	Stan Campbell	Radio talk		Twitter/Facebook + r	Yes
Land Line Now (C	Mark Redding	Radio talk			Unsure if did it
Canada Calling	?? Personal radio	show		Radio show	Yes
Trucking Associations - Carriers					
The Ontario Truc	Stephen Laskows	President & CEO		Unsure	Unsure if did it
OBAC	Joanne Ritchie	Executive director		Facebook (+ shared v	Yes
Nova Scotia Truc	Linda Corkum	Executive director		Don't know--sent ma	Yes
OOIDA (Owner-C	Johanne Couture			Unsure	Unsure if did it
Sector councils/HR associations					
~~Trucking HR Can~~	~~Angela Splinter~~	~~CEO~~	~~No; not right party~~		

Michelle's contacts

Organization	Contacted person	Title		Where promoted?	Completed?
Trucking Associations/councils/HR					
Private motor tr				Unsure/ N/A-- was a	Yes
Truck training sc				Unsure/ N/A-- was a	Yes
Trucking HR				Unsure/ N/A-- was a	Yes
Traffic Injury Res				Unsure/ N/A-- was a	Yes
Ontario Ministry	Loida Pedro	Senior Marketing Planner		Unsure/ N/A-- was a	Yes
Women's Truckir	Shelley Uvanile-H	Founder and CEO		Unsure/ N/A-- was a	Yes
Employment and	Karina Sacco	Officer Labour Affairs		Unsure/ N/A-- was a	Yes
Today's Trucking	John Smith [alrea			Unsure/ N/A-- was a	Yes
Ontario Trucking	Geoffrey Wood	Senior Vice President, Policy		Unsure/ N/A-- was a	Yes
Ministry of Labo	Justin Tai	Strategy Advisor		Unsure/ N/A-- was a	Yes
Infrastructure He	George Lacono	Co-ordinator, Stakeholder and P		Unsure/ N/A-- was a	Yes
Infrastructure He	Ariel White	Communications Writer		Unsure/ N/A-- was a	Yes
Ministry of Labo	Sujoy Dey	Corporate Risk Officer		Unsure/ N/A-- was a	Yes

My contacts

Trucking Companies				Where promoted?	Completed?
Arnone Transport				Gave physical poster	Yes
Thunder Bay Por			Yes	Gave physical poster	Yes
ERB	Josh	Dispatch	Yes	E-mailed materials	Yes/unsure
McKevitt	Colin (?)		Yes	Unsure	Unsure if did it
Canadian Associa	Nancy Irvine	President	Yes--but was email to	To the 400 followers,	Yes

Appendix E: Ethics Approval

Research Ethics Board
t: (807) 343-8283
research@lakeheadu.ca

December 05, 2019

Principal Investigator: Dr. Vicki Kristman
Student: Nyasha Makuto
Faculty of Health and Behavioural Sciences\Health Sciences
Lakehead University
955 Oliver Road
Thunder Bay, ON P7B 5E1

Dear Dr. Kristman and Ms. Makuto:

Re: Romeo File No: 1467507
Granting Agency: N/A
Agency Reference #: N/A

On behalf of the Research Ethics Board, I am pleased to grant ethical approval to your research project titled, "Risk Factors for Depression in Long-haul Truck Drivers: A Cross-sectional Study Design".

Ethics approval is valid until December 5, 2020. Please submit a Request for Renewal to the Office of Research Services via the Romeo Research Portal by November 5, 2020 if your research involving human participants will continue for longer than one year. A Final Report must be submitted promptly upon completion of the project. Access the Romeo Research Portal by logging into myInfo at:

https://erowp.lakeheadu.ca/

During the course of the study, any modifications to the protocol or forms must not be initiated without prior written approval from the REB. You must promptly notify the REB of any adverse events that may occur.

Best wishes for a successful research project.

Sincerely,

Dr. Kristin Burnett
Chair, Research Ethics Board

/sm