U.S. Long-Haul Truck Driver Health Demands Integrated Approach

By: **Adam Hege**, Michael Perko, Yorghos Apostolopoulos, Sevil Sonmez, and Robert Strack

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The purpose of this paper is to provide a review of both occupational safety and health (OSH) and worksite health promotion (WHP) efforts targeted at long-haul truck drivers (LHTDs) and to identify strengths and weaknesses to inform future interventions and/or policy changes. Review of the literature was done to identify theoretical and methodological approaches frequently used for protecting and promoting the health and well-being of LHTDs. Health and safety issues impacting LHTDs are complex and naturally interrelated. Historically, the majority of approaches to the health and safety of LHTDs have emphasized the safety side and there has been a lack of comprehensive and integrated WHP/OSH attempts. The literature pertaining to LHTD health has expanded in recent years, but intervention and policy efforts have had limited success. Several scholars have discussed the need for integrating WHP/OSH efforts for LHTD health, but have not actually provided a description or a framework of what it entails in which the authors provide a conclusion to the review of the literature. The authors provide a critical discussion regarding a collaborative approach focused on National Institute of Occupational Safety and Health's Total Worker Health model. The integration further promotes an advancement of theoretical and methodological strategies.

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US long-haul truck driver health demands integrated approach

Adam Hege
Department of Health and Exercise Science, Appalachian State University, Boone, North Carolina, USA
Michael Perko
Department of Public Health Education, University of North Carolina at Greensboro, Greensboro, North Carolina, USA
Yorghos Apostolopoulos
Department of Health and Kinesiology, Texas A&M University, College Station, Texas, USA
Sevil Sönmez
Department of Tourism, Events and Attractions, University of Central Florida, Orlando, Florida, USA, and
Robert Strack
Department of Health and Exercise Science, Appalachian State University, Boone, North Carolina, USA

Abstract

Purpose – The purpose of this paper is to provide a review of both occupational safety and health (OSH) and worksite health promotion (WHP) efforts targeted at long-haul truck drivers (LHTDs) and to identify strengths and weaknesses to inform future interventions and/or policy changes.

Design/methodology/approach – Review of the literature was done to identify theoretical and methodological approaches frequently used for protecting and promoting the health and well-being of LHTDs.

Findings – Health and safety issues impacting LHTDs are complex and naturally interrelated. Historically, the majority of approaches to the health and safety of LHTDs have emphasized the safety side and there has been a lack of comprehensive and integrated WHP/OSH attempts.

Originality/value – The literature pertaining to LHTD health has expanded in recent years, but intervention and policy efforts have had limited success. Several scholars have discussed the need for integrating WHP/OSH efforts for LHTD health, but have not actually provided a description or a framework of what it entails in which the authors provide a conclusion to the review of the literature. The authors provide a critical discussion regarding a collaborative approach focused on National Institute of Occupational Safety and Health's Total Worker Health model. The integration further promotes an advancement of theoretical and methodological strategies.

Keywords Workplace health, Health promotion, Public health, Organizational culture, Occupational health and safety

Paper type Literature review

Introduction

Work, including the workplace environment and underlying social, political, and economic forces shaping work conditions, has been well established as a significant determinant of health, influencing both behavior and outcomes (Burgand and Lin, 2013; Clougherty *et al.*, 2010; Gordon and Schnall, 2009; Levy *et al.*, 2011; Lipscomb *et al.*, 2006; Schnall *et al.*, 2009). The last 40 years have been marked by substantive

transformation to workplace conditions and environments of millions of workers around the world, due to such factors as the globalization of markets and technological advances. Concurrently, public policy has minimized government regulation over industry, limited workers' rights, and reduced collective bargaining capacities and union protection, having serious implications for worker health (Gordon and Schnall, 2009; Moutsatsos, 2009; Raphael, 2008; Yelin, 2009). Consequently, many have highlighted disparities in health disproportionately affecting particular workers and occupations (Burgand and Lin, 2013; Krieger, 2010; Lipscomb *et al.*, 2006; Siqueira *et al.*, 2014). In response to the complexity of forces impacting the health of workers, programs aimed at improving the health behaviors of workers and active involvement in policy development directed at reducing safety hazards and enhancing the working environment have been attempted (Cherniack and Punnett, 2011).

One occupational segment confronting health disparities is long-haul truck drivers (LHTDs). More than 1.7 million LHTDs deliver freight, wholesale, and non-durable goods across the USA (Bureau of Labor Statistics, 2014), while working in an environment not conducive to good health outcomes. Deregulation of the industry beginning in the late 1970s and continuing into the 1980s intensified an already highly competitive market environment and accentuated efficient production systems (Apostolopoulos *et al.*, 2012a). The US trucking industry is regulated by the Federal Motor Carrier Safety Administration (FMCSA) a sub-agency of the Department of Transportation, which establishes the hours of service (HOS) in which drivers are allowed to work along with other safety hazards involved in the profession, centrally focusing on driving and road safety (FMCSA). Corporate policies and operations in conjunction with the industry's culture (excessive competition, profit driven, efficiency) and the physical environment (trucks and truck stops) all influence truck driver health (Apostolopoulos *et al.*, 2012a). Consequently, truck drivers work long and erratic hours, work at a fast pace and encounter recurrent time pressures, receive limited support from coworkers and supervisors, are socially isolated from family and peers, and lack control over decisions impacting their job duties (Apostolopoulos *et al.*, 2014a, b). Truck drivers, in addition, frequently lack access to health insurance, medical personnel, and other health resources while on the road for extended periods of time (Apostolopoulos *et al.*, 2014a, b; Solomon *et al.*, 2004).

LHTDs are well documented for poor lifestyles (dietary intake, physical inactivity, smoking, alcohol consumption), and in turn elevated obesity rates and associated cardio-metabolic conditions (diabetes, metabolic syndrome, hypertension, cardiovascular disease) (Apostolopoulos *et al.*, 2010, 2012a, 2014a, b; Helmkamp *et al.*, 2013; Jain *et al.*, 2006; Seiber *et al.*, 2014). Risky sexual behavior and subsequent increased risk for sexually transmitted infections (STIs) along with the linkage to substance abuse has been extensively reported (Apostolopoulos *et al.*, 2010, 2013, 2015; Lichtenstein *et al.*, 2008; McCree *et al.*, 2010). Mental illness is a frequent problem among truckers (Shattell *et al.*, 2010), while fatigue and sleep restriction pose serious risks in the form of abnormal circadian rhythm influences on metabolic and hormonal imbalances and an increased risk for traffic and other work-related accidents (Moreno *et al.*, 2006; Philip and Åkerstedt, 2006). Truck drivers have also been reported to disproportionately suffer from musculoskeletal disorders (MSDs) and exposure to pollutants and other harmful substances (Apostolopoulos *et al.*, 2010). Predictably, truck drivers have been cited as having a shorter life span of up to 16 years than the average male in the USA (Apostolopoulos *et al.*, 2014b; Saltzman and Belzer, 2007).

Meanwhile, research shows when intervening for worker health and safety, the most successful outcomes ensue when guided by evidence-based theoretical frameworks and methodologies (Glanz and Bishop, 2010). The field of worksite health promotion (WHP), emphasizing health behavior change, has tended to adopt theoretical concepts from social and behavioral sciences, while occupational safety and health (OSH), centered on work environment and conditions, has been influenced by engineering and industrial hygiene models (Glanz and Bishop, 2010; Green, 1984; Heaney and Goldenhar, 1996). The two disciplines depended upon for promoting and protecting worker health have historically neglected to collaborate and thereby failed to blend and enhance evidence-based theoretical constructs from the respective fields (Sorenson and Barbeau, 2004). As a result, efforts have been limited and disconnected (Sorenson and Barbeau, 2004). Over the last two decades, however, there have been repeated calls for integration of OSH and WHP efforts in the USA (Baker *et al.*, 1996; Baron *et al.*, 2014; DeJoy and Southern, 1993; Goetzel *et al.*, 2008; Sorenson and Barbeau, 2004; Sorenson *et al.*, 2011). Four key reasons supporting the integration of OSH and WHP include: the risk of disease increases due to both occupational hazards and health behaviors; those with the highest risk of hazardous working conditions also typically have poor health behaviors; integration could increase participation and effectiveness; and the approach can help to improve the broad work organization and environment (Sorenson and Barbeau, 2004; Pronk, 2013). These ongoing appeals for integration have culminated in the national initiative Total Worker Health, sponsored by the National Institute of Occupational Safety and Health (NIOSH) Robson *et al.* (2010).

Albeit limited, there have been theory-based WHP and OSH efforts at improving the health of the long-haul trucking population. Therefore, the primary aim of this paper is to provide a review of the literature pertaining to WHP and OSH concerning LHTDs. We conclude with an extensive discussion of an integrated framework consistent with Total Worker Health for improved LHTD health.

Methods

We used search engine databases consisting of EBSCO, Pubmed, CINAHL, Proquest Central, PsycINFO, and Google Scholar to compile our literature base related to the health challenges frequently associated with LHTDs. For the literature search, we used our knowledge and previous work examining the truck driving population to use terms such as "truck drivers, health," "truck drivers, health and safety" "truck drivers, HOS regulations," "truck drivers, ergonomics," "truck drivers, MSDs," "truck drivers, diesel exhaust," "truck drivers, sleep," "truck drivers, obesity," and "truck drivers, STIs." For OSH efforts, the FMCSA website served as the foundation for efforts aimed at protecting drivers from the hazards involved in the profession. The FMCSA website was supplemented by literature pertaining to discussion or efforts to improve trucker health and safety. Regarding WHP, articles describing specific interventions were included in the review and were complemented by previous reviews performed on the LHTD health and wellness programs (Ng *et al.*, 2015; Krueger *et al.*, 2007).

With our original search using the identified search terms, 347 articles were initially considered. In this first search, we decided to eliminate articles that were found multiple times using the search terms. For example, when searching for "truck drivers, health and safety," articles pertaining to obesity and sleep disorders were found that also came up when using the search terms "truck drivers, sleep" and "truck drivers, obesity." With the original 347 articles, one reviewer (A.H.) examined titles and abstracts to eliminate articles that did not focus specifically on "long-haul" truck

drivers, or those drivers spending extended time periods away from home. Many articles examined "short-haul" drivers or transportation workers not considered "long-haul" drivers. From the 89 articles that were kept as potential articles to review, we retrieved full-text copies. In total, 43 more articles were eliminated that did not include an intervention or provide an extensive discussion or recommendations for future interventions. This left us with 46 articles to review for full consideration. In our final review of articles, we included 29 peer-reviewed articles, which related to a variety of interventions or examined intervention strategies. The 29 articles were supplemented by three previous literature reviews on LHTDs and resources provided by the FMCSA website. In total, we used these 33 articles and resources to compile our final review. A flow diagram depicting our review process is provided in Figure 1.

Results

Findings from the literature review were divided into topics impacting LHTD based on whether traditionally considered an OSH or a WHP concern. When applicable, theoretical perspectives which framed interventions are included. Tables I and II provide the OSH and WHP topics related to the primary health issues in which evidence suggests a direct link; the secondary health issues are health problems which potentially also stem from the OSH or WHP concern. In addition, the tables provide key intervention strategies utilized for each as well as pertinent research studies or resources.

Occupational health and safety

There have been limited intervention efforts for the health of LHTDs and most have emphasized OSH approaches. Due to the substantially higher traffic accident rate among truck drivers, much attention is directed at limiting fatigue from the accumulated long and irregular hours of driving. Other frequently addressed safety issues include protection from exposures to hazardous materials, ergonomics, drivers' physical capacity to drive, and drug and alcohol testing. The FMCSA additionally promotes safety training among drivers and their respective employers.

HOS. Aimed at reducing fatigue, sleep deprivation, and drowsy driving among drivers (Jensen and Dahl, 2009), the FMCSA sets HOS regulations for how long drivers can drive and work in a 24-hour period and over either seven or eight consecutive days (FMCSA). HOS regulations began in 1937, after the Motor Carrier Act of 1935 (Robin-Vergeer, 2007), with drivers allowed up to 12 hours of total work per day and no more than 60 hours over a seven-consecutive day period or 70 hours over eight days (Heaton, 2005). In 1938, slight modifications were made limiting driving time to ten hours and a required eight hours of off-duty time (Heaton, 2005). It remained this way until changes were made in 1962 as the 24-hour period was abandoned for HOS purposes, thereby opening the door for drivers to accumulate up to 16 hours per 24-hour cycle of driving time (Saltzman and Belzer, 2002). After studies continued to indicate high rates of fatigue among drivers and increased safety concerns the HOS regulations were modified again in 2003 (Heaton, 2005). Beginning in 2004, drivers had to have a ten-hour off-duty time period during every 24-hour cycle and the driving time was limited to 11 hours of the 14-hour on-duty time (Heaton, 2005). Furthermore, drivers were required to have a 34-hour consecutive off-duty period every week before they could restart; a result of this, however, was the potential for drivers to actually accumulate up to 82 hours of work weekly (FMCSA). In response, effective July 2013, the FMCSA now mandates that drivers have a maximum average work week of

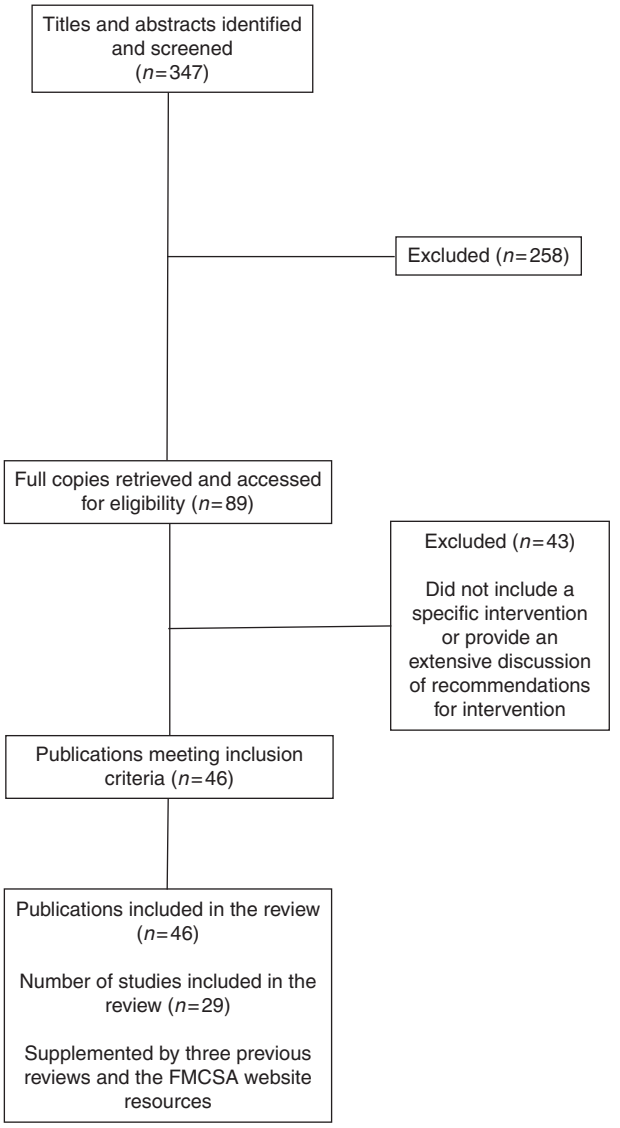

Figure 1.
Flow diagram

70 hours and must have at least two nights of a rest period between 1:00 and 5:00 a.m.; drivers are also required to take a 30-minute rest break while in the first eight hours of their work shift (FMCSA). The latest rules further require trucks to feature electronic onboard monitors to ensure that HOS regulations are followed (Kemp *et al.*, 2013).

The issue of sleep deprivation and fatigue related to reduced driving safety and increased accident risks has been examined substantively (Hanowski *et al.*, 2007; Mccartt *et al.*, 2008; Saltzman and Belzer, 2007). Notably, the irregularity of the drivers' scheduling and HOS has other health influences such as an altered circadian rhythm, or the 24-hour physiological cycle of the human body (Apostolopoulos *et al.*, 2010), while chronic sleep debt

Topic	Primary health and safety issues	Secondary health and safety issues	Key intervention strategies	Key studies and resources
Hours of service	Sleep deprivation; drowsy driving; disrupted biological cycles; accident risks; cardiovascular disease	Mental illness; substance abuse; weight gain/ obesity and its associated comorbidities	11-hour daily driving limit; 14-hour work day limit; maximum avg. work week of 70 hours; 34-consecutive hour rest period with at least two night from 1-5 a.m.; 30-minute break during first 8 hours of a shift; electronic onboard monitoring	FMCSA (2014), Jensen and Dahl (2009), Heaton (2005), Saltzman and Belzer (2007)
Driving ergonomics/ cabin design	Low back pain/ musculoskeletal injury; vibration; excessive noise	Accident risk; fatigue; emotional stress; mental illness; gastrointestinal problems	Fitness to drive; modifications to truck and cab design	FMCSA, Jensen *et al.* (2008), Robb and Mansfield (2007)
Exposure to diesel exhaust and other harmful substances	Respiratory problems, headaches and dizziness, cardiovascular disease	Certain forms of cancer	Training and education; Required safety permits	FMCSA, Steenland *et al.* (1998)
Driving safety	Substance abuse; sleep deprivation; accident risks	Stress/mental fatigue	Drug and alcohol testing; testing for sleep apnea; medical exams; driving safety training; distracted driving and cell phone ban	FMCSA

Table I.
OSH primary areas related to LHTDs

has been associated with hormonal effects (impaired glucose metabolism, abnormal cortisol regulation, altered growth hormone profiles) (Saltzman and Belzer, 2007). An altered circadian rhythm and chronic sleep debt has also been associated with gastrointestinal and cardiovascular complications as well as conditions such as obesity, diabetes, and hypertension (Apostolopoulos *et al.*, 2010; Saltzman and Belzer, 2007). Additionally, long hours and irregular schedules have been associated with mental health problems (Shattell *et al.*, 2010) and negative influences on health behaviors (Hitchcock *et al.*, 2004).

Ergonomics. Due to working in confined truck cabins, experiencing whole-body vibrations, and long periods of time sedentary, LHTDs are susceptible to low back pain and other MSDs (Apostolopoulos *et al.*, 2010; Jensen *et al.*, 2008; Robb and Mansfield, 2007). MSDs hamper drivers' production ability and can lead to added healthcare costs and days missed from work (Stewart *et al.*, 2003). Decreased driving safety has also been associated with several MSDs experienced by LHTDs (Tiller *et al.*, 2008).

Two pivotal strategies employed by the FMCSA in protecting drivers both from personal injury and accident risk are through regulations pertaining to truck and cab design, thereby forcing companies to comply and modify dimensions, and through the

Topic	Primary health and safety issues	Secondary health and safety issues	Key intervention strategies	Key studies and resources
Nutrition	Obesity; type II diabetes; metabolic syndrome; hypertension; CVD	Certain forms of cancer; immune system; sleep apnea and sleep health; osteoarthritis	Health screening; educational materials; incentives and motivational strategies; self-monitoring techniques; computer-based education; counseling	Gill and Wijk (2004), Holmes *et al.* (1996), Krueger *et al.* (2007), Ng *et al.* (2015), Olson *et al.* (2009), Roberts and York (1997, 1998, 1999), Sorenson *et al.* (2010)
Physical activity	Obesity; type II diabetes; metabolic syndrome; hypertension; CVD	Mental health; bone and muscle health; certain forms of cancer; sleep health	Educational materials; health assessments; health coaching; fitness club memberships; family involvement; incentives; computer-based education	Hedberg *et al.* (1998), Holmes *et al.* (1996), Krueger *et al.* (2007), Ng *et al.* (2015), Olson *et al.* (2009), Roberts and York (1997, 1998)
Smoking cessation	CVD; lung and other forms of cancer; respiratory disease	Bone health; dental health; type II diabetes; immune system; rheumatoid arthritis	Educational materials; individual and group activities; telephone counseling	Hedberg *et al.* (1998), Holmes *et al.* (1996), Krueger *et al.* (2007), Ng *et al.* (2015), Sorenson *et al.* (2010)
Stress reduction/ management	CVD; mental health	Fatigue/sleep problems; gastrointestinal; health behavior	Educational materials, stress alleviation techniques; individual and group activities	De Croon *et al.* (2004), Hedberg *et al.* (1998), Krueger *et al.* (2007), Ng *et al.* (2015), Roberts and York (1997, 1998)
Sexual practices/ substance use	STI's; substance abuse	Mental health; accident risks	Sex education through media; drug testing; medical examinations	Apostolopoulos *et al.* (2010, 2013, 2015), Lichtenstein *et al.* (2008), McCree *et al.* (2010)

Table II.
WHP primary areas related to LHTDs

requirements of testing drivers for their physical capacity to drive (FMCSA). LHTDs who have a history of MSDs deemed as hazardous to their ability to safely operate the truck are disqualified from driving (FMCSA).

Exposures to harmful substance, pollutants, and excessive noise. LHTDs are prone to exposure to potentially harmful substances, pollutants such as diesel exhaust, and excessive noise levels (Steenland *et al.*, 1998; FMCSA, 2014). The prolonged exposures to diesel exhaust, specifically, have been associated with certain forms of cancer and other respiratory problems (Steenland *et al.*, 1998). Prolonged exposure to high audible noise levels can damage a trucker's ability to hear, thus posing a safety issue, as LHTDs are placed in situations where hearing capacity is critical when they are operating their truck (FMCSA).

The FMCSA requires drivers to undergo HAZMAT training to prepare for potential exposure to harmful chemicals (FMCSA). Drivers are educated and trained in safety procedures for driving when transferring potentially dangerous cargo or chemicals (FMCSA). Regarding noise, truck companies are required to pass safety tests and comply with noise standards (FMCSA).

Driving safety. There are numerous ways in which the FMCSA monitors and implements strategies for driving safety among LHTDs. All drivers are subject to both random and scheduled drug and alcohol testing by the Department of Transportation. Drivers are required to undergo a comprehensive medical examination to access the driver's physical capacity to operate a truck. During medical exams, drivers are tested for sleep apnea, a frequent complication of LHTDs which poses safety risks (FMCSA). Distracted driving has also been a common hazard and cell phone use has been banned while driving. The FMCSA has also recently begun to offer a multitude of training and educational approaches for drivers to improve their driving skills, including the Smart Driver Safety Education Center, Roller Prevention training, a Safety Belt program, and a Highway-Rail Grade Crossing Safety program (FMCSA).

WHP

The US Department of Transportation (1988, in Korelitz *et al.*, 1993) reported in the mid-1980s of the disproportionate health risks of truck drivers, when compared to other occupational groups, concerning poor health behaviors. This was further supported by findings from a National Trucker Symposium survey, which revealed that truck drivers had high smoking rates, more than half regularly consumed alcohol, most were rarely if ever physically active, most had poor dietary habits, and nearly two of every three drivers was either overweight or obese (Korelitz *et al.*, 1993). This led to a few companies, namely Schneider National and J.B. Hunt, to develop activities designed to modify health behavior. As a result, both companies reported reductions in their healthcare costs, but many of the established programs have since been discontinued (Krueger *et al.*, 2007).

Data regarding the health of LHTDs, predominately focused on public safety regarding traffic accidents, has provided limited evidence regarding chronic disease risks. Further evidence from a recent systematic review (Ng *et al.*, 2015) details the sparse use of WHP in the trucking sector. The interventions employed have concentrated on individual-level strategies and few studies have provided a theoretical framework. Due to obesity and its associated comorbidities, nutritional and physical activity improvements have been key features, while other areas commonly addressed include stress management and smoking cessation.

Although theoretical frameworks and sound methodology help to strengthen WHP interventions, as detailed in Ng *et al.* (2015) review, only two studies clearly define using a specific theory or multiple theories. The theories utilized include the transtheoretical (stages of change) (Olson *et al.*, 2009; Roberts and York, 1997, 1998; Sorenson *et al.*, 2010) and a combination of the social contextual model and social cognitive theory along with job strain theory (Sorenson *et al.*, 2010). Regarding tactics used in interventions, primarily one-on-one counseling, health assessment and feedback, and providing of educational materials have been incorporated.

Nutrition. Five studies described interventions featuring improved nutritional intake as an outcome goal. Holmes *et al.* (1996) performed a survey with drivers to determine frequency of eating, factors contributing to food selection, preferred food choices, capacity to eat healthy, and ultimately the foods actually consumed. Next, researchers put drivers through a health screening (cholesterol, weight, blood pressure, etc.). Drivers were given the results along with educational materials and healthy snack bags; six months later they were re-evaluated. Findings included significant reductions in weight, body fat, cholesterol, and, interestingly, an improvement in smoking habits as a secondary result. A multicomponent program, Gettin' in Gear, developed by Roberts and

York (1997, 1998) and sponsored by the FMCSA, offers the four R's (refueling, rejuvenating, relating, and relaxing) consisting of educational information regarding proper nutrition and recommended healthy foods. The results from a pilot study included significant improvements in 7 out of 15 eating habits (Roberts and York, 1999). In a Swedish study (Gill and Wijk, 2004), researchers used informational tactics with both drivers and the food preparation staff along with menu changes and modifications to food selections at a local truck stop. Drivers were given incentives and motivational strategies for improved eating. As a result of the multi-component intervention, the meal selections had improved nutritional content and drivers were more likely to choose healthier food options. The Safety and Health Involvement for Truckers (SHIFT) program incorporated a weight-loss competition with incentives, computer-based health education training for exercise and diet change for drivers, and a website for drivers to monitor goal attainment (Olson *et al.*, 2009). Drivers also were provided behavioral self-monitoring techniques and received motivational interviewing from trained health coaches. Results included significant reductions in consumption of sugary snacks and drinks, fast food, and calories in fat but no significant improvements in fruit and vegetable consumption. There were also significant reductions in weight, body mass index, and waist circumference. Last, Sorenson *et al.* (2010) as a secondary component of their smoking cessation program also measured dietary changes. The Gear Up for Health Program, featuring telephone counseling, feedback reports, and educational materials, resulted in participants having significant decreases in sugary drink consumption and non-significant decreases in sugary snack consumption.

Physical activity. Four studies had central aims of increased physical activity and improved fitness levels (Hedberg *et al.*, 1998; Holmes *et al.*, 1996; Olson *et al.*, 2009; Roberts and York, 1997, 1998). In addition to the aforementioned nutritional intervention, Holmes *et al.* (1996) provided exercise charts for drivers showing the number of calories specific exercises would expend. However, no significant improvements were found in fitness levels. As part of the Gettin' in Gear program (Roberts and York, 1997, 1998), drivers were educated on physical activity and exercise and provided descriptions of sample exercises to perform. Health assessments in conjunction with health coaching were implemented and several of the associated companies provided fitness club membership opportunities. As a result, the most significant improvements were witnessed in fitness level and exercise habits. In a Swedish intervention (Hedberg *et al.*, 1998), participants were provided health education regarding physical activity and were invited to an information event with their families. The program did result in significant changes in aerobic capacity but limited changes in exercise or physical activity habits. As previously mentioned concerning nutritional intake, the SHIFT program incorporated a weight-loss competition with incentives and computer-based educational training to reach drivers on the road. The results included significant improvements in fatigue tests before and after walk; however, there were no significant improvements in other areas (six-minute walk test and strength tests) as well as self-efficacy regarding exercise.

Smoking cessation. Three interventions sought to reduce smoking among LHTDS. Holmes *et al.* (1996) hypothesized that as a result of their nutrition intervention, other health behaviors would improve including smoking cessation. The findings supported their hypothesis as there were significant reductions in smoking among the participants at the conclusion of the intervention. Focusing on lifestyle changes, Hedberg *et al.* (1998) used educational materials for smoking cessation as well as

individual and group activities focused on the importance of quitting smoking. With the aforementioned primary focus on physical activity and exercise, the intervention found no significant decreases in smoking among the participants. The Gear Up for Health program utilized telephone counseling sessions to reach drivers on the road, feedback reports, and written educational materials (Sorenson *et al.*, 2010). The intervention sought to meet truckers within their environment and adapt behaviors within a difficult work context for behavior change. However, when comparing baseline measures, those participating in the intervention were more than twice as likely to quit smoking as those in the control group.

Stress management. According to a survey as part of the Gettin' in Gear program, stress was rated as the third most important health risk factor among drivers, falling only behind sleep disorders and drug and alcohol use (Krueger, 2007). However, only three studies described stress reduction or coping as a portion of the intervention. Of the four R's within the Gettin' in Gear program, two were explicitly dedicated to reducing stress. One educated drivers on the importance of relationships and how to improve relationships in their social networks, while another provided stress alleviation techniques to manage daily stresses of work and life (Roberts and York, 1997, 1998; Krueger, 2007). Nonetheless, the program provided no significant improvement in helping drivers improve relationships with others or in successfully managing their stress levels (Roberts and York, 1999). Hedberg *et al.* (1998) as previously referred to in reference to other behaviors, provided educational materials and individual and group activities aimed at helping drivers cope with stress. The researchers used an intervention group and a reference group, who just received educational materials. Interestingly, the reference group, but not the intervention group, experienced significant improvements in perceived stress and loneliness. Researchers in the Netherlands aspired to understand how the use of on board computer systems would affect drivers' stress levels while working and at the completion of their shift (de Croon *et al.*, 2004). They collected data regarding the drivers' job demands and decision latitude, mental health, and attitudes toward their job. When compared to two reference groups (one did not use computers, one did prior to baseline measures), the intervention group which used the on board computer systems actually experienced negative effects on their work environment and attitudes toward their job. Researchers found no significant differences regarding perceived stress or mental health outcomes stemming from work.

Unsafe sex practices, STIs, and substance abuse. Much literature pertaining to LHTD health has focused on their increased risks for STIs through unsafe sexual behaviors with commercial sex contacts (CCs) and the linked affiliation with substance abuse. Inconsistent use of condoms and other forms of protection, lack of knowledge about STIs or the risk of mixing with drug use, and the reputation of being risk takers are described as plausible influences (Lichtenstein *et al.*, 2008; McCree *et al.*, 2010). When examining further, researchers have found, however, that much of the unhealthy behavior and consequences are directly connected to the work environment within the profession. LHTDs frequently report loneliness and socially isolation while on the road away from their families for extended periods of time and work-time conflicts; therefore, LHTDs are desperate for social interactions (Apostolopoulos *et al.*, 2010, 2015).

When LHTDs stop at truckstops at the conclusion of their day of driving, female sex workers are often times lurking; some studies have shown that sex workers instantly identify with each other in terms of their shared life experiences

(Apostolopoulos *et al.*, 2013). Many times it starts out with truckers and sexworkers partying together as a way of relaxing from the occupational stress and it leads to trading drugs for sex (Apostolopoulos *et al.*, 2010, 2013; Lichtenstein *et al.*, 2008; McCree *et al.*, 2010). When it comes to the rapid spread of STIs within the population and becomes a much broader public health and safety issue, much of it is attributed to the mobility involved with the profession. Drivers are in different cities daily which creates situations in which STIs can be spread to other truckers and sexworkers but also spouses and committed partners as well (Apostolopoulos *et al.*, 2010, 2013; Lichtenstein *et al.*, 2008).

Strengths/limitations

OSH and WHP efforts aimed at LHTDs have had notable successes. For instance, Hanowski *et al.* (2007) reported from their study an increased quantity of sleep as a result of modified HOS regulations as well reduced accident rates. This is one specific study, but it is logical to believe that given more time for rest, drivers would obtain more sleep. Further studies have shown that traffic accidents among LHTDs have continued to decline since the late 1970s (FMCSA). Ergonomic modifications and regulations linked to chemical and noise exposure as well as safety training programs have also supported driver health and safety. While not always identifying specific theoretical frameworks, a number of WHP programs have been framed in health promotion constructs, albeit at the individual level. Most of the WHP has at least indirectly attempted to modify multiple behavior and components simultaneously. Lastly, it is recognized that LHTDs are a difficult population to reach and recent initiatives have properly sought to meet drivers within their working environment and tailor programs for their most frequent work settings (Olson *et al.*, 2009; Sorenson *et al.*, 2010).

While successes should be lauded, there have been many limitations for the OSH and WHP targeting LHTD health and safety. Much of the weakness pertains to work organization and HOS regulations. While not specifically detailed and lacking the use of sound theory, much OSH has focused chiefly on physical safety hazards without expanding to frequent psychosocial job stressors found in the profession. With the emphasis predominantly on protecting roadway safety, work organization, and HOS regulations have neglected to attend to other physical health outcomes influenced by irregular scheduling and ensuing job strain. Research has further shown that trucking companies and LHTDs have regularly failed to follow HOS regulations in attempts to increase productivity (Beilock, 1995). The recent addition of electronic onboard monitoring, while trying to ensure drivers and companies adhere to HOS regulations, could place additional stress on drivers and ultimately have an adverse effect on both safety and health (Kemp *et al.*, 2013). Among the weaknesses of WHP for LHTDs has been the low participation of drivers, also common in other blue-collar work populations (Krueger, 2007). For LHTDs, this has much to do with the difficulty in reaching them due to their mobility and lone worker status (Olson *et al.*, 2009). The majority of interventions failed to consider changes to the work environment as a target for changing behavior. One specific area highlighted when exploring the environmental disadvantages on physical activity and healthy eating for drivers is lack of availability and access at truck stops (Apostolopoulos *et al.*, 2011, 2012b). Most significantly, there was no discussion of changes to organizational practice or policy to support the health of LHTDs or anything indicative of an organizational commitment to a "culture of health" as part of a comprehensive program integrating OSH and WHP (Fabius *et al.*, 2013).

Integration of OSH and WHP for LHTD health

Recurring evidence shows the wide-ranging role in which work functions as a determinant of health. Work not only serves as a direct mechanism for injury or illness but also serves as the chief source of income and benefits such as health insurance, while extending to influence all aspects of life. In her article Workers are People Too, Krieger (2010) uses her ecosocial perspective to illustrate the impact that societal context, including politics, economics, and public policy have on work conditions, resulting in health disparities among occupations. In effect, the health disparities experienced by professions such as LHTD directly intersect with the much broader social determinants of health, including socioeconomic status, living conditions, and access to health insurance and services. Specific to LHTDs, globalization, technological advances, and neoliberal polices have resulted in union membership declines and a reduction in labor regulations at the federal and state levels; not surprisingly, trucking companies pay less attention to safety and health policies to protect drivers and human resource policies do little to promote health (Belzer, 2000; Landsbergis *et al.*, 2014). LHTDs are, therefore, subjected to long hours, irregular scheduling, physical and chemical hazards, sedentariness, delivery time pressures, and work-life conflicts (Apostolopoulos *et al.*, 2014a). Naturally, this organization of work is profoundly influential on worker health, in this case LHTDs, through three mechanisms: physiologically, psychologically, and at the health behavior level (Landsbergis *et al.*, 2014). As the current review exposes, most interventions have continued to solely focus on improving individual health behaviors (Apostolopoulos *et al.*, 2014a). However, we contend that an integrated framework (Figure 2), demanding that OSH and WHP work collaboratively rather than independently, can help the trucking industry yield better health outcomes among its LHTDs.

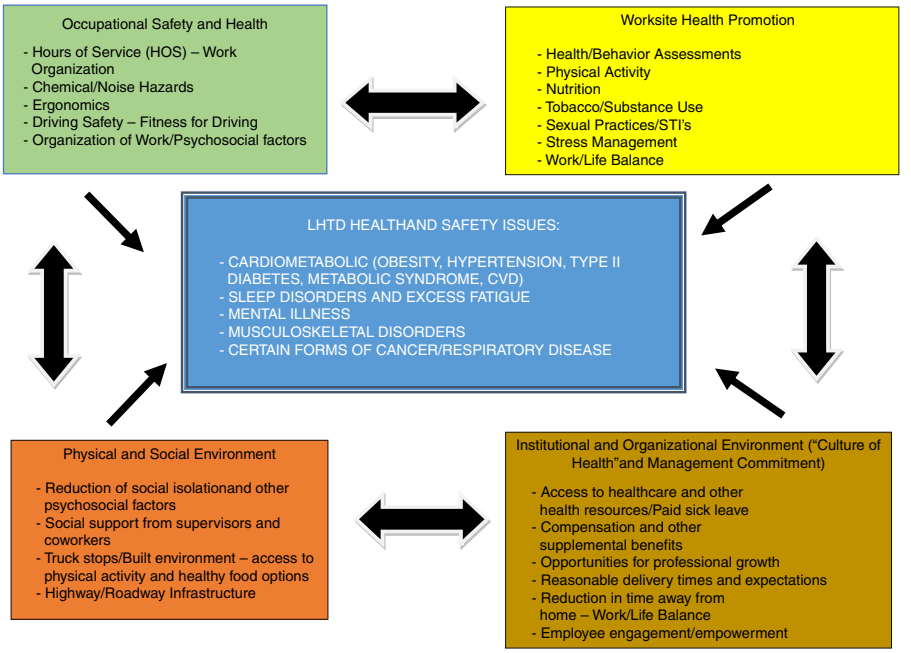

Figure 2.
Integrated model for LHTD health

Figure 1 depicts the ways in which OSH and WHP, in conjunction with the physical and social environmental aspects of the work environment influence the common health and safety issues impacting LHTDs. Critically, the institutional and organizational environment and commitments at the leadership level to health in every aspect of the organization serves as foundational to supporting the integrated model (Sorenson *et al.*, 2013); when trucking companies provide health insurance, supportive compensation structures, opportunities to grow professionally, reasonable delivery times, schedule limited extended times away from home, and engage their employees in the processes involved with the job, they are creating environments that value the total worker and which promotes and protects health. These strategies would not only support LHTDs health while in the workplace but would also extend to their non-work life (Sorenson *et al.*, 2013). In turn, with WHP and OSH programs put into place collaboratively, the management level is showing their commitment to a healthy and safe workforce. For example, research has implicated the combination of stress management programs with reductions in job stressors as being the best strategy for preventing poor mental health among employees (Hammer and Sauter, 2013), while a combined effort of safety education and training and modifications to the physical environment of the workplace as the most effective mechanism for preventing accidents on the job (Bhattacharjee *et al.*, 2011). A key area for LHTDs, specifically, is the prevalence of obesity (Seiber *et al.*, 2014), particularly with its linkage to cardiometabolic disease; with the rising obesity rate, it makes logical sense to move beyond traditional individual-focused physical activity or nutritional interventions. In contrast, integrated programs could address truck stop environments not supportive of physical activity and work with food industry representatives to improve food options, while concurrently providing health education strategies. In addition, work schedules allowing time for physical activity, slower eating practices, and adequate sleep could help to support WHP programs.

Using integrated frameworks, such as Total Worker Health, with work populations like LHTDs, is critically dependent upon the use of complex theoretical and methodological tools, which can help to forecast where to intervene most effectively. Systems science, particularly with its emerging advancement into public health research, serves as an invaluable tool for LHTD health (Apostolopoulos *et al.*, 2014a). A systems theoretical perspective recognizes that cause and effect is not linear, but is rather dynamic and complex – in the case of LHTDs, disease, injury, and mortality are caused by many factors acting upon and often times either positively or negatively reinforcing each other simultaneously (Diez Roux, 2011; Leischow *et al.*, 2008; Sorenson *et al.*, 2011). This can also include health issues serving as causal feedback processes on each other (Apostolopoulos *et al.*, 2014a); for example, the relationship between irregular work hours, sleep schedules, and obesity among LHTDs has been suggested to be intricately linked (Marqueze *et al.*, 2012; Moreno *et al.*, 2006). It is acknowledged in a systems framework that health outcomes are dependent upon the continuous interaction between biology and social, physical, and political environments, while the lifecourse and life experiences can act as an underlying influence (Diez Roux, 2011). Systems science approaches to research can make use of methods and computer simulation models such as systems dynamics, network analysis, and agent-based modeling to examine relationships between populations, such as LHTDs, and the multitude of factors, including work characteristics, influencing their behaviors and health outcomes (Luke and Stamatakis, 2012). Fundamentally, using systems science methods for intervention

or policy development, regardless of the safety or health issue, requires collaboration across a wide range of professional disciplines (Luke and Stamatakis, 2012).

Examples of disciplines involved in LHTD health would include labor unions, company leaders, policy-makers, government officials (FMCSA, EPA, labor, etc.), health education, OSH professionals, and representative truck drivers. The further benefits of a systems science approach includes opportunities for knowledge development and more rigorous use of data as well as the types of data that need to be collected for better understanding (Diez Roux, 2011).

This could vitally lead to discovering facts that have been neglected or have not been adequately addressed pertaining to LHTD health, and thus foster support in the pursuit of a more comprehensive approach.

Conclusions

It is increasingly clear that the health and safety of LHTDs in the USA is a critical public health problem due to a multitude of poor health outcomes in the form of chronic disease risks and the extensive public safety hazards attributed to the profession. LHTDs work in an environment not conducive to healthy living and much of the time their decision-making capacity, whether it pertains to work processes or health behaviors, is out of their immediate control. As evidenced in this review and previous reviews, there is a very limited literature base regarding intervention efforts for improved health of LHTDs, but as this paper has sought to demonstrate, with the use of current evidence-based models put forth by the CDC, NIOSH, and others, there is much opportunity and a vital need for innovative efforts for improving the health of LHTDs.

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About the authors

Adam Hege is an Assistant Professor in the Department of Health and Exercise Science at the Appalachian State University. His research explores the complex relationship between work and health. He is most interested in occupational health disparities and worksite health promotion among blue-collar occupations with an emphasis on commercial drivers. Adam Hege is the corresponding author and can be contacted at: hegeba@appstate.edu

Michael Perko is an Associate Professor in the Department of Public Health Education at the University of North Carolina at Greensboro. His research interests include worksite health promotion and helping companies understand the benefits of having healthy employees.

Yorghos Apostolopoulos is an Associate Professor in the Department of Health and Kinesiology at the Texas A&M University. His research focuses on occupational health disparities with a primary emphasis on the health and well-being of commercial drivers.

Sevil Sönmez is a Professor in the Department of Tourism, Events and Attractions at the University of Central Florida. Her research is interdisciplinary and applied delves into the nexus of leisure, work, and health.

Robert Strack is an Associate Professor in the Department of Public Health Education at the University of North Carolina at Greensboro. His community-based research emphasizes an appreciation of the social ecological model and that social issues are more effectively impacted through policy, systems, and individual-level change strategies.