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# Environmental determinants of obesity-associated morbidity risks for truckers

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## Abstract

**Purpose** – The purpose of this paper is to examine how the transportation environment triggers, exacerbates and sustains truckers' risks for obesity and associated morbidities.

**Design/methodology/approach** – An extensive literature review of PubMed Central and TRANSPORT databases was conducted on truckers' obesity risks and 120 journal articles were identified for closer evaluation. From these, populations, exposures, and relevant outcomes were evaluated within the framework of the broad transportation environment.

**Findings** – Connections between the transportation environment and truckers' risks for obesity-associated comorbidities were delineated, and an original conceptual framework was developed to illustrate links between the two. This framework addresses links not only between the transportation environment and trucker obesity risks but also with other health strains – applicable to other transport occupational segments. Moreover, it provides direction for preliminary environmental-scale interventions to curb trucker obesity. The utilization of this framework further underscores the need for: an appraisal of the health parameters of trucking worksites; assessment of truckers' obesity-risk trajectories, and examination of potential causality between the transportation environment, inactivity and diet-related morbidities; and the development, implementation and evaluation of interventions to mitigate trucker obesity. While there is a geographic emphasis on North America, data and assertions of this paper are applicable to trucking sectors of many industrialized nations.

**Originality/value** – The paper brings to light the influences of the transportation environment on trucker obesity-associated morbidity risks.

**Keywords** United States of America, Commercial road vehicles, Transportation, Occupational health and safety, Regulations, Truck drivers, Obesity, Government policy, Corporate policies, Built environment, Work organization

**Paper type** Literature review

## Introduction

Employment in the trucking sector has been linked to a series of musculoskeletal, gastrointestinal, cardiovascular, and psychophysiological problems (Federal Motor Carrier Safety Administration (FMCSA), 2005). Truck drivers are particularly



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susceptible to a wide array of occupation-induced health conditions, exemplified by high morbidity and mortality rates (Saltzman and Belzer, 2007). The trucking milieu places a plethora of strains on truckers and creates various barriers to overall healthy living (Apostolopoulos and Sönmez, n.d.a), which in turn create risks for excess weight-gain and other health repercussions (Roberts and York, 2000). Due to a limited evidence base on trucker-related health, the role of the transportation environment, which includes government regulations, trucking operations, corporate policies in trucking settings, and the built environment in elevating truckers' risks for obesity and associated morbidities remains largely unknown (Apostolopoulos and Sönmez, n.d.b).

In this paper, we assume that prevalent overweight and obesity and associated morbidities of US truckers are predominantly attributable to the broad transportation environment, which impedes regular sleep patterns that in turn influence metabolic processes and hinders reasonably active living along with prudent food choices (Apostolopoulos and Sönmez, n.d.a, b). The aims of this paper are to examine how the intertwined components and underlying mechanisms of the transportation environment trigger, exacerbate, and increase truckers' risks for obesity and associated comorbidities; put forward a conceptual framework to address the institutional, corporate, and built-environment influences on trucker obesity; and place obesity-related morbidity risks of underserved truckers firmly within the discourse of health promotion. While there is a geographic emphasis on the USA, data and assertions of this paper are applicable to trucking sectors of many industrialized nations.

### **Occupational health risks and associated morbidities of truckers**

The surface transport sector in the USA, encompassing the motor carrier/freight and warehousing subsectors, includes tens of millions of bus drivers, truckers, train conductors, trolley and cable-car drivers, light-rail workers, and mechanics. As far back as 1953, *Lancet* published the "London bus-driver study" explicating connections between low physical activity and coronary heart disease as an occupational outcome among bus conductors (Morris *et al.*, 1953). Over the past half century, strong correlational and some causal links have been established between the work associated with many transport occupations and a series of psychosocial strains, physiological and metabolic disorders, and other morbid conditions (Poulsen, 2004).

Given that trucking is classified among the highest-risk occupations in the USA (Bureau of Labor Statistics (BLS), 2005), workplace conditions not only operate as detriments to truckers' health but also induce unhealthful behavioral patterns that place additional strains on their well-being (Apostolopoulos and Sönmez, n.d.a, b). These conditions and resultant behaviors are mainly attributed to government and corporate policies that define work in loading areas, warehouses, truckstops, and trucks (Apostolopoulos and Sönmez, n.d.a, b). Subsequently, truckers operate in sweatshop conditions "with low wages, long hours, and unsafe and unsanitary conditions" (Belzer, 2000). There is a real void in systematic health data for truckers, namely because the bulk of research on truckers has focussed on issues of public safety linked to accidents and fatal crashes (Krueger *et al.*, 2007). This is understandable to a point, considering that the gamut of transport workers have remained an underserved population. Within this void in systematic data on trucker health, evidence supports that US truckers are at much higher risk than the general population for musculoskeletal strains such as prolapsed vertebral discs (Krause *et al.*, 2004); exposure to carcinogenic substances such as diesel exhaust (Garshick *et al.*, 2003);

respiratory strains such as asthma and reductions in pulmonary function and allergic inflammation (Steenland *et al.*, 1998); psychological distress and psychiatric disorders (İşsever *et al.*, 2002); hypertension, stroke, and ischemic heart morbidity and mortality (Kurosaka *et al.*, 2000); fatal vehicle crashes due to disrupted sleep patterns (Hanowski *et al.*, 2003); substance misuse, risk-laden sexual activity, and gambling (Apostolopoulos *et al.*, 2007); and assaults, robberies, and other forms of violence (Ouellet, 1994).

The foregoing facts are corroborated by US mortality data that show excess proportionate mortality for ischemic heart disease (IHD), acute myocardial infarction (AMI), and lung cancer among short-/long-haul truckers (Robinson and Burnett, 2005).

Further, hospital admission records in Denmark document higher admission rates for truckers due to IHD, cerebrovascular and chronic obstructive pulmonary diseases, lung cancer, and prolapsed cervical discs, compared with other occupations (Hannerz and Tüchsen, 2002). Particularly startling is the short life expectancy of 63 years among unionized drivers in the USA and only 55.7 years among members of the Owner-Operator Independent Drivers Association, compared with 77 for the average American male (CDC, 2006; Saltzman and Belzer, 2007). Despite demonstrated ramifications of ill-health-inducing work conditions, the epidemiology of US trucking has received scant attention. Clearly, the multilevel impacts of trucking on drivers' elevated morbidities and mortality – particularly those linked to obesity-related risks – require more thorough investigation (Apostolopoulos and Sönmez, n.d.a, b).

### **Influences on obesity and associated morbidities**

Nearly 70 percent of American adults are overweight or obese (Flegal *et al.*, 2010), and obesity is linked to a number of metabolic abnormalities and morbid conditions such as sleep-disordered breathing, hypertension, hyper-insulinemia, cancer, and cardiovascular disease. Consequently, with about 400,000 annual preventable deaths, the ramifications of obesity are rapidly overtaking tobacco as the major cause of death (CDC, 2006), with economic costs approaching US\$147 billion annually, exceeding even those of smoking and alcohol misuse (Finkelstein *et al.*, 2009). While most Americans do not get the required amount of physical activity and do not follow nutritional guidelines to maintain sound health, US\$33 billion are spent annually on weight-loss products and services. On average, more than two-thirds of adults try to lose weight or keep from gaining weight, many do not follow guidelines that recommend a combination of fewer calories and more physical activity, and only 15 percent receive advice from a health professional about weight management (CDC, 2005).

While genetic susceptibility is critical in excess weight, a multitude of demographic, psychological, cognitive, emotional, behavioral, and environmental factors influence adults' physical activity and food-choice decisions (Lobstein *et al.*, 2005). Some key correlates of physical activity include self-efficacy, expected benefits and barriers, attitudes, modeling, trends and opportunities, choices between sedentary and active leisure pursuits, and land-use trends (Baker *et al.*, 2000; Bauman *et al.*, 2002). On the other hand, key dietary determinants include self-efficacy, attitudes toward healthy eating, peer pressure, motivation, food addiction, access to fastfood and snacks, emotional distress, trends in food supplies, nutritional and diet trends, and food advertising and pricing (French *et al.*, 2001; Knoop *et al.*, 2004). Environmental factors are particularly critical for trucking worksites that operate under specific institutional

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guidelines (e.g. hours-of-service (HOS) regulations, distribution methods) and within certain physical boundaries, which can, in turn, restrict healthful behavior patterns (Sorensen *et al.*, 2004).

## Methods

The US FMCSA's report on the consequences of the new work-hour provisions for truckers (FMCSA, 2005) and our own research engagement with trucking populations (Apostolopoulos and Sönmez, n.d.c) provided leads for our search in PubMed Central and Transport databases focussing on trucker obesity. PubMed Central, which includes MEDLINE, is the US National Institutes of Health archive for biomedical and life sciences, while TRANSPORT is the premier bibliographic database of transportation research produced by the Organization for Economic Co-operation and Development, the US Transportation Research Board of the National Academies, and the European Conference of Transport Ministers. Keywords and medical subject headings were selected to represent the outcomes (i.e. overweight, obesity, CVD, diabetes, stroke, hypertension, and cancer) and main exposures of interest (i.e. long work hours, shiftwork, sleep deprivation, sedentary lifestyle, occupational stressors, lack of physical activity, and unhealthy diets). The result included the identification of 120 journal articles and reports, representing predominantly cohort and case control studies, as current as 2009, from which populations, exposures, and outcomes were evaluated within the framework of the broad transportation environment.

## Results

The results of the literature review are organized into four themes, as follows: first, formulation and in-depth analysis of the conceptual and actual "transportation environment" and its impact on trucker health; second, delineation of the relationship between the transportation environment and truckers' risks for obesity and associated comorbidities; third, development of an original conceptual framework that addresses links not only between the transportation environment and trucker obesity risks but also other health strains (also applicable to other transport occupational segments); and finally, presentation of environmental-scale interventions to curb trucker obesity.

### *Transportation environment and trucker health*

The broad environment of the North American transport sector – hereafter referred to as the "transportation environment" – is a multidimensional concept that encompasses economic, physical, social, occupational, organizational, and institutional components. It includes truckers' workplaces in their broadest form along with policies and regulations that govern them. The transportation environment is a highly modifiable entity that critically affects truckers' lives, from the air they breathe and food they eat to their sleep patterns and physical activity levels (Apostolopoulos and Sönmez, n.d.c).

Key components of the transportation environment include government regulations, trucking operations, corporate policies that shape trucking settings, the built environment (Apostolopoulos and Sönmez, n.d.c), and economic forces pressing on carriers and truck drivers in an environment of near perfect competition. While these components are discussed below as separate parts, in reality they are inextricably interconnected. Lessons from top-down changes in trucking and their catalytic consequences for truckers over the past two decades have shown that, for improvement measures to be sustainable they must account for the idiosyncrasies of

this complex environment as a whole. For instance, health promotion programs would be ineffective if not tailored to truckers' long work hours and unpredictable schedules and would be inaccessible to most as a result of their constant mobility. A summary of the transportation environment and its potential effects on trucker health, with an emphasis on obesity and associated morbidities is provided in Table I.

*Economic competition and government regulation.* Deregulation and HOS constitute two pieces of legislation that are most relevant to the professional and personal domains of truckers. Until the 1970s, motor carriers operated under federal economic

TE components	Main dimensions of TE 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 lifestyles; 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, truckstops, terminals, and truck cabins	Lack of exercise facilities; poor dietary options; unhealthy and inactive settings and few options; exposure to noise and fumes; constant vibration while driving; irregular and unhealthy dietary options; long and irregular working time	Obesity and high exposure to smoking/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, truckstops, and trucking terminals (design, layout, pedestrian, and walking services, access)	Efficient, safe, and healthy work settings; location, proximity, and accessibility of truckstops/terminals from/to community services/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

**Table I.**  
Overview: transportation environment and trucker health

**Notes:** TE, transportation environment; HOS, hours-of-service; PA, physical activity; CVD, cardiovascular disease; LTL, less-than-truckload; TL, truckload

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regulation, administered by the Interstate Commerce Commission, which kept competition within the industry limited. Administrative deregulation of the late 1970s and the Motor Carrier Act of 1980, which wrote interstate deregulation into law, caused the rapid restructuring of the sector with immeasurable effects on motor-carrier operations and services rendered (Belzer, 2002). Further, the Federal Aviation Administration Authorization Act of 1994 prohibited economic regulation of intrastate trucking as well, further intensifying competition among motor carriers. The effects of deregulation on freight rates, route structures, and labor policies led to greater concentration in the “less-than-truckload” (LTL) and substantial consolidation in the “truckload” (TL) subsectors, which are both explained below (Belzer, 2000), exerting profound impacts on truck drivers’ bargaining power and working conditions (Belzer, 1994).

Truckers who cross state lines are subject to federally mandated HOS regulations that dictate how long they may drive, be on-duty, and rest (FMCSA, 2005); such regulations have been present since the 1930s (Saltzman and Belzer, 2002). As a response to increasing crash fatalities, HOS rules were modified in 2004 with the intent to “allow the human body to operate in accord with its circadian rhythm – a 24-hour cycle in the physiological processes of living beings – and the driver to sleep on the same schedule each day” (FMCSA, 2005). Briefly, HOS provisions allow truckers to drive up to 11 hours within a 14-hour window once on-duty while requiring ten hours off-duty before driving again; and prohibit truckers from driving after they have been on-duty for 60/70 hours in seven or eight consecutive days. An exception in the regulation allows them to restart their eight-day clock after being off-duty for 34 hours (FMCSA, 2005). Based on these provisions, truckers can drive up to 74 hours weekly but can work up to 84 hours with the addition of non-driving duties (FMCSA, 2005; Saltzman and Belzer, 2007). In fact, based on the “reset” and “11th hour of driving” provisions, truckers can reach as many as 77/88 work hours per seven- or eight-day week (FMCSA, 2005).

While trucking has always been a labor-intensive economic sector, deregulation and HOS have led to even longer work hours for drivers, thus “supplying excess labor to the marketplace in what has become a self-perpetuating sweatshop environment” (Belzer, 2000). Layoffs, sharply lower earnings, and the absence of pension, health insurance, and retirement plans have adversely impacted highway safety (Rodriguez *et al.*, 2003) as well as individual trucker health.

*Trucking operations.* Within these federal regulations, trucking operations involve diverse but interconnected components and activities that carry their own weight for truckers’ professional and personal lives (Saltzman and Belzer, 2007). Truck ownership – a factor of utmost significance for truckers’ personal health – separates the sector into “private carriers,” which include trucking operations of manufacturing (e.g. Ford Motor Company) and retail companies (e.g. Walmart); and “for-hire carriers” that haul “TL-sized” (e.g. J.B. Hunt) and “LTL-sized” (e.g. Yellow-Roadway) shipments (a TL shipment weights more than 10,000 pounds). This paper examines primarily the “for-hire service” segment, which is commonly viewed as the trucking industry, and its LTL and TL components. LTL carriers consolidate, haul, and distribute goods via the “hub-and-spoke” system, which is a network of trucking terminals where un/loading at larger hubs takes place for further distribution to more distant and smaller locations. TL carriers usually travel longer distances to move entire shipments directly from origin to destination. Within this division, shippers and consignees that receive freight shipments dominate the market by defining rates, scheduling, and

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providing services, because they have greater bargaining power than carriers; they are the source of business for carriers, and as a result, they maintain powerful market leverage (Saltzman and Belzer, 2007). Similarly, third-party logistics providers as well as freight brokers who match shippers and truckers on an individualized basis are important links in the supply chain. Especially with the increased use of “just-in-time” deliveries, there is immense pressure on truckers to meet tight schedules by working shifts that are oftentimes at odds with their biological cycles (Saltzman and Belzer, 2007).

*Corporate policies in trucking settings.* Because conventional workplace classifications are not fully applicable to trucking, diverse trucking milieus and worksites such as truckstops and truck plazas, trucking terminals, warehouses, other highway facilities (e.g. rest areas), and truck cabs are included in the umbrella-term “trucking settings.” Corporate policies that influence truckers’ professional welfare and health unfold within the public and commercial infrastructure of these settings.

When truckers are not driving, they spend much of their time at truckstops and trucking terminals, which therefore function not only as truckers’ worksites but also as their homes on the road outside of the truck cab (Apostolopoulos and Sönmez, n.d.b). These environments are designed, built, and run by a nationwide network of multimillion-dollar corporations (e.g. PILOT) that cater to a captive market of truckers via a multitude of services, collaborating with transnational franchises (e.g. McDonald’s) and with their own “trucker stores” and restaurant chains (e.g. Iron Skillet) to supply meals and personal and professional goods. Truckstops include food and maintenance amenities (e.g. restaurants, showers, laundromats), truck operation and support services (e.g. repairs, freight brokers), and entertainment, communication, and leisure amenities (e.g. internet kiosks, movie lounges) (National Association of Truckstop Operators (NATSO), 2006). Truckstops are infamous for their poor air quality (e.g. tobacco smoke, diesel exhaust), notoriously unhealthy food (e.g. deep fried foods, fastfood), and scarce opportunities for physical activity (Apostolopoulos and Sönmez, n.d.a, b). Moreover, frequently used equipment at truckstops and terminals along with truck design (e.g. suspension, whole-body vibration) create significant ergonomic and musculoskeletal hazards for truckers. No other aspect of the transportation environment touches upon truckers’ daily lives and health as critically as truckstop and terminal policies, resources, and amenities (Apostolopoulos and Sönmez, n.d.a, b).

*Built environment.* The built environment of trucking, encompasses all physical and spatial aspects of truckstops, trucking terminals, warehouses, and specific types of highway locales (e.g. rest areas) (Apostolopoulos and Sönmez, n.d.a, b). Spatial and physical aspects include land-use patterns, transportation systems, and design characteristics (Handy, 2005) as dimensions of private and public land-use planning. With respect to the built environment of trucking, this paper is interested in how well planned and designed trucking-related built spaces can facilitate an active and healthful life for their principal clients. Key elements involve type, location, design, and layout of trucking workplaces, spatial distribution of human activities, pedestrian and walking facilities and walkable areas, accessibility and proximity to community resources and services, esthetic qualities, and air and water quality. The underlying criteria for evaluating these environments are their ability to promote opportunities for physical activity and healthy dietary patterns. Ideally, the built environment should be efficient, comfortable, affordable, spacious, user-friendly, safe, and representative of a healthful lifestyle. In reality, however, not only are the spatial and physical attributes



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of typical truckstops and trucking terminals inconducive to a healthy lifestyle, they are in fact, filled with oftentimes insurmountable barriers to truckers' healthy choices (Apostolopoulos and Sönmez, n.d.a, b).

*Transportation environment and obesity risks of truckers*

Notwithstanding anecdotal evidence regarding truckers' sedentary lifestyles, unhealthy diets, and excess weight (Apostolopoulos and Sönmez, n.d.a, b), or published reports on the consequences of trucking work environment on truckers' health (Saltzman and Belzer, 2002; FMCSA, 2005; Saltzman and Belzer, 2007), there is no substantiated explanation of how this occupational context aggravates truckers' obesity-associated morbidity risks. Neither the delayed onset of many of these morbidities nor the sector's high turnover rates sufficiently explain why motor-carrier/freight populations have not attracted the research attention they urgently need (Larsen, 2004). It is important to note that when truckers leave the profession, they drop off the radar screen and their ailments become even more difficult to track. Given that diverse factors (e.g. occupational hazards, access to medical care) have a bearing on morbidity and mortality rates in the general population, the transportation environment places truckers in particularly disadvantageous situations vis-à-vis two of the most easily-modifiable obesity correlates: dietary patterns and physical activity.

Truckers appear to suffer disproportionately from certain morbidities directly related to their occupational context and consequential lifestyles. Just as there are inadequate general-health indicators for truckers, there are also insufficient systematic data on truckers' behavioral risk factors with regard to overweight and obesity incidence and prevalence, physical activity rates, dietary patterns, and associated morbidities and mortality. The absence of monitoring of truckers' health presents a major health hazard not only because it perpetuates disparities for this particular working-class population and weakens the implementation of effective interventions, but also because it is very possible for truckers' personal health to affect public health by adversely impacting road safety (Apostolopoulos and Sönmez, n.d.a, b; FMCSA, 2005; Saltzman and Belzer, 2007).

Limited data indicate that 87.3 percent of truckers are either overweight or obese – with 37.7 percent overweight, 43.3 percent obese, and 6.2 percent morbidly obese (Roberts and York, 2000) – compared with a 68 percent combined rate of overweight and obesity among adult men in the general US population (CDC, 2010a). Furthermore, obese drivers (BMI > 30) represent a twofold higher accident involvement rate than their non-obese counterparts (Roberts and York, 2000). While sleep debt may cause metabolic changes that frequently result in weight gain (Gangwisch *et al.*, 2005), baseline obesity is associated with increased risks for sleep-disordered breathing (Hasler *et al.*, 2003).

Biomedical and epidemiological research demonstrate that overweight and obesity are linked to increased morbidities and mortality and identify dietary and physical activity patterns as two of the most reliable correlates of overweight and obesity (Visscher and Seidell, 2001). A balanced diet combined with regular physical activity has the potential to reduce risks for both physiobiological diseases (e.g. heart disease, hypertension, diabetes, cancer) and psychological illnesses (e.g. depression, anxiety) (Bauman, 2004). A wellness program for commercial drivers found fried foods and animal fats to be at the top of truckers' favorite menu selections while on the road, their snacks to include mainly candy, donuts, cookies, and chips, and consumption of five or

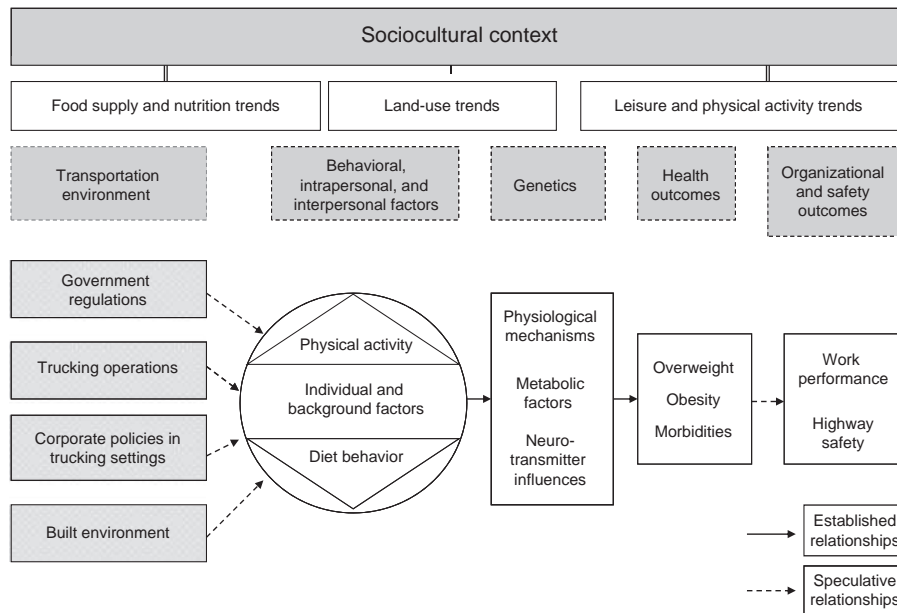
more daily servings of fruits and vegetables by only 15 percent of those studied (Holmes *et al.*, 1996). Consequences of such unhealthful nutritional practices are further exacerbated by an occupation-induced, highly sedentary lifestyle characterized by little to no physical activity and intensified by widespread smoking and alcohol use. The only recorded measurement of observed inactivity among truckers (Korelitz *et al.*, 1993) revealed that 50 percent never participate and only 8 percent regularly participate in aerobic exercise, compared with 25.1 percent of the general US male population that is inactive (Hootman *et al.*, 2003).

Overweight and obesity are well-established risk factors for hypertension, stroke, cardiovascular disease, and diabetes, among others (Sturm, 2005). Hypertension increases risks for stroke, heart disease, diabetes, and some cancers (Bianchini *et al.*, 2002). Despite federal regulations requiring maximum blood pressure levels of 160/90 mmHg for commercial vehicle drivers (Bianchini *et al.*, 2002), data reveal a high prevalence of hypertension among truckers. In a study with a sample of nearly 3,000 truckers attending a trade show, 33 percent had blood pressure above 140/90 mmHg, and 11 percent had above 160/95 mmHg (Korelitz *et al.*, 1993), representing a combined total of 44 percent with elevated blood pressure. A total of 20 percent of drivers sampled in an insurance study and 17 percent of truckers in a sleep-apnea study were found to have blood pressure >160/95 mmHg (Stoohs *et al.*, 1993) (by comparison, only 26.3 percent of males in the US general population have blood pressure >140/90 mmHg; American Heart Association (AHA), 2007a). Further, a strong correlation was found between elevated blood pressure and employment length among Norwegian truckers when compared to other industrial workers (Evans, 1994).

Cardiovascular disease – principally heart disease and stroke – is the leading killer in the industrialized world (AHA, 2007b) involving a complex set of risk factors that are individual (e.g. high cholesterol, hypertension), occupational (e.g. long work hours, physical stressors, shiftwork, and sleep irregularity, deprivation and debt), or lifestyle related (e.g. substance misuse, stress, sedentary lifestyle) (Yarnell *et al.*, 2005). While these risks are frequently induced by occupational and other environmental settings, they are practically inherent to trucking operations. Male professional drivers, including truckers, in Denmark were found to be at increased risk for stroke (Tüchsen *et al.*, 2006), while truckers in Lithuania and Sweden had elevated risks for myocardial infarction due to the primary risk factor of hypertension (Bigert, 2007). Population studies from Sweden and Denmark have also suggested strong correlations between driving occupations and elevated cardiovascular risks (Bigert *et al.*, 2004). Research on industrial workers linked AMI risks to overtime work and insufficient sleep (Liu and Tanaka, 2002), which are both experienced by US truckers due to HOS regulations. Further, chronic partial sleep loss – a combined outcome of circadian-cycle violation and excess weight, which are both prevalent among truckers – was also associated with adverse cardiovascular effects (Alvarez and Ayas, 2004). An epidemiological study with 450,000 Canadian men of various occupations corroborated that truckers faced higher death risks than other men did, not only from non-alcohol cirrhosis, motor-vehicle accidents, cancer (e.g. colon, laryngeal, and lung) and diabetes, but also for ischemic heart disease (Aronson *et al.*, 1999).

*Transportation environment and trucker obesity: ecological conceptual framework*

A conceptual framework grounded in a synergy of social cognitive and ecological theories, which explicates relationships between the transportation environment and factors influencing truckers' obesity risks, is illustrated in Figure 1. A tenet central to



**Figure 1.**  
Ecological conceptual  
framework: transportation  
environment and  
trucker obesity

both perspectives is that behavior and environment are reciprocal systems with bidirectional influences (Glanz *et al.*, 2002; Macintyre and Ellaway, 2000). As noted in the context of the transportation environment, several intrapersonal (e.g. short-/long-haul driver), interpersonal (e.g. peer pressure regarding junk food), and environmental (e.g. limited choice of healthful foods at truckstops) factors influence healthy eating and active living and ultimately, trucker health. Simply stated, while the transportation environment shapes, maintains, and constrains truckers' behaviors, this work environment can potentially be created or changed by truckers, stakeholders, and other citizen groups. The section that follows exemplifies the key variables and operational definitions of the framework, based the general literature on physical activity and obesity determinants as well as on the transportation environment and its repercussions for trucker obesity.

Sociocultural context encompasses those broad societal, governmental, and market forces that influence truckers' nutritional choices and physical activity patterns. These forces shape resources, infrastructure, and individual access at highways, truckstops, trucking terminals, and other trucking settings. Three such overarching factors are food supply and nutrition trends, physical activity trends and opportunities, and urban development policies and planning (French *et al.*, 2001).

Broadly viewed transportation environment includes truckers' workplaces, their infrastructure, institutions, and policies that govern them, as well as ramifications for truckers' lives. It includes economic competition, government regulations, trucking operations, corporate policies in trucking settings, and the built environment. Predicated on mounting anecdotal information but little empirical evidence, these underinvestigated dimensions of the transportation environment emerge as critical determinants of the patterns of truckers' health behaviors and increasing morbidities.

Behavioral, intrapersonal, and interpersonal factors describe truckers' personal and occupational characteristics that have the potential to influence their diets and physical activity patterns. They include individual and background factors and determinants of physical activity and dietary behaviors. More specifically, individual and background factors include personal factors, psychological properties, and relationships with primary social groups, and include sociodemographics, behavioral factors, psychosocial factors, personal and family health history, and spatial and temporal attributes. Physical activity determinants include parameters that have the potential to influence trucker involvement in any form of physical activity. They include self-efficacy, expected benefits and barriers, socially supportive environments, cognitive and affective attitudes toward physical activity, modeling, intention to get involved, outcome expectations, and biological factors (Baker *et al.*, 2000; Bauman *et al.*, 2002). Diet behavior factors cover determinants of truckers' adoption of and commitment to healthy diets. Key components are self-efficacy, attitudes toward healthy eating, time constraints, marketing and pricing of food items, knowledge about balanced diet, peer pressure, motivation and perceived benefits, junk-food addiction, easy access to fast-food and snacks, intentions to maintain a healthy diet, and emotional distress (French *et al.*, 2001; Knoop *et al.*, 2004).

Genetics oftentimes function as pathways to overweight, obesity, and other morbid conditions and situations. They primarily include physiological mechanisms, metabolic factors, and neurotransmitter influences (CDC, 2010b).

Finally, there are health outcomes and organizational and safety outcomes. The former include primarily overweight and obesity and secondarily cardiovascular disease and associated comorbidities (Apostolopoulos *et al.*, 2010). The latter include mainly work performance (e.g. productivity, psychological strains) and highway safety (e.g. accidents, crashes) (Apostolopoulos *et al.*, 2010). Table II summarizes the main concepts of the framework.

Several of these variables can operate as either mediators or moderators of obesity risks and associated morbidities as well as other health outcomes. While mediators can intervene between predictor and outcome variables, moderators can affect the direction and/or strength of the relationship between variables. This is a critical distinction as it influences research design and operations as well as data analysis (Baron and Kenny, 1986). In this framework, several variables can operate as moderators or mediators, ultimately defining physical activity, eating behaviors, and other health outcomes – and of course, in different contexts, a given variable could be either of the two (Bauman *et al.*, 2002).

The framework presented herein does not constitute the basis for an integrated theoretical approach to the role of the transportation environment in truckers' health behaviors with an emphasis on those that contribute to obesity and associated comorbidities. It does, however, represent a logical step toward the eventual formulation of such a theory because it permits the operationalization of diverse constructs that can be empirically tested. While the primary focus of this concept paper lies in the ways environmental forces influence trucker obesity, Figure 1 represents a comprehensive schema encompassing individual, environmental, and biological dimensions of truckers' obesity-associated comorbidities and other adverse consequences.

*Environmental interventions to curb trucker obesity: preliminary thoughts*

“These lifestyle choices (e.g. heavy smoking, inactivity, poor dietary patterns) are bound to have profound effects on the health and wellness of commercial motor-vehicle

Variables	Operational definitions
<i>Sociocultural context</i>	
Food-supply trends	Low fruit/vegetable intake, processed foods
Nutrition and eating-out trends	Food content, portions and frequency, fast food
Food marketing and pricing trends	TV, nutrition labels, healthy food promotions
Physical activity trends	TV, automobiles, PCs, community resources
Leisure-activity trends	Recreation space, health clubs, home entertainment
Urban and rural development trends	Land use, planning, zoning, public transportation
<i>Transportation environment</i>	
Government regulations	Deregulation, hours-of-service requirements
Trucking operations	Shipping, dispatching, scheduling
Corporate policies in trucking settings	Physical activity resources and food options
Built environment	Land-use design, truckstop layout, proximity
<i>Individual and background factors</i>	
Sociodemographics	Age, race, ethnicity, income, education
Behavioral factors	Alcohol and tobacco use, illicit substance use
Psychosocial properties	Social connectedness, social ties
Personal and family health history	History of obesity risks and chronic diseases
Occupational factors	Work-related stressors, driver characteristics
Spatial and temporal attributes	Trucker pathways, itinerary, location
<i>Physical activity determinants</i>	
Self-efficacy	Truckers' beliefs that they can perform activity
Perceived benefits	Expected positive health outcomes
Supportive environment	Support systems, social capital, networks
Attitude toward exercise	Cognitive and affective attitudes toward outcomes
Modeling	Learning a physical activity from others
Outcome expectancies	Likely outcomes from being physically active
<i>Diet behavior determinants</i>	
Attitudes toward eating	Views regarding healthy eating habits
Emotional distress	Stress, emotional eating, bingeing, comfort food
Time constraints and pricing	Both perceived and actual barriers
Peer pressure	Co-worker pressure to eat/acceptability of junk food
Junk-food addiction	Convenience/flavor of junk foods, eating while driving
Nutrition and diet knowledge	Information about healthy nutrition
<i>Genetics</i>	
Physiological mechanisms	Stomach emptiness/fullness, hunger, bloating
Metabolic factors	Nutrient and vitamin deficiencies, metabolic efficiency
Neurotransmitter influences	Effects of epinephrine, norepinephrine, dopamine
<i>Outcomes</i>	
Primary health outcomes	Overweight, obesity
Secondary health outcomes	Hypertension, hypercholesterolemia, obesity comorbidities
Other outcomes	Absenteeism, occupational hazards

**Table II.**  
Sample variables of  
conceptual framework

drivers and in the Agency's (*Federal Motor-Carrier Safety Administration (FMCSA)*) best judgment may, by themselves, be predictive of higher rates of cancer, cardiovascular disease, diabetes, and back problems" (FMCSA, 2005, bracketed text added). The FMCSA blatantly acknowledges that poor diet and inactivity patterns of truckers are a time bomb ready to explode; however, by equating major health detriments of truckers with "lifestyle choices" it indirectly rejects the effects of the trucking environment on truckers' behavioral patterns and thus removes

responsibility from the transport sector. The foregoing analysis has substantiated that it is mainly interlocking governmental and corporate policies and practices that trigger, exacerbate, and sustain truckers' elevated risks for obesity and associated comorbidities.

Because conventional strategies to mitigate obesity (e.g. stressing the need for changing individual diet and physical-activity behaviors) have not demonstrated long-term effectiveness (Dalton, 2006), the modification of environmental influences on behaviors is a promising new strategy that may be more generalizable, cost-effective, and sustainable than conventional methods (Gadde, 2005). Environmental approaches can utilize policies, programs, and organizational practices to alter the environment so that it promotes healthful behaviors (French *et al.*, 2001). Worksites, in particular, can be feasible and potentially effective settings for the implementation of environmental interventions to promote behavior changes due to their potential for reaching large numbers of individuals (Hagihara *et al.*, 2002).

The imperative need to restructure the trucking sector is obvious, and truckstops and trucking terminals constitute viable venues for reaching truckers and initiating long-overdue interventions for the entire spectrum of the transportation environment. Meaningful collaboration of truck driver unions and trade associations, trucking companies, truckstop corporations, shipping and receiving companies, insurance companies, government, and citizen groups is essential to the success of such programs. Effective interventions, among others, can eventually lead to increased physical activity and improved dietary intakes of truckers. Policies related to sleep and fitness, fitness-center discounts and establishment of worksite gyms, and wellness programs along with greater availability of healthful food choices, portion size reduction, and price incentives for healthier lower-calorie foods in cafeterias and vending machines, or providing point-of-purchase nutrient and calorie information for foods can comprise some initial steps.

Environmental interventions at truckstops and terminals hold the added potential to enhance social support from fellow truckers that can reinforce positive dietary and physical activity behaviors. Work schedules that begin in the middle of the night or early in the morning, shiftwork, long hours and schedules that disrupt sleep patterns, as well as worksite factors such as artificial lighting, uncomfortable temperatures, and lack of clean air may contribute to unhealthy eating habits as well as physical inactivity. Support from truckstop and trucking terminal administration and management, as well as from employees who routinely interact with truckers is an important consideration for the successful implementation of interventions. The organizational and built environment attributes of trucking settings can be used to promote behavior change and to motivate, facilitate, and sustain efforts of truckers to lose weight, prevent weight gain, and/or promote weight management (Institute of Medicine and Transportation Research Board (IOM and TRB), 2005). The numerous benefits of worksite wellness programs include improved morale, reduced turnover, increased potential for recruitment, reduced absenteeism, containment of health-care costs, and overall improved trucker health status.

For even modest changes to be effective, the transportation environment needs to be considered carefully and requires an eventual overhaul. In this framework, an issue of prime importance involves the inhumanely long work hours of truckers. A study by the National Institute of Occupational Safety and Health on the effects of lengthy workshifts (Rosa and Colligan, 1997) concluded that extended workdays and

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workweeks – that exceed eight and 40 hours, respectively – appear to be associated with diminished health, increased injury rates, increased illnesses, or increased mortality. Individuals working long hours generally have a greater risk for unhealthy weight-gain; increased alcohol-use, smoking, health complaints, on-the-job injuries, and fatigue; diminished neuropsychological performance; reduced vigilance on task measures, cognitive function, overall job-performance; as well as slower work and decreased alertness, particularly when they enter the 9-12 hours segment of work. Considering the above comment, it should be remembered that under HOS regulations, millions of North American truckers are permitted to work up to 84 hours weekly, more often than not driving trucks exceeding 80,000 pounds.

### Conclusions

The aim of the foregoing discussion is to shed light on the environmental forces that shape individual behaviors of the working-class populations of the motor-freight/ carrier and warehousing sectors. This paper also intends to bring to the fore both the importance and responsibility of government and corporate entities in the health of individual workers within a large occupational segment of the workforce as well as for general public health and safety.

This paper presented a critical review of multidisciplinary literature, an analysis of the role of the transportation environment in trucker obesity, a conceptual framework for addressing connections between the transportation environment and trucker obesity, and considerations for promising interventions in the transportation environment. At the same time, this paper is an urgent call for much needed interdisciplinary empirical work as well as for sustainable intervention programs designed for the entire transport sector.

Within this framework, this paper constitutes the basis for our ongoing research involving the appraisal of health parameters of trucking settings; assessment of truckers' trajectories of obesity risks and examination of potential causality between the transportation environment and obesity-related morbidities; development, implementation, and evaluation of interventions to mitigate trucker risks for obesity-associated comorbidities; and improved understanding of resulting adverse organizational (e.g. work performance) and public-health (e.g. road safety) ramifications. The ultimate goal of this research agenda within the context of this concept paper is the sustainable health promotion of underserved working-class motor-freight populations.

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