

Worksite-Induced Morbidities Among Truck Drivers in the United States

by Yorghos Apostolopoulos, PhD, Sevil Sönmez, PhD, Mona M. Shattell, PhD, RN, and Michael Belzer, PhD

ABSTRACT

A critical review was conducted of social, psychological, and health science literature on the array of health risks and morbidities of truckers. Multilevel worksite-induced strains (e.g., long work hours and fatigue, shift work and sleep deprivation, postural fatigue and exposure to noise and vibration, sedentary lifestyle and unhealthy diet, exposure to diesel exhaust fumes, and other occupational stressors) were categorized into six primary morbidities for truckers: (1) psychological and psychiatric disorders; (2) detriments resulting from disrupted biological cycles; (3) musculoskeletal disorders; (4) cancer and respiratory morbidities; (5) cardiovascular disease; and (6) risk-laden substance use and sexual practices. Elevated morbidity risks suggest the need for the design and implementation of systematic epidemiological research and environmental interventions in the transport sector.

Many occupations within the transport sector have long been linked to a multitude of adverse health outcomes. Taxi, bus, and truck drivers, train conductors, and trolley and cable-car operators, among other professional drivers, have experienced musculoskeletal, psychophysiological, gastrointestinal, cardiovascular, and other morbidities (Federal Motor Carrier Safety Administration [FMCSA], 2005). Such health ramifications, which have been predominantly attributed to workplace conditions, have negatively influenced the quality of life of many of these workers (Apostolopoulos & Sönmez, n.d.a).

ABOUT THE AUTHORS

Dr. Apostolopoulos is Associate Professor, Department of Public Health Education, University of North Carolina at Greensboro, NC. Dr. Sönmez is Professor, School of Health and Human Performance, University of North Carolina at Greensboro, NC. Dr. Shattell is Associate Professor, School of Nursing, University of North Carolina at Greensboro, NC. Dr. Belzer is Associate Professor of Economics, Wayne State University, Detroit, MI.

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*Address correspondence to Yorghos Apostolopoulos, PhD, Department of Public Health Education, University of North Carolina at Greensboro, Greensboro, NC 27402-6170. E-mail: Y_APOSTO@uncg.edu.
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Nearly 15 million truck drivers who traverse the continental United States are particularly susceptible to a wide array of occupationally induced health conditions, exemplified by high morbidity and mortality rates (Saltzman & Belzer, 2007). One particularly startling statistic underscores the gravity of the situation: life expectancy is only 63 years for U.S. male unionized truckers and 55.7 years for members of the Owner-Operator Independent Drivers Association—both significantly lower than the 75.1 years for the general U.S. male population (Heron et al., 2009; Saltzman & Belzer, 2007). These alarming statistics are mainly attributable to the far-reaching consequences of a series of governmental and corporate policies that go beyond truckers' professional welfare and critically define their personal health (Apostolopoulos & Sönmez, n.d.c).

Despite demonstrated adverse working conditions in the surface transport sector (Roberts & York, 2000), neither the epidemiology of trucking nor the surveillance of multilevel effects on truckers' morbidity and mortality in North America have received substantive research attention. Consequently, truckers remain both a highly vulnerable and a seriously underserved working population

with low health care access and use (Layne, Rogers, & Randolph, 2009; Reed & Skeeters Cronin, 2003; Solomon, Doucette, Garland, & McGinn, 2004).

The aims of this literature review were to (1) elucidate the ways in which the transportation environment causes, aggravates, or perpetuates multilevel health risks; and (2) place the population of underserved truckers firmly within the discourse of occupational health promotion by putting forth initial interventions for the broad transportation sector. Although emphasis has been placed on North America, data and assertions of this article may be applicable to the trucking sectors of industrialized and developing nations.

THE HEALTH OF TRUCKERS

Trucking has been classified as one of the highest-risk occupations in the United States (Bureau of Labor Statistics [BLS], 2007). Workplace conditions not only are detrimental to truck drivers' health but also encourage unhealthy behavioral patterns that can adversely affect truckers' well-being (Apostolopoulos & Sönmez, n.d.a). These conditions are attributed to the transportation environment, including trucking operations in loading areas, warehouses, terminals, truck stops, and even truck cabs (Apostolopoulos & Sönmez, n.d.a). This environment has occupational, institutional, organizational, physical, social, and governmental dimensions, including the policies and regulations that govern them (Apostolopoulos & Sönmez, n.d.a). Inextricably connected, key components include government regulations, trucking operations, corporate policies, and the built environment (Apostolopoulos & Sönmez, n.d.a) (Table 1). Although modifiable, the transportation environment critically affects truckers' lives—from the air they breathe and the food they eat to their sleep patterns and opportunities for physical activity (Apostolopoulos & Sönmez, n.d.c). Delineating the role of the transportation environment in the health and safety of both individual truckers and the public is long overdue, particularly given the growing recognition of environmental factors in shaping health behaviors (Booth et al., 2001).

Government deregulation and hours of service (HOS) define trucking operations in North America. Deregulation during the late 1970s was the impetus for restructuring the trucking sector from the 1980s on, with profound effects on truckers' bargaining power and work conditions (Belzer, 2000). According to Saltzman and Belzer (2007), drivers are allowed to work as much as 84 hours in a 7-day work week. Consequently, deregulation and HOS have resulted in a marketplace with excessive labor, fueling the creation of a self-perpetuating "sweatshop environment" (Belzer, 2000). This environment is characterized by high turnover, comparatively low earnings, and the absence of health insurance and pension plans for truckers and, in turn, adversely impacts truckers' health directly linked to highway safety (Rodriguez, Rocha, Khattak, & Belzer, 2003).

Trucking operations involve diverse but interconnected components and activities. At the heart of trucking lies the "for-hire service" segment, compared to private carriers,

and its two main components: "less-than-truckload" (LTL) and "truckload" (TL). LTL carriers consolidate, haul, and distribute goods via the hub-and-spoke system, which involves a network of centrally located trucking terminals or hubs where loading and unloading occur in preparation for distribution to outlying locations. TL carriers, on the other hand, usually travel longer distances and move shipments directly from origin to destination. Within this division, shippers and consignees who receive freight shipments dominate the market by defining rates, schedules, and services. They thereby place pressure on truckers to meet tight schedules with "just-in-time" deliveries, oftentimes made possible only by working shifts that conflict with biological cycles (Belzer, 2000).

Corporate policies that shape trucking unfold within the public and commercial infrastructure of truck stops, trucking terminals, and warehouses. Truck stops, in particular, are designed, built, and operated by a nationwide network of multimillion-dollar corporations that collaborate with other transnationals and cater to a captive market of truckers. Services include food, truck operations, maintenance, and support, as well as entertainment, communication, and leisure amenities (National Association of Truckstop Operators [NATSO], n.d.). Truck stops are infamous for their poor air quality, unhealthy food consisting of mostly deep-fried and fat- or sodium-laden offerings, and scarce room and opportunities for physical activity.

Finally, the built environment of trucking encompasses all physical and spatial dimensions of truck stops, trucking terminals, and warehouses (Apostolopoulos & Sönmez, n.d.a). Because truckers spend significant time in these settings, their built environment must be efficient, comfortable, spacious, user-friendly, and safe and, above all, must offer opportunities for truckers to make healthful food and physical activity choices during non-working hours. However, the spatial and physical attributes of typical truck stops and terminals are not conducive to healthy lifestyles and are filled with obstacles to healthy living that are difficult to overcome. The combination of poor design and layout discouraging walking, lack of healthy food choices, difficulty accessing community resources, and extremely poor air quality makes it difficult for truckers to sustain healthful behaviors (Apostolopoulos & Sönmez, n.d.a, n.d.c).

Within this context, an inexplicable lacuna of epidemiological research on North American truckers exists and, in fact, the chronic multilevel effects of trucking in North America on driver morbidity and mortality remain largely unknown (Apostolopoulos & Sönmez, n.d.a; Rosa & Colligan, 1997; Saltzman & Belzer, 2007). To date, no comprehensive epidemiological investigations of the role of shift work, long work hours, chronic stress, exposure to constant vibration, diesel fumes and poor air quality, sedentary lifestyle, postural fatigue, steady diet of unhealthy food, and other occupational stressors on the health of truckers have been undertaken.

METHODS

This literature review emerged from an extensive review of the U.S. Department of Transportation's FMCSA

Table 1

Transportation Environment and Trucker Health

| Transportation Environment Components | Main Dimensions of Transportation Environment Components | What It Means for Trucking and Truckers | Effects on Trucker Health |
|--|---|--|--|
| Government regulations | Pro-competitive economic regulation of trucking (“deregulation”) and HOS provisions | Competitive carriers and labor markets; unionization decline; lower wages and benefits; poor working conditions; “sweatshop” environment produced by contingent compensation and precarious employment; HOS violations | Disrupted biological cycles; fatigue and sleep loss and metabolic strains; stress symptoms; sedentary lifestyle, obesity; CVD and diabetes risks; low wages linked with more crashes |
| Trucking operations | Logistics and market structure; TL/LTL carriers; hub-and-spoke system; terminals and warehouses; shippers and consignees | Segmented market with shippers holding immense bargaining leverage; harsh working conditions and long hours for drivers; lack of organization-based health promotion programs | Sedentary, stressful lifestyle; low physical energy (fatigue) and mental alertness; social isolation; eating while driving; headaches; respiratory, CVD risks; musculoskeletal disorders |
| Corporate policies in trucking settings | Overall infrastructure; conditions; resources; amenities; ergonomics of highways, truck stops, terminals, and truck cabins | Lack of exercise facilities; exposure to noise and fumes; constant vibration while driving; irregular and unhealthy dietary options; long and irregular working hours | Obesity and high exposure to smoking or diesel exhausts are predictive of stroke, diabetes, and other endocrine disorders, CVD, arthritis, back pain, and cancer risks |
| Built environment | Spatial and physical aspects of highways, truck stops, and trucking terminals (design, layout, pedestrian and walking services, access) | Efficient, safe, and healthy work settings; location, proximity, and accessibility of truck stops and terminals to and from community services or resources; availability, adequacy, and quality of space that supports activity; social isolation | Sedentary lifestyle, limited access to healthier foods, and limited clean air with associated risk factors for obesity, CVD, diabetes, cancer, and other morbidities; higher risks of depression and suicide |

Note. HOS = hours of service; CVD = cardiovascular disease; LTL = less-than-truckload; TL = truckload.

report, with a specific focus on the potential impact of HOS provisions for the operators of commercial motor vehicles, predominantly truckers (FMCSA, 2005). From this report, more than 200 primary bibliographical references were studied, leading to the development of three comprehensive lists involving relationships between the transportation environment and trucker morbidities. More specifically, the trucker morbidities were identified as “health compromising situations,” “documented morbid conditions,” and “speculative morbidities or those not established with truckers.” This classification then led to the compilation of 120 journal articles and reports (through May 2009) that were identified from PubMed Central, PsycINFO, and TRANSPORT databases. PubMed Cen-

tral is the National Institutes of Health digital archive of biomedical and life sciences literature; PsycINFO is the most inclusive database of psychological literature, provided by the American Psychological Association; and TRANSPORT is the premier bibliographical database of transportation research, produced by the Organization for Economic Co-operation and Development, the U.S. Transportation Board of the National Academy of Sciences, and the European Conference of Transport Ministers. Using these sources, populations, exposures, and outcomes were evaluated within the transportation environment. Key words and health-related subject headings were selected to represent outcomes (e.g., respiratory morbidities, cancer, hypertension, musculoskeletal disor-

ders, vehicular crashes) and exposures of interest (e.g., shift work, sleep deprivation, exposure to diesel exhaust, lack of physical activity, unhealthy diet).

RESULTS

Findings were organized to present a wide array of health-compromising situations for truckers. Documented morbidities for truckers and speculative morbidities or those not established with truckers had to be supported by two lists with key citations to be included (Table 2). Due to space limitations and for optimal organization, the following were used to amplify the gamut of truckers' broad health problems: (1) psychological and psychiatric disorders; (2) detriments resulting from disrupted biological cycles; (3) musculoskeletal disorders; (4) cancer and respiratory morbidities; (5) cardiovascular disease; and (6) risk-laden substance use and sexual practices.

Psychological and Psychiatric Disorders

Several reports corroborated truckers' heightened levels of stress and significant risk for various psychiatric disorders (Apostolopoulos & Sönmez, n.d.a; Bernard, Bouck, & Young, 2000; Wong, Tam, & Leung, 2007). In a test of psychological distress, parcel-delivery truck drivers scored significantly higher than any other occupational group. Truck drivers were also found to be in the 91st percentile for the Global Stress Index portion of the Symptom Checklist SCL-90 (Orris et al., 1997). Other studies have revealed stressful situations and conditions (i.e., traffic congestion; loneliness and social isolation or being "out-of-phase" with society; fear of assault, robbery, and other forms of violence; lack of job satisfaction and control; crash fatality risks; financial pressures; disrespectful treatment by shipping and receiving personnel; insufficient sleep and chronic fatigue; tight schedules; and continually rotating shift patterns) (Anderson, 2004; Anderson & Reed, 2002; Belman & Monaco, 2001; Belzer, 2000; Saltman & Belzer, 2003) directly linked to the milieu of trucking.

Stressors, whether individual or in combination, appear to induce suboptimal psychophysiological states among workers in diverse occupational categories, thus potentially producing high levels of occupational stress (Kivimäki et al., 2006). Repercussions from chronic stress range from relationship and family problems, to increased cholesterol levels linked to dietary patterns and overweight and obesity, to high rates of suicide (Bernard et al., 2000; Steptoe & Brydon, 2005). In most cases, these adverse effects are independent of individual factors. Among Australian long-haul truckers, suicide accounted for 10% of all deaths, was the fourth most common cause of death among these drivers, involved victims younger than 36 years, and was linked to financial pressures (Quinlan, 2001).

Work-related psychological stress also contributes to increased numbers of injuries and illnesses, even when employees are away from work. Although aggregate injuries and illnesses in the United States declined for all occupations by about 20% from 1992 to 1999, incidence

rates for truckers increased by nearly 5% between 1992 and 1996 (BLS, 2002). Finally, an International Labor Organization report indicated that work-related stress expenditures cost employers more than U.S. \$200 billion annually (Tangri, 2003).

Detriments Resulting From Disrupted Biological Cycles

Links between truckers' shift work and sleep patterns and resulting adverse effects have attracted significant research attention (Freund, 1999; Hanowski, Wierwille, & Dingus, 2003). When the circadian rhythm, a 24-hour cycle in the physiological processes of living beings originating from a clock circuit in the hypothalamus set by information from the optic nerve, is altered due to rotating schedules, various gastrointestinal, cardiovascular, reproductive, and other dysfunctions are reported and conditions such as diabetes, epilepsy, and psychiatric disorders can be severely exacerbated (Barton & Folkard, 1993; Scott, 2000).

Fragmented and erratic work schedules that result in sleep deprivation and frequent distortions in the perception of sleepiness have been empirically linked with fatal crashes (Hakkanen, Psych, & Summala, 2000; Lyznicki, Doege, Davis, & Williams, 1998). In studies on verifiable sleep, determined via actigraph watch or electroencephalogram, truckers averaged 3.8 to 5.2 hours of sleep daily (Balkin et al., 2000; Dinges, Maislin, Krueger, Brewster, & Carroll, 2005), much below the 6 to 8 hours associated with a healthy lifestyle (Caruso, Hitchcock, Dick, Russo, & Schmit, 2004). Moreover, nighttime fatigue-induced accident rates for truckers are more than three times higher than daytime rates, and fatal sleep-related crashes are particularly frequent between midnight and 6 a.m., likely the result of truckers' efforts to defy their circadian clocks (Akerstedt, Czeisler, Dinges, & Horne, 1994).

Sleep-disordered breathing, or sleep apnea, doubles truckers' accident rates (Stoohs, Guillemineault, Itoi, & Dement, 1994). In fact, obstructive sleep apnea, in particular, is correlated with obesity and large neck size (Baskin, Ard, Franklin, & Allison, 2005; Drake, 2003), both of which are prevalent among truckers. Obese truckers have a twofold higher accident-involvement rate compared with their non-obese counterparts (Roberts & York, 2000). In a road safety survey, 25% of truckers reported falling asleep at the wheel in the past year and 47% reported the same at some time in their careers (McCartt, Rohrbaugh, Hammer, & Fuller, 2000). Finally, sleep debt resulting from semi-chronic, partial sleep restriction has additional metabolic and endocranial repercussions, leading to increased risks for obesity, pre-diabetic states, and impaired immune functions (Ayas et al., 2003; Buxton, Spiegel, & van Cauter, 2002). Recent research suggests that disruptions in sleep patterns, often linked to 24-hour lifestyles, are associated with increased body fat and altered metabolism, although the cause-effect relationship of these associations has not been fully explained (Baskin et al., 2005; Bray & Young, 2007). Further, although sleep debt may cause metabolic changes, baseline obesity is

Table 2

Occupational Risks and Documented/Speculative Morbidities for Truckers

| Health-Compromising Situations for Truckers | Documented Morbidities for Truckers | Key Studies | Speculative Morbidities or Those Not Established With Truckers | Key Studies |
|---|---|---|--|--|
| Long work hours and fatigue | Musculoskeletal disorders; CVD; accidents | Jansen et al., 2008; Liu & Tanaka, 2002 | Neuropsychological problems; alcohol abuse; smoking; injuries; weight gain | Apostolopoulos et al., n.d.a; Caruso et al., 2004 |
| Shift work and sleep deprivation | Fatigue; disrupted biological cycles; fatal crashes; CVD | Alvarez & Ayas, 2004; Bigert et al., 2003; Dinges et al., 2005; Hanowski et al., 2003 | Metabolic and endocranial repercussions; impaired immune functions | Ayas et al., 2003; Baskin et al., 2005; Buxton et al., 2002 |
| Postural fatigue and exposure to noise or vibration | Musculoskeletal disorders, injuries, and disabilities; fatigue, insomnia, and headaches | Clark et al., 2001; FMCSA, 2005; Miyamoto et al., 2000 | Circulatory, bowel, and respiratory problems | Cann et al., 2004 |
| Exposure to diesel fumes | Headaches, dizziness, and nausea; respiratory strains, stroke, CVD | Steenland et al., 1992 | Bladder and ovarian cancer | Colt et al., 2004; FMCSA, 2005; Garshick et al., 2003; Hannerz & Tuchsén, 2001 |
| Sedentary lifestyle and unhealthful diet | Overweight and obesity; high cholesterol; hypertension; CVD; stroke; diabetes | Bigert et al., 2004; Evans, 1994; Harrington, 1995; Korelitz et al., 1993; Roberts & York, 2000 | Lower back pain; arthritis | Field et al., 2001 |
| Other cumulative occupational stressors and risks | Psychological distress; psychiatric disorders; depression; suicide; substance abuse; sexual risks; violence (assault, weapons, robbery) | Apostolopoulos & Sönmez, 2007; Crouch et al., 1993; Quinlan, 2001; Stratford et al., 2000 | Musculoskeletal disorders; CVD | Rugulies et al., 2004 |
| Overall occupational consequences | Elevated morbidity and mortality rates and resulting low life expectancy | Aronson et al., 1999; Saltzman & Belzer, 2007 | | |

Note. CVD = cardiovascular disease; FMCSA = Federal Motor Carrier Safety Administration.

also associated with increased risks for sleep-disordered breathing (Hasler et al., 2004; Taheri, Lin, Austin, Young, & Mignot, 2004). Considering that abnormal sleep and wake patterns are believed to alter intracellular circadian clocks (Baskin et al., 2005; Bray & Young, 2007), potential links between obesity rates among truckers and the routine disruption of their sleep patterns clearly warrant closer examination.

Musculoskeletal Disorders

As a consequence of long workdays, whole-body vibration, and postural fatigue, truckers experience severe ergonomic strains (FMCSA, 2005; Jensen et al., 2008). These strains cause musculoskeletal disorders, injuries, and disabilities; work-related musculoskeletal disorders account for more than one third of occupational injuries and illnesses involving lost work time for the general pop-

ulation (U.S. Department of Labor [USDOL], n.d.). Among the unionized LTL work force, drivers and yard workers account for a disproportionately high share of permanent disability payments due to musculoskeletal disorders (Rogers, 2003). Prevalent health problems include low back injuries and knee disorders, which represent nearly half of all workers' compensation claims.

Whole-body vibration, a function of the truck's age, speed, and maintenance, the design of the truck cab including suspension and power steering, and the roadway type and condition, has been highly correlated with low back injuries (Mayhew & Quinlan, 2001; Miyamoto et al., 2000). Exposure to vibration and noise can cause fatigue, insomnia, and headaches, and prolonged exposure may contribute to circulatory, bowel, and respiratory problems (Cann, Salmoni, & Eger, 2004; Mabbott, Foster, & McPhee, 2001; Occupational Health Clinics for Ontario Workers, Inc., 2005). Beverage delivery and ready-mix concrete drivers, in particular, face extreme ergonomic stresses ranging from slips and falls to serious fractures due to worksite hazards such as walking on wet surfaces and damaged sidewalks and stairwells (Clark et al., 2001; McCann, 2003; McGlothlin, 2003).

Besides physical exposures that manifest stronger and more consistent effects leading to musculoskeletal disorders, work-related psychosocial exposures, whether independent of or interacting with physical exposures, are also risk factors for musculoskeletal disorders (Rugulies et al., 2004). Truckers, who experience the complex interplay of both physical and psychosocial conditions in the workplace, are at increased risk for psychophysiological stress reactions and subsequent musculoskeletal disorders, as is the case with other occupational groups (Theorell & Karasek, 1996).

Cancer and Respiratory Morbidities

Studies of truckers and railroad employees report an increased incidence of lung cancer due to their exposure to diesel fumes (Garshick et al., 2003). Truckers who drive gasoline tankers especially complain of acute headaches, dizziness, and nausea. Diesel exposure has been associated with chronic respiratory problems such as wheezing, asthma, reduction in pulmonary function, and allergic inflammation (Steenland, Deddens, & Stayner, 1998; Steenland, Silverman, & Zaebst, 1992).

Although risks associated with high levels of diesel exposure are undeniable (Steenland et al., 1998), U.S. policy makers question causal connections between diesel exposure and cancer. Primary reasons for doubting causation include confounders such as synergistic effects of other pollutants (e.g., smoking prevalence among truckers), inconclusive research due to methodological shortcomings and deficient data, and the long latency period of most cancers (FMCSA, 2005). For example, keeping trucks idling while waiting at trucking terminals and truck stops, during traffic congestion, or while running heat or air conditioning when using the sleeper berth generates higher exposure than actual highway driving. High levels of diesel particulate matter are also present on loading docks (Clean Air Task Force, 2005; Garshick et al., 2003;

Steenland et al., 1992, 1998), although it is difficult to estimate possible combinations of various conditions.

Undoubtedly, the extent of cancer risk depends on length of exposure (Steenland et al., 1998). Case-control studies in Germany and Denmark have established significant associations between lung cancer and years of employment (Brüske-Hohlfeld et al., 1999; Soll-Johanning, Bach, & Jensen, 2003). Similar associations have been demonstrated between trucking and bladder cancer and ovarian cancer in female drivers (Colt et al., 2004; Guo et al., 2004). Finally, more recent epidemiological studies from Sweden have identified links between exposures of male truckers in the construction sector to diesel exhaust and increased rates of prostate cancer (Järnholm & Silverman, 2003).

Cardiovascular Disease

Biomedical and epidemiological research has related conditions of overweight and obesity to a wide range of morbidities (Järnholm & Silverman, 2003). However, a balanced diet and physical activity, two reliable correlates of weight control, can significantly reduce risks for physiological (e.g., heart disease, hypertension, diabetes) and psychological (e.g., depression, anxiety, stress) illnesses (Bauman, 2004). Extant data indicate that 85% of truckers are overweight or obese (Martin, Church, Bonnell, Ben-Joseph, & Borgstadt, 2009), compared with 66.9% of men older than 20 years in the general U.S. population (Bernstein, Bilheimer, & Makuc, 2010). In a study on the development of a wellness program for commercial drivers, fried foods and animal fats were found to be favorite menu selections for truckers on the road (Holmes, Power, & Walter, 1996). The consequences of such unhealthful nutritional practices are further exacerbated by a highly sedentary, occupation-induced lifestyle characterized by the lack of regular physical activity, further worsened by prevalent smoking and alcohol use. The only recorded measurement revealed that 92% of male truckers are inactive; they do not participate regularly in aerobic exercise (Korelitz et al., 1993), compared to 27.89% of the general U.S. male population (Pate et al., 1995).

Overweight and obesity not only are well-established risk factors for stroke, cardiovascular disease, hypertension, and diabetes (Ostbye, Dement, & Krause, 2007), but also exacerbate arthritis and lower back pain (Field et al., 2001) and in conjunction with menopausal status, low activity level, and a predisposition to insulin resistance (Seidell, Kahn, Williamson, Lissner, & Valdez, 2001) place individuals at higher risk for cancer. Despite mounting empirical and anecdotal evidence about the magnitude of trucker obesity, particularly among long-haul truckers, few epidemiologic studies focus on truckers' obesity-associated morbidities such as high blood pressure and heart disease.

Hypertension increases the risk of heart disease, stroke, diabetes, and colon, breast, kidney, and esophageal cancer (Bianchini, Kaaks, & Vainio, 2002). Despite U.S. federal guidelines stating that commercial drivers' blood pressure levels shall not exceed 140/90 mmHg (Blumen-

thal et al., 2002), in a sample of 3,000 truckers attending a trade show, 33% recorded blood pressures greater than 140/90 mmHg and 11% were greater than 160/95 mmHg (Korelitz et al., 1993), a combined total of 44% with elevated blood pressure. Twenty percent of drivers sampled in an insurance study (Harrington, 1995) and 17% of truckers in a sleep apnea study (Stoohs, Guilleminault, & Dement, 1993) also had blood pressure readings greater than 160/95 mmHg. Yet, only 26.3% of males in the general U.S. population have blood pressure readings greater than 140/90 mmHg (American Heart Association, 2007). A strong correlation exists between elevated blood pressure and length of employment among Norwegian truckers and bus drivers compared to other industrial workers (Evans, 1994).

Cardiovascular disease, principally heart disease and stroke, is the leading cause of death in the United States (American Heart Association, 2004), involving a complex set of individual (e.g., high cholesterol, hypertension, obesity), occupational (e.g., long work hours, physical stressors, shift work, and sleep irregularity, deprivation, and debt), and lifestyle-related (e.g., substance misuse, stress, sedentary nature) risk factors (Byrne & Espnes, 2008; Yarnell et al., 2005). Although many of these risks are frequently induced or exacerbated by occupational and other environmental factors, they are particularly inherent in trucking operations.

In Denmark, male professional drivers, including truckers, were found to be at increased risk of stroke (Tüchsen, Hannerz, Roepstorff, & Krause, 2006), whereas truckers in Lithuania and Sweden demonstrated elevated risks for acute myocardial infarction and hypertension, a primary risk factor (Bigert et al., 2003; Gustavsson et al., 1996; Malinauskienė, Theorell, Grazuleviciene, Malinauskas, & Azaraviciene, 2004). Population studies from Sweden and Denmark have suggested strong correlations between driving occupations and elevated cardiovascular risks (Bigert et al., 2003, 2004). In a study of industrial workers, overtime work, comparable to the U.S. truckers' HOS, and insufficient sleep, a routine problem for all truckers, were linked to risk for acute myocardial infarction (Liu & Tanaka, 2002). Finally, chronic partial sleep loss, due to circadian cycle disruptions, and excess weight, both prevalent among truckers, were also associated with adverse cardiovascular effects (Alvarez & Ayas, 2004; Spiegel et al., 2004).

Risk-Laden Substance Use and Sexual Practices

Occupational pressures often induce, facilitate, or exacerbate substance use and sexual activity risk taking by transport personnel (Apostolopoulos & Sönmez, 2007). Published research indicates that substance misuse can be a significant problem for commercial drivers (Apostolopoulos et al., 2010; Crouch et al., 1993; Insurance Institute for Highway Safety, 2007; Korelitz et al., 1993). A study of 3,500 truckers attending a trade show found between 49% and 54% of participants smoked and 30% misused alcohol (Korelitz et al., 1993). Furthermore, the presence of alcohol was reported after crashes for 18% of fatally injured truckers (Roberts & York, 2000), stimulants were

found to be the most frequently unidentified (15%) drug class among fatally injured truckers (Insurance Institute for Highway Safety, 2007), 33% of 168 fatally injured truckers tested positive for psychoactive drugs or alcohol, and marijuana, cocaine, and other stimulants were detected in 13%, 8%, and 12% of fatally injured truckers, respectively (Crouch et al., 1993). More recent statistics indicate that estimated deaths among tractor-trailer drivers with a blood alcohol concentration of 0.08 declined from 16% in 1982 to 2% in 2005 (Insurance Institute for Highway Safety, 2007), attributable to the drug and alcohol testing that became a requirement in the United States in 2001. Ongoing ethnographies corroborate truckers' far-reaching use of amphetamines, cocaine, crack, and marijuana to stay awake and alert while driving, get high while partying, relax between trips, or improve sleep (Apostolopoulos & Sönmez, 2007; Apostolopoulos et al., 2010).

The sexual health of truckers and their partners is also a concern because of truckers' risk-laden sexual interactions on the road, which have remained a long known "occupational" hazard. In addition to voluminous anecdotal information, truckers' extensive risky sexual encounters with multiple partners in highway, trucking, and Internet cruising milieu have been empirically substantiated (Apostolopoulos & Sönmez, n.d.b; Ouellet, 1994; Overdrive Staff, 2002; Stratford et al., 2000). Furthermore, concurrent sexual transactions with sex workers and other casual partners of both genders in disparate locations are sometimes linked to elevated risk for sexually transmitted and bloodborne infections, including HIV, gonorrhea, syphilis, and chlamydia (Apostolopoulos & Sönmez, n.d.b; Cook, Royce, Thomas, & Hanusa, 1999). Due to their mobility, truckers can influence the dissemination of sexually transmitted infections as they interact with populations and geographic areas with high and low prevalence of sexually transmitted infections (Apostolopoulos & Sönmez, n.d.b).

ADVANCING EPIDEMIOLOGICAL RESEARCH AND OCCUPATIONAL HEALTH INTERVENTIONS IN THE TRUCKING SECTOR

"Lifestyle choices are bound to have profound effects on the health and wellness of commercial motor-vehicle drivers [truckers] and in the Agency's [Federal Motor-Carrier Safety Administration (FMCSA)] best judgment may, by themselves, be predictive of higher rates of cancer, CVD, diabetes, and back problems" (FMCSA, 2005). The FMCSA blatantly acknowledges the problem, anticipated spikes in morbidity rates, but equates truckers' occupation-induced health detriments with lifestyle choices. By doing so, the FMCSA not only ignores the indisputable impact of the trucking environment on drivers' behavioral patterns, but also denies any responsibility for the dismal state of health of transport-sector personnel by completely shifting blame to the workers themselves. However, the foregoing discussion has substantiated it is mainly governmental and corporate policies that trigger, exacerbate, and sustain truckers' elevated risks for a plethora of morbidities.

Whereas conventional strategies to mitigate diverse, primarily behavioral risk factors (e.g., smoking, diet) that focus on individuals have not been effective (Dalton, 2006), the modification of environmental influences on behavior seems more promising because it is generalizable, cost-effective, and sustainable (Gadde, 2005). Ecological approaches can use policies, programs, and organizational practices to alter the work environment and promote healthful behaviors (French, Story, & Jeffery, 2001; Larkin, 2003; Wakefield, 2004; Wing et al., 2001). Worksites, in particular, can be effective settings for occupational health nurses to implement environmental interventions designed to promote behavior changes by reaching large numbers of individuals (Hagihara, Tarumi, & Nobutomo, 2002; Sorensen, Linnan, & Hunt, 2004; Sorensen et al., 1998; Texas Health Institute, 2006).

The need for modifications in trucking operations remains. Truck stops and trucking terminals are two viable venues for occupational health nurses to reach truckers and initiate long-overdue interventions. Occupational health nurses can collaborate with truckers' unions and trade associations, trucking and truck stop corporations, shipping and receiving companies, insurance companies, governmental agencies, and citizen groups to plan health-related programs. Work schedules that begin early in the morning, shift work, long hours and schedules that disrupt sleep patterns, artificial lighting, uncomfortable temperatures, and lack of clean air may contribute to unhealthy behavioral patterns. Initial interventions could include policies that encourage the initiation of wellness programs; fitness center discounts and price reduction incentives for healthier food purchases at cafeterias and vending machines located at truck stops; availability of healthier food choices, reduced portion sizes, and point-of-purchase nutrient and calorie information for foods at truck stop eateries; and the establishment of small-scale on-site gyms and smoke-free areas.

Interventions at truck stops and trucking terminals may also enhance social support from fellow truckers for healthier behavior patterns. Support from truck stop and terminal management and employees who interact with truckers is a consideration for successful program implementation. The organizational and built-environment attributes of trucking settings can also be used to promote behavior changes and motivate, facilitate, and sustain truckers' efforts to manage weight and prevent smoking (Hayden, 2005; Transportation Research Board, 2002). Benefits of worksite wellness programs, primarily in truck stops and terminals, planned, implemented, and evaluated by occupational health nurses and truckers include improved morale, reduced turnover, increased recruitment, decreased health care costs, and improved trucker health status (Krueger, Brewster, Dick, Inderbitzen, & Staplin, 2007).

For even modest changes to be feasible and effective, however, the managers of transportation environments must consider an eventual overhaul, including an end to extremely long work hours. A study by the National Institute for Occupational Safety and Health on the effects of lengthy work shifts concluded that extended workdays

and weeks, exceeding 40 hours and 8 days, respectively, appeared to be associated with diminished health and increased injury, morbidity, and mortality rates (Caruso et al., 2004). Individuals who work long hours are generally at greater risk for unhealthy weight gain, alcohol use, smoking, other health complaints, and injuries while working; inferior (or diminished) neuropsychological performance; reductions in vigilance on task measures, cognitive function, and overall job performance; increased fatigue; decreased alertness; and slower work, particularly in the first 9 to 12 hours of the shift. Under the HOS regulations, millions of U.S. truckers can work up to 84 hours a week (Saltzman & Belzer, 2007), driving trucks weighing up to 80,000 pounds. The European Union recently announced the reduction of work hours for truckers from a 74- to a 60-hour week, including time spent loading and unloading, making shipping companies co-responsible for violations of these regulations (European Commission, 2006).

CONCLUSION

This comprehensive literature review brings to light some alarming patterns in the health of trucking populations in North America. Two large-scale (Canadian and Danish) population cohort studies compared truckers to the general population and found elevated risks for morbidity and mortality among truckers. Hospital records in Denmark revealed much higher admission rates for lung cancer, ischemic heart and cerebrovascular disease, chronic obstructive pulmonary disease, prolapsed cervical discs, and low back injuries for truckers compared to the general male working population (Hannerz & Tuschsen, 2001). Canadian truckers had higher mortality risks than men in other occupations for cancer of the colon, larynx, and lung, diabetes, ischemic heart disease, non-alcohol cirrhosis, and motor vehicle accidents (Aronson et al., 1999).

Despite the non-systematic and overall limited data on truckers' health, truckers suffer routinely and disproportionately from a wide array of health-related conditions directly related to their occupational contexts and consequential lifestyles. The delayed onset of health problems due to their long latency periods, combined with high job turnover rates (Larsen, 2004), does not sufficiently explain why motor carrier or freight populations have not attracted the research attention they deserve and urgently need. Unfortunately, as drivers leave the profession, they are lost and their ailments become more difficult to track. Furthermore, the lack of surveillance data creates a major obstacle because it perpetuates disparities among working-class populations and limits the planning and implementation of effective interventions.

This critical review is intended to provide the foundation for the development of research hypotheses regarding the role of the transportation environment in the prevalence of truckers' illnesses and injuries, as there exists no substantiated explanation for the ways the transportation environment aggravates truckers' risks for occupation-induced morbidities. As a result, the identification of risk etiology could contribute to the development, imple-

IN SUMMARY

Worksite-Induced Morbidities Among Truck Drivers in the United States

Apostolopoulos, Y., Sönmez, S., Shattell, M. M., & Belzer, M.

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- 1 Trucking has been classified as a high-risk occupation. North American truck drivers are susceptible to occupation-induced health conditions.
- 2 Health-compromising issues for truckers include psychological and psychiatric disorders, disrupted biological cycles, musculoskeletal disorders, cancer and respiratory morbidities, and risk-laden substance use and sexual practices.
- 3 High morbidity and mortality rates among truck drivers suggest the need for systematic epidemiological research and environmental interventions.

mentation, and evaluation of occupational health nurses' interventions to mitigate truckers' risks for worksite-related morbidities and reduce potential spillover effects on public health and safety.

REFERENCES

- Akerstedt, T., Czeisler, C. A., Dinges, D. F., & Horne, J. A. (1994). Accidents and sleepiness: A consensus statement from the international conference on work hours, sleepiness, and accidents. *Journal of Sleep Research, 3*, 195.
- Alvarez, G. G., & Ayas, N. T. (2004). The impact of daily sleep duration on health: A review of the literature. *Progress in Cardiovascular Nursing, 19*, 56-59.
- American Heart Association. (2004). *New statistics show heart disease still America's no. 1 killer, stroke no. 3*. Retrieved from www.charitywire.com/charity8/05090.html
- American Heart Association. (2007). *Men and cardiovascular disease: 2007 update*. Retrieved from www.americanheart.org/downloadable/heart/1168613214141MEN07.pdf
- Anderson, D. G. (2004). Workplace violence in long-haul trucking: Occupational health nursing update. *AAOHN Journal, 52*, 23-27.
- Anderson, D., & Reed, D. (2002, November). *Violence and stress experienced by female long-haul truck drivers*. Retrieved from http://apha.confex.com/apha/130am/techprogram/paper_40320.htm
- Apostolopoulos, Y., & Sönmez, S. (2007). Tracing the diffusion of infectious diseases in the transport sector. In Y. Apostolopoulos & S. Sönmez (Eds.), *Population mobility and infectious disease* (pp. 131-156). New York, NY: Kluwer.
- Apostolopoulos, Y., & Sönmez, S. (n.d.a). *Environmental and occupational barriers to a healthy trucking lifestyle*. Unpublished working paper, Mobility and Population Health Office, Emory University School of Medicine, Atlanta, Georgia.
- Apostolopoulos, Y., & Sönmez, S. (n.d.b). *Trucker risk networks, drug use, and disease transmission: Preliminary findings from the first large-scale investigation in North America*. Unpublished working paper, Mobility and Population Health Office, Emory University School of Medicine, Atlanta, Georgia.
- Apostolopoulos, Y., & Sönmez, S. (n.d.c). *Truckstops across America: Drugs, prostitution, poor air quality, and fatty foods*. Unpublished working paper, Mobility and Population Health Office, Emory University School of Medicine, Atlanta, Georgia.
- Apostolopoulos, Y., Sönmez, S., Kronenfeld, J., & Smith, D. (2007). Sexual networks of truckers, truckchasers, and disease risks. In G. Herdt & C. Howe (Eds.), *21st Century sexualities: Contemporary issues in health, education and rights* (pp. 112-114). London: Routledge.
- Apostolopoulos, Y., Sönmez, S., Shattell, M., Rothenberg, R., Kronenfeld, J., Miller, M., et al. (2010). *Sexual mixing, drug exchanges, and disease risk among truckers in North America*. Manuscript submitted for publication.
- Aronson, K. J., Howe, G. R., Carpenter, M., & Fair, M. E. (1999). Surveillance of potential associations between occupations and causes of death in Canada, 1965-1991. *Occupational and Environmental Medicine, 56*, 265-269.
- Ayas, N. T., White, D. P., Al-Delaimy, W. K., Manson, J. E., Stampfer, M. J., Speizer, F. E., et al. (2003). A prospective study of self-reported sleep duration and incident diabetes in women. *Diabetes Care, 26*, 380-386.
- Balkin, T., Thorne, D., Sing, H., Thomas, M., Redmond, D., Wesensten, N., et al. (2000). *Effects of sleep schedules on commercial motor vehicle driver performance* (DOT-C-00-133). Washington, DC: U.S. Department of Transportation, Federal Motor Carrier Safety Administration.
- Barton, J., & Folkard, S. (1993). Advancing versus delaying shift systems. *Ergonomics, 36*, 59-64.
- Baskin, M. L., Ard, J., Franklin, F., & Allison, D. B. (2005). National prevalence of obesity: Prevalence of obesity in the United States. *Obesity Reviews, 6*, 5-7.
- Bauman, A. E. (2004). Updating the evidence that physical activity is good for health: An epidemiological review 2000-2003. *Journal of Science and Medicine in Sport, 7*(Suppl. 1), 6-19.
- Belman, D. L., & Monaco, K. A. (2001). The effects of deregulation, deunionization, technology, and human capital on the work and work lives of truckers. *Industrial Labor & Relations Review, 54*(2A), 502-524.
- Belzer, M. H. (2000). *Sweatshops on wheels: Winners and losers in trucking deregulation*. New York, NY: Oxford.
- Bernard, T. M., Bouck, L. H., & Young, W. S. (2000). Stress factors experienced by female commercial drivers in the transportation industry. *Professional Safety, 45*(9), 20-26.
- Bernstein, A., Bilheimer, L. T., & Makuc, D. M. (2010). *Health, United States, 2009: With special feature on medical technology*. Hyattsville, MD: Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics.
- Bianchini, F., Kaaks, R., & Vainio, H. (2002). Overweight, obesity, and cancer risk. *The Lancet Oncology, 3*, 565-574.
- Bigert, C., Gustavsson, P., Hallqvist, J., Hogstedt, C., Lewné, M., Plato, N., et al. (2003). Myocardial infarction among professional drivers. *Epidemiology, 14*, 333-339.
- Bigert, C., Klerdal, K., Hammar, N., Hallqvist, J., & Gustavsson, P. (2004). Time trends in the incidence of myocardial infarction among professional drivers in Stockholm 1977-1996. *Occupational and Environmental Medicine, 61*, 987-991.
- Blumenthal, R., Braunstein, J., Connolly, H., Epstein, A., Gersh, B. J., & Wittels, E. H. (2002). *Cardiovascular advisory panel guidelines for the medical examination of commercial motor vehicle drivers*. Retrieved from www.fmcsa.dot.gov/facts-research/research-technology/publications/cardio.htm#a66
- Booth, S. L., Mayer, J., Sallis, J. F., Hill, J. O., Birch, L. L., Frank, L. D., et al. (2001). Environmental and societal factors affect food choice and physical activity: Rationale, influences, and leverage points. *Nutrition Reviews, 59*, S21-S39.
- Bray, M. S., & Young, M. E. (2007). Circadian rhythms in the development of obesity: Potential role for the circadian clock within the adipocyte. *Obesity Reviews, 8*, 169-181.
- Brüske-Hohfeld, I., Möhner, M., Ahrens, W., Pohlabein, H., Heinrich, J., Kreuzer, M., et al. (1999). Lung cancer risk in male workers occupationally exposed to diesel motor emissions in Germany. *American Journal of Industrial Medicine, 36*, 405-414.

- Bureau of Labor Statistics. (2002). *Lost-work time injuries and illnesses: Characteristics and resulting time away from work, 2000* (USDL Publication No. 02-196). Retrieved from www.bls.gov/iif/oshwc/osh/case/osnr0015.pdf
- Bureau of Labor Statistics. (2007). *Census of fatal occupational injuries 2005*. Retrieved from www.bls.gov/iif/oshcfoi1.htm
- Buxton, O. M., Spiegel, K., & van Cauter, E. (2002). Modulation and endocrine function and metabolism by sleep and sleep loss. In T. L. Lee-Chiong, M. J. Sateia, & M. A. Carskadon (Eds.), *Sleep medicine* (pp. 59-69). Philadelphia: Hanley & Belfus.
- Byrne, D. G., & Espnes, G. A. (2008). Occupational stress and cardiovascular disease. *Stress and Health, 24*, 231-238. doi:10.1002/smi.1203
- Cann, A. P., Salmoni, A. W., & Eger, T. R. (2004). Predictors of whole-body vibration exposure experienced by highway transport truck operators. *Ergonomics, 47*, 1432-1453.
- Caruso, C. C., Hitchcock, E. M., Dick, R. B., Russo, J. M., & Schmit, J. M. (2004). *Overtime and extended work shifts: Recent findings on illnesses, injuries, and health behaviors* (DHHS [NIOSH] Publication No. 2004-143). Retrieved from www.cdc.gov/niosh/docs/2004-143/pdfs/2004-143.pdf
- Clark, N., Dropkin, J., Kaplan, L., & Selikoff, J. (2001). *Ready mixed concrete truck drivers: Work-related hazards and recommendations for controls*. Retrieved from www.elcosh.org/record/document/506/d000493.pdf
- Clean Air Task Force. (2005). *Diesel engines: Emissions and human exposure*. Retrieved from http://catf.us/publications/factsheets/Diesel_Emissions_and_Exposures.pdf
- Colt, J. S., Baris, D., Stewart, P., Schned, A. R., Heaney, J. A., Mott, L. A., et al. (2004). Occupation and bladder cancer risk in a population-based case-control study in New Hampshire. *Cancer Causes & Control, 15*, 759-769.
- Cook, R. L., Royce, R. A., Thomas, J. C., & Hanusa, B. H. (1999). What's driving an epidemic? The spread of syphilis along an interstate highway in rural North Carolina. *American Journal of Public Health, 89*, 369-373.
- Crouch, D. J., Birky, M. M., Gust, S. W., Rollins, D. E., Walsh, J. M., Moulden, J. V., et al. (1993). The prevalence of drugs and alcohol in fatally injured truck drivers. *Journal of Forensic Sciences, 38*, 1342-1353.
- Dalton, S. (2006). Obesity trends: Past, present, and future. *Topics in Clinical Nutrition, 21*, 76-94.
- Dinges, D. F., Maislin, M. S., Krueger, G. A., Brewster, R. M., & Carroll, R. J. (2005). *Pilot test of fatigue management technologies* (FMCSA-RT-05-002). Retrieved from www.fmcsa.dot.gov/facts-research/research-technology/publications/pilot-test/pilottest-fmt-finalreport.htm
- Drake, C. (2003, April). *Sleep apnea*. Paper presented at the International Conference on Truck Driver Occupational Safety and Health, Detroit, Michigan.
- European Commission. (2006). *Driving time and rest periods* (Regulation No. EC 561/2006). Retrieved from http://ec.europa.eu/transport/road/social_provisions/driving_time_en.htm
- Evans, G. W. (1994). Working on the hot seat: Urban bus operators. *Accident: Analysis and Prevention, 26*, 181-193.
- Federal Motor Carrier Safety Administration. (2005). *Hours-of-service regulations*. Retrieved from www.fmcsa.dot.gov/rules-regulations/topics/hos/hos-2005.htm
- Field, A. E., Coakley, E. H., Must, A., Spadano, J. L., Laird, N., Dietz, W. H., et al. (2001). Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Archives of Internal Medicine, 161*, 1581-1586.
- French, S. A., Story, M., & Jeffery, R. W. (2001). Environmental influences on eating and physical activity. *Annual Review of Public Health, 22*, 309-335.
- Freund, D. M. (1999). *An annotated literature review related to proposed revisions to the hours-of-service regulation for commercial motor-vehicle drivers* (DOT-MC Publication No. 99-129). Washington, DC: Office of Motor Carrier Safety, U.S. Department of Transportation.
- Gadde, K. M. (2005). Endocannabinoid receptor antagonists and other emerging pharmacological strategies for weight reduction. *Current Drug Targets: Cardiovascular & Haematological Disorders, 5*, 549-558.
- Garshick, E., Laden, F., Hart, J. E., & Smith, T. J. (2003). Exposure assessment issues in epidemiology studies on chronic health effects of diesel exhaust. In Health Effects Institute (Ed.), *Improving estimates of diesel and other emissions for epidemiological studies* (pp. 17-26). Boston: Health Effects Institute.
- Guo, J., Kauppinen, T., Kyyrönen, P., Heikkilä, P., Lindbohm, M. L., & Pukkala, E. (2004). Risk of esophageal, ovarian, testicular, kidney and bladder cancers and leukemia among Finnish workers exposed to diesel or gasoline engine exhaust. *International Journal of Cancer, 111*, 286-292.
- Gustavsson, P., Alfredsson, L., Brunberg, H., Hammar, N., Jakobsson, R., Reuterwall, C., et al. (1996). Myocardial infarction among male bus, taxi, and lorry drivers in middle Sweden. *Occupational and Environmental Medicine, 53*, 235-240.
- Hagihara, A., Tarumi, K., & Nobutomo, K. (2002). Grouping participants for tailored worksite weight loss programs: A signal detection approach. *American Journal of Industrial Medicine, 14*, 269-278.
- Hakkanen, H., Psych, L., & Summala, H. (2000). Sleepiness at work among commercial truck drivers. *Sleep, 23*, 49-57.
- Hannerz, H., & Tuchsén, F. (2001). Hospital admissions among male drivers in Denmark. *Occupational and Environmental Medicine, 58*, 253-260.
- Hanowski, R. J., Wierwille, W. W., & Dingus, T. A. (2003). An on the road study to investigate fatigue in local/short haul trucking. *Accident: Analysis and Prevention, 35*, 153-160.
- Harrington, L. (1995). To your driver's health. *Private Carrier, 32*(2), 22-24.
- Hasler, G., Buysse, D. J., Klaghofer, R., Gamma, A., Ajdacic, V., Eich, D., et al. (2004). The association between short sleep duration and obesity in young adults: A 13-year prospective study. *Sleep, 27*, 661-666.
- Hayden D. (2005, April). *Contested landscapes*. Paper presented at the Conference on the History of the Built Environment in North America, Cambridge, Massachusetts.
- Heron, M. P., Hoyert, D. L., Murphy, S. L., Xu, J. Q., Kochanek, K. D., & Tejada-Vera, B. (2009). *Deaths: Final data for 2006*. Retrieved from www.cdc.gov/nchs/data/nvsr/nvsr57/nvsr57_14.pdf
- Holmes, S. M., Power, M. L., & Walter, C. K. (1996). A motor-carrier wellness program: Development and testing. *Transportation Journal, 35*(3), 33-48.
- Hootman, J. M., Macera, C. A., Ham, S. A., Helmick, C. G., & Sniezek, J. E. (2003). Physical activity levels among the general U.S. adult population and in adults with and without arthritis. *Arthritis and Rheumatism, 49*, 129-135.
- Insurance Institute for Highway Safety. (2007). *Fatality facts 2007: Alcohol*. Retrieved from www.iihs.org/research/fatality_facts_2007/alcohol.html
- Järvholm, B., & Silverman, D. (2003). Lung cancer in heavy equipment operators and truck drivers with diesel exhaust exposure in the construction industry. *Occupational and Environmental Medicine, 60*, 516-520.
- Jensen, A., Kaerlev, L., Tuchsén, F., Hannerz, H., Dahl, S., Nielsen, P. S., et al. (2008). Locomotor diseases among male long-haul truck drivers and other professional drivers. *International Archives of Occupational and Environmental Health, 81*, 821-827.
- Kivimäki, M., Virtanen, M., Elovainio, M., Kouvonen, A., Väänänen, A., & Vahtera, J. (2006). Work stress in the etiology of coronary heart disease: A meta-analysis. *Scandinavian Journal of Work, Environment & Health, 32*, 431-442.
- Korelitz, J. J., Fernandez, A. A., Uyeda, V. J., Spivey, G. H., Browdy, B. L., & Schmidt, R. T. (1993). Health habits and risk factors among truck drivers visiting a health booth during a truck trade show. *American Journal of Health Promotion, 8*, 117-123.
- Krueger, G., Brewster, R., Dick, V., Inderbitzen, R., & Staplin, L. (2007). *Commercial truck and bus safety synthesis 15: Health and wellness programs for commercial drivers*. Washington, DC: Transportation Research Board.
- Larkin, M. (2003). Can cities be designed to fight obesity? *The Lancet, 362*, 1046-1047.
- Larsen, D. (2004, July). *Special report: FMCSA links high driver turnover rate to crash incidents*. Retrieved from www.landlinemag.com/Special_Reports/2004/July04/07-02-04%20FMCSA%20speci

- al%20report.htm
- Layne, D. M., Rogers, B., & Randolph, S. A. (2009). Health and gender comparisons in the long-haul trucking industry. *AAOHN Journal*, 57(10), 405-413.
- Liu, Y., & Tanaka, H. (2002). Overtime work, insufficient sleep, and risk of non-fatal acute myocardial infarction in Japanese men. *Occupational and Environmental Medicine*, 59, 447-451.
- Lyznicki, J. M., Doege, T. C., Davis, R. M., & Williams, M. A. (1998). Sleepiness, driving, and motor vehicle crashes. *Journal of the American Medical Association*, 279, 1908-1913.
- Mabbott, N., Foster, G., & McPhee, B. (2001). *Heavy vehicle seat vibration and driver fatigue*. Retrieved from www.infrastructure.gov.au/roads/safety/publications/2001/pdf/Fatig_Trans_8.pdf
- Malinauskienė, V., Theorell, T., Grazulevičienė, R., Malinauskas, R., & Azaravičienė, A. (2004). Low job control and myocardial infarction risk in the occupational categories of Kaunas men, Lithuania. *Journal of Epidemiology and Community Health*, 58, 131-135.
- Martin, B., Church, T., Bonnell, R., Ben-Joseph, R., & Borgstadt, T. (2009). The impact of overweight and obesity on the direct medical costs of truck drivers. *Journal of Occupational and Environmental Medicine*, 51(2), 180-184.
- Mayhew, C., & Quinlan, M. (2001). The effects of changing patterns of employment on reporting occupational injuries and making worker's compensation claims. *Safety Science Monitor*, 5, 1-12.
- McCann, M. (2003, April). *Ready mixed concrete truck drivers*. Paper presented at the International Conference on Truck Driver Occupational Safety and Health, Detroit, Michigan.
- McCart, A. T., Rohrbaugh, J. W., Hammer, M. C., & Fuller, S. Z. (2000). Factors associated with falling asleep at the wheel among long-distance truck drivers. *Accident: Analysis & Prevention*, 32, 493-504.
- McGlothlin, J. (2003, April). *Injuries among beverage drivers*. Paper presented at the International Conference on Truck Driver Occupational Safety and Health, Detroit, Michigan.
- Miyamoto, M., Shirai, Y., Nakayama, Y., Gembun, Y., & Kaneda, K. (2000). An epidemiologic study of occupational low-back pain in truck drivers. *Journal of Nippon Medical School*, 67, 186-190.
- National Association of Truckstop Operators. (n.d.). *NATSO*. Retrieved from www.natso.com/am/Template.cfm?Section=Home
- Occupational Health Clinics for Ontario Workers, Inc. (2005). *Whole body vibration*. Retrieved from www.ohcow.on.ca/resources/handbooks/whole_body_vibration/WBV.pdf
- Orris, P., Hartman, D. E., Strauss, P., Anderson, R. J., Collins, J., Knopp, C., et al. (1997). Stress among package truck drivers. *American Journal of Industrial Medicine*, 31, 202-210.
- Ostbye, T., Dement, J. M., & Krause, K. M. (2007). Obesity and workers' compensation: Results from the Duke Health and Safety Surveillance System. *Archives of Internal Medicine*, 167, 766-773.
- Ouellet, L. J. (1994). *Pedal to the metal*. Philadelphia: Temple University Press.
- Overdrive Staff. (2002, September). *When trouble knocks: Overdrive*, 42. Retrieved from www.etrucker.com/apps/news/article.asp?id=25389
- Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., et al. (1995). Physical activity and public health: A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association*, 273(5), 402-407.
- Quinlan, M. (2001). *Report of inquiry into safety in the long haul trucking industry*. Sydney, Australia: Motor Accident Authority of New South Wales.
- Reed, D. B., & Skeeters Cronin, J. (2003). Health on the road: Issues faced by female truck drivers. *AAOHN Journal*, 51(3), 120-125.
- Roberts, S., & York, J. (2000). *Design, development, and evaluation of driver wellness programs*. Retrieved from www.fmcsa.dot.gov/documents/wellness-1.pdf
- Rodriguez, D. A., Rocha, M., Khattak, A. J., & Belzer, M. H. (2003). Effects of truck driver wages and working conditions on highway safety: Case study. *Transportation Research Record*, 1833, 95-102.
- Rogers, W. (2003, April). *Workers' compensation: Types and cost of injury*. Paper presented at the International Conference on Truck Driver Occupational Safety and Health, Detroit, Michigan.
- Rosa, R. R., & Colligan, M. J. (1997). *Plain language about shiftwork* (DHHS [NIOSH] Publication No. 97-145). Retrieved from <http://origin.cdc.gov/niosh/pdfs/97-145.pdf>
- Rugulies, R., Braff, J., Frank, J. W., Aust, B., Gillen, M., Yen, I. H., et al. (2004). The psychosocial work environment and musculoskeletal disorders: Design of a comprehensive interviewer-administered questionnaire. *American Journal of Industrial Medicine*, 45, 428-439.
- Saltzman, G. M., & Belzer, M. H. (2007). *Truck driver occupational safety and health: 2003 Conference report and selective literature review* (DHHS [NIOSH] Publication No. 2007-120). Retrieved from www.cdc.gov/niosh/docs/2007-120/pdfs/2007-120.pdf
- Scott, A. J. (2000). Shiftwork and health. *Primary Care*, 27, 1057-1079.
- Seidell, J., Kahn, H., Williamson, D., Lissner, L., & Valdez, R. (2001). Report from a Centers for Disease Control and Prevention workshop on use of adult anthropometry for public health and primary health care. *American Journal of Clinical Nutrition*, 73, 123-126.
- Soll-Johanning, H., Bach, E., & Jensen, S. S. (2003). Lung and bladder cancer among Danish urban bus drivers and tramway employees: A nested case-control study. *Occupational Medicine*, 53, 25-33.
- Solomon, A. J., Doucette, J. T., Garland, E., & McGinn, T. (2004). Healthcare and the long haul: Long distance truck drivers. A medically underserved population. *American Journal of Industrial Medicine*, 46, 463-471.
- Sorensen, G., Linnan, L., & Hunt, M. K. (2004). Worksite-based research and initiatives to increase fruit and vegetable consumption. *Preventative Medicine*, 39(2, Suppl.), S94-S100.
- Sorensen, G., Stoddard, A., Hunt, M. K., Herbert, J. R., Ockene, J. K., Avrunin, J. S., et al. (1998). The effects of a health promotion-health protection intervention on behavior change: The WellWorks study. *American Journal of Public Health*, 88, 1685-1690.
- Spiegel, K., Leproult, R., L'Hermitte-Balériaux, M., Copinschi, G., Penev, P. D., & van Cauter, E. (2004). Leptin levels are dependent on sleep duration: Relationships with sympathovagal balance, carbohydrate regulation, cortisol, and thyrotropin. *The Journal of Clinical Endocrinology and Metabolism*, 89, 5762-5771.
- Steenland, K., Deddens, J., & Stayner, L. (1998). Diesel exhaust and lung cancer in the trucking industry: Exposure-response analyses and risk assessment. *American Journal of Industrial Medicine*, 34, 220-228.
- Steenland, K., Silverman, D. T., & Zaebs, D. (1992). Exposure to diesel exhaust in the trucking industry and possible relationships with lung cancer. *American Journal of Industrial Medicine*, 21, 887-890.
- Steptoe, A., & Brydon, L. (2005). Associations between acute lipid stress responses and fasting lipid levels 3 years later. *Health Psychology*, 24, 601-607.
- Stoohs, R. A., Guilleminault, C., Itoi, A., & Dement, W. C. (1994). Traffic accidents in commercial long-haul truck drivers: The influence of sleep-disordered breathing and obesity. *Sleep*, 17, 619-623.
- Stratford, D., Ellerbrock, T. V., Akins, J. K., & Hall, H. L. (2000). Highway cowboys, old hands, and Christian truckers: Risk behavior for human immunodeficiency virus infection among long-haul truckers in Florida. *Social Science & Medicine*, 50, 737-749.
- Taheri, S., Lin, L., Austin, D., Young, T., & Mignot, E. (2004). Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. *PLoS Medicine*, 1, 210-217.
- Tangri, R. P. (2003). *Stress costs: Stress cures*. Victoria, Canada: Trafford Publishing.
- Texas Health Institute. (2006). *Obesity in Texas: Policy implications*. Retrieved from www.dshs.state.tx.us/obesity/pdf/THI_PolicyBrief06.pdf
- Theorell, T., & Karasek, R. A. (1996). Current issues relating to job strain and cardiovascular disease research. *Journal of Occupational Health Psychology*, 1, 9-26.
- Transportation Research Board. (2005). *Does the built environment influence physical activity? Examining the evidence* (TRB Special Report 282). Retrieved from <http://onlinepubs.trb.org/onlinepubs/sr/sr282.pdf>
- Tüchsen, F., Hannerz, H., Roepstorff, C., & Krause N. (2006). Stroke among male professional drivers in Denmark, 1994-2003. *Occupational and Environmental Medicine*, 63, 456-460.
- U.S. Department of Labor (n.d.). *Injuries, illnesses, and fatalities*. Retrieved from <http://data.bls.gov/iif>
- Wakefield, J. (2004). Fighting obesity through the built environment.

- Environmental Health Perspectives*, 112, A616-A618.
- Wing, R. R., Goldstein, M. G., Acton, K. J., Birch, L. L., Jakicic, J. M., Sallis, J. F., et al. (2001). Behavioral science research in diabetes: Lifestyle changes related to obesity, eating behavior, and physical activity. *Diabetes Care*, 24, 117-123.
- Wong, W. C. W., Tam, S. M., & Leung, P. W. S. (2007). Cross-border truck drivers in Hong Kong: Their psychological health, sexual dysfunctions and sexual risk behaviors. *Journal of Travel Medicine*, 14, 20-30.
- Yarnell, J., Yu, S., McCrum, E., Arveiler, D., Hass, B., Dallongeville, J., et al. (2005). Education, socioeconomic and lifestyle factors, and risk of coronary heart disease: The PRIME study. *International Journal of Epidemiology*, 34, 268-275.

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