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The Obesogenic Environment of Commercial Trucking: A Worksite Environmental Audit and Implications for Systems-Based Interventions

Yorghos Apostolopoulos,[a] Michael Lemke,[a] Sevil Sönmez,[b] and Adam Hege[c]

[a]Texas A&M University; [b]University of Central Florida; [c]Appalachian State University

ABSTRACT

Background: Commercial trucker health is a vital public health concern. Enhanced understanding of the multiplicity, diversity, interdependence, and complexity of policies, resources, and stakeholders relevant to healthful living in trucking worksites can guide future interventions. **Purpose:** This article examines how the environmental attributes of commercial trucking worksites influence truck drivers' opportunities for healthful eating and active living and provides a preliminary discussion on how complexity science can help design more efficacious interventions. **Methods:** A 250-item audit instrument was used to measure the presence of corporate, social, and built environment attributes of 25 diverse trucking worksites that can influence food choices and physical activity of truckers. **Results:** Findings from truckstops, trucking terminals, warehouses, and highway rest areas along key transportation routes revealed that these worksites are severely burdened by structural and institutional barriers and essentially represent what can be called *healthy living deserts*. **Discussion:** Comprehensive interventions to address organizational barriers for health-supportive trucking worksites are critical because truck driver health has far-reaching ramifications for drivers and others. **Translation to Health Education Practice:** Because traditional worksite wellness programs for truckers have had limited success, the application of complex systems methodologies has an increased potential to advance high-leverage, sustainable intervention configurations.

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Background

Healthy eating and physical activity both have a critical bearing on the obesity pandemic as well as the associated comorbidities and escalating health care costs.[1–3] With working adults in mind, obesity-related health promotion efforts targeted for worksites offer distinct advantages.[4] Because workers spend nearly half their waking hours at work and also consume a significant amount of their food intake there, addressing nutrition behaviors and physical activity through workplace interventions can have substantial impacts.[5,6]

Commercial truck driving is replete with health risk factors, because millions of drivers operate in an excessively "obesogenic" and ultimately pathogenic work environment containing numerous risk factors for the development of obesity.[7,8] Trucking worksites include truck cabs where truckers spend the great majority of their time, truck stops, trucking terminals, warehouses, and highway rest areas. Work and personal lives for many truckers are inextricably linked, because they spend nearly all of their time on the road in one or another component of the foregoing worksites.[7] The amount of time a trucker spends in these settings can range from a few minutes to multiple days and vary by worksite type, their hours-of-service used, and characteristics of a given load. Whereas employees of other occupations leave their worksites at the end of their shifts, truckers spend most of their off-time at or around worksites, often eating and sleeping in their truck cab.

Commercial trucker health is a vital public health concern. Commercial truckers are facing a burgeoning health crisis: they have disproportionately high obesity and obesity-attributable comorbidities; greatly diminished life expectancies; and an elevated accident risk, which poses a threat to the safety of the motoring public.[8–12] The current organization of trucking leaves drivers vulnerable to problems inherent in the milieux of their worksites—clearly revealing a burgeoning health crisis for truckers.[12] Unfortunately, responses among trucking industry stakeholders to this crisis are typically reactive and focused on the individual and fail to address those structural factors that induce or regulate obesity risks, including worksite-level factors that have potential to promote healthier living.[13,14] There have been few

CONTACT Michael Lemke Michael.Lemke@hlkn.tamu.edu Department of Health and Kinesiology, Texas A&M University, 4243 TAMU, College Station, TX 77843.

interventions that have targeted the advancement of commercial driver health, which have shown positive outcomes and significant potential; unfortunately, most are underfunded, fragmented, and narrow in scope and thus unable to mitigate the daunting array of barriers for drivers to engaging in and sustaining healthful eating and regular physical activity patterns.[7,14,15] Enhanced understanding of the multiplicity, diversity, interdependence, and complexity of policies, resources, and stakeholders relevant to healthful living in trucking worksites can guide future interventions and assure their efficacy.

Purpose

The purpose of this study was to examine the resources and barriers of trucking worksites that can influence the health behaviors of millions of North American motor-freight workers. These resources and barriers can inform best practices, so that health professionals can be better prepared to design interventions to enhance health protection and health promotion of this occupation. Grounded in ecosocial[16] and social contextual[17] theories, we (*a*) examine how trucking worksites' environmental attributes influence truckers' opportunities for healthful eating and active living and (*b*) provide a preliminary discussion on how complexity-science principles can advance the generation of more efficacious intervention configurations.

Methods

Audit instrument

The Healthy Trucking Worksites Audit Instrument (HEATWAI) was used to assess the health-promotive attributes of trucking work environments.[18] The HEATWAI is a 250-item instrument, with 5 summary scales and 15 subscales, which uses observation to measure the presence of corporate, social, and built environment attributes of trucking worksites that influence food and physical activity patterns of truckers. Baseline interrater reliability analysis produced a kappa = 0.87 ($P < .001$), 95% confidence interval (0.760 – 0.980).[7,8]

The Healthful Food Environment summary scale (HEFE) measures the presence of healthful food options in conventional (25 items) and fast food (18 items) restaurants, vending machines (50 items), and convenience stores (21 items), as well as resources in lunch breakrooms (14 items). Because highway rest areas do not have restaurants, food establishment evaluation was carried out only at trucking terminals, warehouses, and truckstops.

The Active Living Environment (ACLE) summary scale assesses the availability of resources that facilitate physical activity on surrounding grounds (13 items) and the built environment (14 items), resources and facilities that encourage physical activity (19 items), and exercise and fitness facilities (19 items). In our evaluation of exercise facilities, overall we did not anticipate the availability of many such resources at trucking terminals, warehouses, and highway rest areas. Highway rest areas do, however, provide ample walking paths and other recreational opportunities more often than not. Due to the volume of truckers passing through and amount of time spent at truck stops, we had anticipated some type of exercise room, resistance equipment, or equipment used for cardiovascular exercise in a space even if not dedicated exclusively to fitness. In evaluating resources that encourage physical activity, we recorded outdoor pedestrian, walking, or running trails; outdoor paths, lanes, rack spaces, lockers, or rentals for bicycles; in/outdoor recreational facilities or playgrounds, such as table tennis or pool tables, basketball, tennis, or racquetball courts; showers, lockers, weight scales, laundry machines, and/or spas; and resources that encourage sedentary behaviors (e.g., video arcades). To evaluate the physical and built environment, we recorded the presence of open green space, vegetation, well-maintained landscaping, perceived safety, freedom from noise, and absence of diesel fumes, among others.

The Health Information Environment (HEIE) summary scale records all visible print media with potential to motivate weight management in the form of healthful eating (8 items) and physical activity (7 items). To evaluate print media, all bulletin boards, notices, postings, posters, brochures, and fliers with educational messages on nutrition/diet, weight management, or physical activity were recorded. The Health-Supportive Social Environment (HESE) summary scale measures the social environment related to food (9 items) and physical activity (9 items). Finally, the Health-Supportive Community Environment (HESCE) summary scale measures the healthfulness of areas surrounding worksites—critical for truckers' decisions regarding food (11 items) and physical activity (13 items). Table 1 provides an overview of all HEATWAI components.

Each time one worksite characteristic presumed to have positive effects on eating and physical activity of truckers was encountered, points were assigned to that particular category. We created a scorecard to permit a total score for the entire worksite as well as scores for summary scales and subscales. Subsequently, an overall rating was developed to indicate the level of support for healthy living. When a worksite scored 90% – 100% of the maximum possible points, that worksite was deemed to be fully supportive of healthy living; a 75% – 89.9% score was considered mostly supportive; 50% – 74.9% partially supportive; 35% – 49.9%

Table 1. HEATWAI summary scales and subscales.[a]

Healthful Food Environment (128 items)	
HEFE subscale 1 (25 items)	Healthful menu items in restaurants with waiters or cafeteria style
HEFE subscale 2 (18 items)	Healthful menu items in fast food restaurants
HEFE subscale 3 (50 items)	Healthful items in vending machines
HEFE subscale 4 (21 items)	Healthful items in convenience stores and/or mini-marts
HEFE subscale 5 (14 items)	Healthful diet supportive resources in lunch/breakrooms, driver lounges, and picnic areas
Active Living Environment (65 items total)	
ACLE subscale 1 (13 items)	Support for physical/recreational activity in natural environments and surrounding grounds
ACLE subscale 2 (14 items)	Support for physical and recreational activity in built environment
ACLE subscale 3 (19 items)	Resources and facilities that encourage physical and recreational activity
ACLE subscale 4 (19 items)	Exercise and fitness facilities that support physical activity
Health Information Environment (15 items)	
HEIE subscale 1 (7 items)	Evidence of physical and recreational activity promotion
HEIE subscale (8 items)	Evidence of promotion of healthful food choices and eating behaviors
Health-Supportive Social Environment (18 items total)	
HESE subscale 1 (9 items)	Social support for physical and recreational activity
HESE subscale 2 (9 items)	Social support for healthful eating and food options
Health-Supportive Community Environment (24 items total)	
HESCE subscale 1 (13 items)	Physical and recreational activity amenities and opportunities in community
HESCE subscale 2 (11 items)	Healthful food options in community

[a] HEATWAI indicates Healthy Trucking Worksites Audit Instrument; HEFE, Healthful Food Environment; ACLE, Active Living Environment; HEIE, Health Information Environment; HESE, Health-Supportive Social Environment; HESCE, Health-Supportive Community Environment.

scarcely supportive; and <35% not at all supportive of healthy living. The higher the score a worksite received, the more promotive of health it was rated.

Data collection and analysis

Data were collected from 8 truckstops, 8 trucking terminals, 7 warehouses, and 2 highway rest areas—all located in North Carolina in proximity to highways I-85 and I-40. Although truck cabs are a key component of truckers' work environment, because their ergonomics and size are not conducive to active living and foods truckers carry with them are mainly purchased from truck stops, baseline data were not collected from cabs. Research sites were selected based on geographic and corporate representativeness, proximity to the highway, and worksite size. Onsite observation was conducted during daylight hours and lasted an average of 75 minutes per worksite, though not all HEATWAI components were present or applicable at every type of worksite. Data analysis included descriptive statistics and interrater correlation analysis so that key psychometric attributes of the environmental measure HEATWAI could be established. Institutional Review Board approval was granted by the Institutional Review Board at the University of North Carolina – Greensboro.

Results

Resources and options for healthful eating

Food establishments

Conventional restaurants (sit-down, cafeteria/buffet-style) and fast food establishments comprise the core of venues that sell food primarily at truck stops (counted at 3.4 food venues per truck stop). The assessment of restaurants with waiters and cafeterias resulted in a rating of 104 points for the presence of healthful items out of a maximum of 575 possible points—representing 18.1% of support for healthful eating. Few healthful food options (e.g., low-fat items, reduced portions at prices lower than those charged for full portions) and prompts (e.g., visible signs featuring healthy menu items) were recorded (Table 2, Subscale 1). When assessing fast food restaurants, which were only present at truck stops, healthy items received 22 out of a maximum of 144 possible points, which is a low rating of 15.3% in terms of their support for healthful eating. The evaluation of fast food restaurants revealed few healthful food options (i.e., salads, vegetable-based soups) or prompts (i.e., point-of-purchase advertisements for combo meals with vegetables and beverages other than soda; Table 2, Subscale 2).

Vending machines

Vending machines contribute significantly to truckers' nutritional intakes. Offerings include snacks that drivers can use to tide them over until their next hot meal on long workdays (sometimes exceeding 14 hours)—whether at home, a truck stop, or fast food restaurant off the highway. Especially in those settings where restaurants are scarce, vending machines are important. Our evaluation yielded an average of 3.1 vending machines at truck stops, 5.2 at trucking terminals, 4.7 at warehouses, and 7.5 at highway rest areas, where these machines are the only source of food and beverage. From a total of 50 food options representing a maximum of

Table 2. Ratings of trucking worksites for healthful-eating promotive attributes.[a]

HEFE Subscales	Trucking Terminals ($N = 8$)	Warehouses ($N = 7$)	Truck Stops ($N = 8$)	Highway Rest Areas ($N = 2$)	Total Score out of Maximum Possible Score	Rating of Healthful Eating Support[b] (%)
Subscale 1: Conventional restaurants	40	27	37	N/A	104 (575)	18.1
Subscale 2: Fast food restaurants	N/A	N/A	22	N/A	22 (144)	15.3
Subscale 3: Vending machines	65	52	77	31	225 (1250)	18
Subscale 4: Food stores	N/A	N/A	20	N/A	20 (168)	11.9
Subscale 5: Lunch breakrooms	24	19	18	8	69 (334)	20.7

[a] HEFE indicates Healthful Food Environment.
[b] 90%–100% of maximum possible score (fully supportive of healthful eating); 75%–89.9% (mostly supportive); 50%–74.9% (partially supportive); 35%–49.9% (scarcely supportive); <35% (not at all supportive).

1250 points, the actual availability of healthful options received 225 points, or an 18% (not at all supportive) rating for healthful eating (Table 2, Subscale 3). Examples of healthful items included low-fat yogurt, ready-to-eat vegetables, fruit slices, and signs featuring healthy items. Sodas comprised more than 75% of cold drinks, and only 23% of nonrefrigerated snacks could be considered healthful (e.g., dried fruit, nuts).

Food stores

The availability of healthful options at food stores is an important contributor to overall community health. Convenience stores or mini-marts selling food and beverages were located only at truck stops (average of 1.7 stores per truck stop), with more than 85% of the carried items deemed extremely unhealthy options (i.e., hot dogs, chips, doughnuts). The cumulative score of healthful items (i.e., fresh fruit, nuts) available for purchase was 20 out of a possible score of 168 points. This performance provided the lowest rating—11.9%, or not at all supportive of healthful eating (Table 2, Subscale 4).

Lounges

Examples of items promoting healthful eating in lunch breakrooms, lounges, or picnic areas included the presence of microwave ovens, refrigerators, filtered water coolers, and seating areas. The presence of such items achieved 69 out of a maximum of 334 possible points; in other words, a rating of 20.7% (not at all supportive) for healthful eating. These amenities were found to be more readily available at trucking terminals and warehouses but less often at truck stops. Although their availability does contribute positively to maintaining healthful dietary patterns in general, truckers are restricted for logistical reasons from carrying home-cooked food with them or preparing food on the road beyond a sandwich or heating TV dinners. As a result, these amenities are used at best to keep or heat frozen dinners or other processed food items (Table 2, Subscale 5).

Resources and options for physical activity

Exercise facilities

Access to facilities that support physical activity, exercise, and fitness is a critical parameter for potential regular involvement. Out of 23 worksites with over 750 staff that serve several thousand truckers each month, not one had even a mixed-use room that included some form of exercise equipment (e.g., stationary bikes, ping-pong table); space was instead usually dedicated to television lounges and video arcades. Trucking worksites received 0 out of a total 437 possible points, or 0% (not at all supportive) of overall support for physical activity (Table 3, Subscale 1).

Resources that encourage physical activity

The presence of resources that encourage or facilitate physical activity may be the most significant aspect of trucking worksites, because they are the easiest to provide and can represent not only the provision of an essential service to drivers but also profitable enterprises for truck stop companies. We found limited outdoor pedestrian paths, walking or running trails (in only 2 out of 25 observed worksites), outdoor paths, lanes, rack spaces, lockers, or rentals for bicycles (0 out of 25); in/outdoor recreational facilities or playgrounds, such as table tennis or pool tables, basketball, tennis, or racquetball courts (6 out of 25); and showers, lockers, weight scales, laundry machines, and/or spas (18 out of 25). Resources that encourage sedentary behaviors (e.g., video arcades) were observed in 13 out of 25. Trucking worksites scored 126 out of a total 469 possible points, or 26.9% (not at all supportive) for physical activity (Table 3, Subscale 2).

Table 3. Ratings of trucking worksites for physical and recreational activity promotive attributes[a].

ACLE Subscales	Trucking Terminals ($N = 8$)	Warehouses ($N = 7$)	Truck Stops ($N = 8$)	Highway Rest Areas ($N = 2$)	Total Score out of Maximum Possible Score	Rating of Active Living Support[b] (%)
Subscale 1: Exercise and fitness facilities	0	0	0	N/A	0 (437)	0.0
Subscale 2: Resources/facilities encouraging physical activity	24	14	72	16	126 (469)	26.9
Subscale 3: Natural environments/surrounding grounds	24	14	40	16	94 (325)	28.9
Subscale 4: Built environment	40	28	16	4	88 (330)	26.7

[a] ACLE indicates Active Living Environment.
[b] 90% – 100% of maximum possible score (fully supportive of active living); 75% – 89.9% (mostly supportive); 50% – 74.9% (partially supportive); 35% – 49.9% (scarcely supportive); < 35% (not at all supportive).

Physical and built environment

The attributes of the natural environment and surrounding grounds are linked to worksite type.

Truck stops and highway rest areas are often located along highways surrounded by or adjacent to wooded areas or green spaces, whereas trucking terminals and warehouses are mostly located in industrial neighborhoods. Therefore, our assessment of natural grounds revealed that they were not conducive to physical activity. The physical environment scored 94 from a maximum of 325 points, representing 28.9% of total possible support from trucking worksites for some form of physical activity—an environment that is not at all supportive of active living (Table 3, Subscale 3).

The built environment is equally important because it can provide additional opportunities for physical activity. This dimension of trucking worksites is substantial and often includes several adjoining buildings, large parking lots, loading docks, and a high volume of traffic. Most buildings assessed had no more than 2 floors (mean number of floors = 1.6; mean number of buildings = 6.3). Few worksites (17%) had elevators, but those with stairwells had few steps (mean number per worksite = 13). The observed stairwells appeared visible and safe, although not especially appealing and also lacking signage designed to encourage their regular use. Truck stops and rest areas in particular where drivers spend large amounts of time often have few or no stairs and therefore provide no opportunities for use. The built environment scored 88 out of a maximum of 330 possible points, which resulted in only a 26.7% or not at all supportive rating for physical activity (Table 3, Subscale 4).

Resources promotive of healthful living

Social environment

Considering the amount of time spent at the workplace, it can be an ideal setting in which to establish a social environment for fostering a culture of health. In fact, both the perceived and actual support for health-promotive activities within the worksite social space remains among the strongest contributors to individual patterns of physical activity and healthful eating.[19] Workplace policies, coworkers, friends at work, and other networks can define health behaviors.[20] Our assessment of trucking worksites revealed the complete absence of organized, onsite health-promotion activities for nutrition and physical activity, committees to oversee healthy eating programs, wellness committees, and health risk appraisals, among others, from all trucking contexts. The healthful-eating support rating for the social environment received 41 out of a maximum possible 207 points, or 19.8%, and the active-living support rating was the lowest among all subscales—a disappointing 8.2%, or a total score of 23 out of a possible 280 and not at all supportive for either (Table 4, Subscales 1, 2).

Print media

The presence of print and other forms of health protection, promotion, and information media is important to healthful eating, physical activity, and wellness because they have the potential to educate and even influence health behaviors. Health information environments were evaluated and received a score of 44 out of a maximum possible 175 points, or 25.5%, and 24 out of a possible 125 points, or 19.2%—not at all supportive of either healthful eating or active living (Table 4, Subscales 3, 4).

Surrounding communities

Though resources available within the boundaries of worksites hold the strongest potential to sustainably influence health behaviors, surrounding neighborhoods can provide supplemental opportunities. The presence of food stores carrying affordable whole foods and affordable fitness and other recreational resources is also a vital contributor to neighborhood health.[21] Because

Table 4. Ratings of trucking worksites for resources promotive of healthful living[a].

HESE, HEIE, and HESCE Subscales	Trucking Terminals ($N = 8$)		Warehouses ($N = 7$)		Truck Stops ($N = 8$)		Highway Rest Areas ($N = 2$)		Total Score out of Maximum Possible Score		Ratings of Healthful Living Support[b] (%)	
	PA	HE	PA	HE	PA	HE	PA	HE	PA	HE	PA	HE
Subscales 1, 2: Social environment (HESE)	16	13	7	15	0	13	N/A	N/A	23 (280)	41 (207)	8.2	19.8
Subscales 3, 4: Health Information (HEIE)	8	15	0	10	16	18	0	1	24 (125)	44 (175)	19.2	25.2
Subscales 5, 6: Surrounding communities (HESCE)	16	9	14	8	16	11	0	6	46 (325)	34 (275)	14.2	12.4

[a] HESE indicates Health-Supportive Social Environment; HEIE, Health Information Environment; HESCE, Health-Supportive Community Environment; PA, physical activity; HE, healthful eating.
[b] 90%–100% of maximum possible score (fully supportive); 75%–89.9% (mostly supportive); 50%–74.9% (partially supportive); 35%–49.9% (scarcely supportive); <35% (not at all supportive).

communities around warehouses, trucking terminals, and most truck stops are situated in either heavily commercial or economically depressed areas, they have comparatively fewer supermarkets that sell foods needed to maintain a healthy diet but have many more fast food chains than their higher-income counterparts, and they offer scarce opportunities for physical activity that are safe from crime or heavy traffic. Similarly, highway rest areas, which are more often than not geographically and socially isolated, offer next to nothing. Not surprisingly, none of the worksites that were assessed provided easy access to healthful food options, and a lack of perceived safety made unfeasible any attempt to seek out fresh and whole food stores in the surrounding communities. The total score was 34 out of a maximum of 275 possible points, and overall community support was rated only 12.4%, a not-at-all supportive environment for healthful eating. In the same vein, for over 90% of trucking worksites, it was very difficult to access the closest community where fitness or recreational facilities could be found, due to the unavailability of safe walking paths or a public transit system. Communities surrounding trucking worksites scored 46 out of a maximum possible 325 points; an overall community support for resources and amenities for physical activity was found to be only 14.2%—not at all supportive of active living (Table 4, Subscales 5, 6).

Discussion

Structural barriers for health-promotive trucking worksites

Overall, our research revealed that health-supportive resources and options for drivers for healthy eating and physical activity were extremely poor, although differences across various types of worksites do exist. Highway rest areas appear to provide the most support for healthy eating, followed by trucking terminals, truck stops, and warehouses. Similarly, highway rest areas earned the highest active-living support rating, far above truck stops, trucking terminals, and warehouses (Table 5). Though the latter is easily explained, the former is rather surprising but at the same time supports ample evidence of the meager state of healthful food choices in those settings where truckers eat most often. As a whole, these 25 trucking worksites, with an overall poor health-supportive rating of 18.2%, not only do they provide insufficient resources to support physical activity or healthy eating but they either create significant barriers (i.e., pricing, availability) or encourage diets high in saturated fats and calories as well as other processed foods.[12,13,22] The pervasive lack of health-supportive resources reveal trucking worksites to be healthy living deserts; they simultaneously support increased energy intake through unhealthy eating and restrict energy

Table 5. Aggregate active living and healthful eating scores and support ratings by type of trucking worksite[a]

Type of Trucking Worksite	Active Living		Healthful Eating	
	Total Score (out of Maximum Possible Score)	Rating of Active-Living Support[b] (%)	Total Score (out of Maximum Possible Score)	Rating of Healthful-Eating Support[b] (%)
Trucking terminals	128 (760)	16.8	166 (928)	17.9
Warehouses	77 (665)	11.6	131 (812)	16.2
Truck stops	160 (760)	21.1	216 (1,240)	17.5
Highway rest areas	36 (102)	35.3	46 (148)	31.1
All work settings	401 (2,287)	17.5	559 (3,128)	18.9

[a] Overall healthy living support = 18.2%.
[b] 90%–100% of maximum possible score (fully supportive); 75%–89.9% (mostly supportive); 50%–74.9% (partially supportive); 35%–49.9% (scarcely supportive); <35% (not at all supportive).

output by depriving drivers of opportunities to engage in physical activity, ultimately resulting in excess weight gain.

Findings also corroborate the conclusion that commercial trucking remains an overall highly underserved occupation,[13] providing a partial explanation for the 2-fold obesity rates (69%) of truckers compared to 34.9% of the general population,[23,24] their excessively high obesity-related comorbidities,[25] as well as life expectancy 16 years lower than that of the general population.[26] Similar to other blue-collar occupations, truck driving remains highly underserved in terms of access to health-supportive resources, particularly those relevant to engaging in physical activity and healthful eating.[27] These trends have also been corroborated with other segments of the commercial driving occupation. An assessment of urban bus garages in Minnesota found limited availability of grocery stores or restaurants within sight of garages, and only 15% of foods and 26% of beverages available in vending machines met healthful criteria; in addition, bus drivers did not perceive the existence of administrative support for either physical activity or weight management in their worksites.[28] However, unlike trucking worksites evaluated herein, bus garages were found to have some form of fitness resources on site,[28] indicating that truckers may be uniquely underserved among commercial driver segments. Unfortunately, a paucity of studies on health-supportive attributes of transport worksites means that comparative assessments of other relatively similar settings do not exist. The only relevant study reports serious structural barriers for transport workers regarding fruit and vegetable consumption as a result of time pressures, long workdays, irregular shifts, economic pressures, federal regulations, and parking constraints.[27]

These health-adverse characteristics of truck driving, along with a mix of labor, transportation, and corporate policies (i.e., trucking deregulation; pay-by-the-mile; lack of health insurance, sick leave, and paid vacation) have transformed the profession into "sweatshops on wheels."[(p.5)29] These further compound the negative impacts that result from the absence of worksite supports for driver health-promotive behaviors. Because of these institutional limitations as well as the work built environment, access to goods and services outside of worksites is restricted due to practical and logical reasons, thereby creating a captive market of truckers. This is especially the case for truck stops, where drivers spend a great deal of time eating, sleeping, resting, fueling, shopping, doing laundry, completing paperwork, and communicating with friends and family. Truckers are overly dependent on resources provided at worksites, because they have little flexibility in accessing alternative settings or resources on the road, both in terms of time restrictions and inability to park their tractor-trailers wherever they like. Lack of support at worksites for engaging in health-promotive behaviors is often compounded by the excess physical and psychosocial strains that truckers experience. These types of strains often generate coping strategies, such as consuming large quantities of "comfort food" (high in carbohydrates and fats) or remaining sedentary during downtimes due to chronic fatigue, further extending their occupation-endemic sedentariness. Though these are quite understandable considering the difficulties of long-haul driving, these coping strategies simply exacerbate drivers' negative health behaviors.[7,8]

Worksites as complex systems and intervention implications

Despite federal guidelines suggesting that worksites offer comprehensive health promotion programs,[30] the very few such programs that exist in the context of commercial driving are able to reach only a small proportion of drivers and have had limited success.[13] Most interventions to date have been in the form of wellness programs initiated mainly by large trucking companies such as Schneider National, JB Hunt, and Con-Way Freight. These companies have seen reductions in health care costs, compensation claims and costs, accident rates, and driver turnover, as well as reductions in drivers' weight and blood pressure.[14,15] Lately, other stakeholders, including truck stop companies, government agencies, and trade associations, have initiated programmatic efforts to enhance driver health as well.[31]

Despite foregoing efforts, millions of truckers remain excluded from any comprehensive worksite-based programs aiming at the protection and promotion of their health, and hundreds of thousands of truck stops, trucking terminals, warehouses, and truck cabs remain outside of systematic efforts that advance the health-promotive attributes of these settings.[13] Interventions targeting individual drivers are usually small-scale, individual-based, behavior-driven, reactive, and ultimately unsustainable as they do not focus on *the causes of the causes* of drivers' excess chronic syndemicity—predominantly attributable to the interaction of nutritional patterns and work-induced strains.[32] On the other hand, interventions targeting the structural barriers of trucking worksites are in reality nonexistent, and a few such ongoing efforts are slow, superficial, uncoordinated, inadequate, and ultimately ineffective.[13]

Federal labor and transportation policies, food systems, trucking industry regulations, stakeholder capacity, and trucking worksites collectively comprise a

highly complex and dynamic system that operates within other larger complex systems (i.e., social policy, health systems, food production and delivery) that synergistically influence the overall health of drivers. Nested within this complex system, trucking worksites themselves comprise a complex and dynamic subsystem spanning multiple, multilevel, diverse, interacting, and oftentimes reciprocal factors, domains, and mechanisms, while closely interacting with other subsystems, which critically influence the eating behaviors and physical activity patterns of commercial drivers. The few extant individual-based intervention approaches as well as minimal organizational and structural changes in worksites, both aiming at curbing the explosion of obesity-related diseases and their connections to sleep disorders and highway accidents, underestimate this systemic complexity and the complexity of the root causes of driver health problems; hence, interventions have generated merely disappointing and unsustainable results.[32]

Occupational health challenges such as worksites' role in truckers' excess weight gain and associated comorbidities function as complex adaptive social systems (CASS). Within the CASS framework, trucking worksites are composed of many pieces or actors functioning as causal risk domains and interacting with each other in nonlinear ways, the structure of which heavily defines the overall behavior of the entire system—in this case, the health-promotive nature of worksites. Key CASS properties include individuality (where actors are autonomous), heterogeneity (where parts are diverse), interdependence (where elements interact through feedbacks and in nonlinear ways), emergence (where emergence of unexpected phenomena is difficult to predict unless holistically viewing all system elements), adaptation (where systems adjust to changing circumstances), and tipping (where small changes can create disproportionate outcomes).[33–35]

Translation to Health Education Practice

Commercial driver health is particularly impacted by resources and barriers present at worksites. Our findings reveal that trucking worksites are in essence healthy living deserts, which explains not only the disproportionately high obesity burden and chronic comorbidities of drivers but also why transportation workers are included as "the worst occupation" on the national Wellbeing Index.[36] Transport workers scored the lowest for positive physical and emotional health, good work environment, and access to insurance and other basic health resources.

Though interventions for truckers have been limited in scale and success, in this dismal state of affairs for drivers, the conceptualization of trucking worksites as CASS and the application of complex systems methodologies have the potential to offer enhanced, impactful, and sustainable interventions, especially because complexity can be a substantial challenge for the design of interventions. CASS conceptual and analytic procedures can capture elements of interventions that are evasive using more traditional methodologies.[34] The interconnected dynamics of CASS may lead some interventions to overlook potential synergies, or efficacious interventions in a single area may be counteracted by responses elsewhere in the system, or nonlinearity makes prediction very difficult. Within the complexity framework, several tools can help uncover the underlying dynamics of trucking worksites identifying the most critical areas for interventions, where leverage may be best applied for most successful results. These tools center on various forms of statistical, mathematical, and computer-based modeling and simulation such as agent-based modeling, system dynamics modeling, dynamic microsimulation, and so forth.[33] Ultimately, computational and simulation modeling techniques represent a promising avenue to address the systemic complexities of trucking worksites as either health-promotive or -inhibiting settings. These techniques provide "virtual laboratories," where simulations can be conducted to examine potential outcomes of various intervention configurations across time frames often not viable using conventional intervention implementation and evaluation. These tools offer invaluable opportunities to health education practitioners. Computational and simulation modeling can be highly cost-effective and time-saving methods of determining which interventions have the highest potential for success, rather than a series of trial-and-error efforts to test the effectiveness of various interventions on this occupational segment.

References

1. Finkelstein EA, Trogdon JG, Cohen JW, et al. Annual medical spending attributable to obesity: payer- and service-specific estimates. *Health Aff*. 2009;28:w822-w831.
2. Popkin B, Monteiro C, Swinburn B. Overview: Bellagio conference on program and policy options for preventing obesity in the low-and middle-income countries. *Obes Rev*. 2013;14:1-8.
3. Wells NM, Ashdown SP, Davies EHS, et al. Environment, design, and obesity. *Environ Behav*. 2007;39:6-33.
4. Goetzel RZ, Ozminkowski RJ. The health and cost benefits of work site health promotion programs. *Annu Rev Publ Health*. 2008;29:303-323.
5. Larson N, Story M. A review of environmental influences on food choices. *Ann Behav Med*. 2009;38:56-73.
6. Pratt CA, Lemon SC, Fernandez ID, et al. Design characteristics of worksite environmental interventions for obesity prevention. *Obesity*. 2007;15:2171-2180.

7. Apostolopoulos Y, Shattell M, Sonmez S, et al. Active living in the trucking sector: environmental barriers and health promotion strategies. *J Phys Act Health*. 2012;9:259-269.
8. Apostolopoulos Y, Sonmez S, Shattell M, et al. Barriers to truck drivers' healthy eating: environment influences and health promotion strategies. *J Workplace Behav Health*. 2011;26:122-143.
9. Anderson JE, Govada M, Steffen TK, et al. Obesity is associated with the future risk of heavy truck crashes among newly recruited commercial drivers. *Accid Anal Prev*. 2012;49:378-384.
10. Caban AJ, Lee DJ, Fleming LE, et al. Obesity in U.S. workers: the National Health Interview Survey, 1986 to 2002. *Am J Public Health*. 2005;95:1614-1622.
11. Martin BC, Church TS, Bonnell R, et al. The impact of overweight and obesity on the direct medical costs of truck drivers. *J Occup Environ Med*. 2009;51:180-184.
12. Olson R, Anger WK, Elliot DL, et al. A new health promotion model for lone workers: results of the Safety & Health Involvement For Truckers (SHIFT) pilot study. *J Occup Environ Med*. 2009;51:1233-1246.
13. Apostolopoulos, Y. *Work Organization and the Epidemiology of Commercial Driving: From Monocausal to Multilevel Approaches*. Winston–Salem, NC: Center for Worker Health Seminar Series Wake Forest University School of Medicine; 2012;.
14. Krueger GP, Brewster RM, Dick VR, et al. *Health and Wellness Programs for Commercial Drivers*. Washington, DC: Transportation Research Board; 2010.
15. Osland A, Clinch N, Ramsay L, et al. *Wellness Lessons From Transportation Companies*. San Jose, CA: Mineta Transportation Institute; 2011.
16. Krieger N. *Epidemiology and the People's Health: Theory and Context*. New York, NY: Oxford University Press; 2011.
17. Sorensen G, Barbeau E, Hunt MK, et al. Reducing social disparities in tobacco use: a social–contextual model for reducing tobacco use among blue-collar workers. *Am J Public Health*. 2004;94:230-239.
18. Apostolopoulos Y. *Healthy Trucking Worksites Audit Instrument*. Greensboro, NC: The University of North Carolina at Greensboro; 2010.
19. French SA, Harnack LJ, Toomey TL, et al. Association between body weight, physical activity and food choices among metropolitan transit workers. *Int J Behav Nutr Phys Act*. 2007;4:1-12.
20. Barnett E, Anderson T, Blosnich J, et al. *Heart-Healthy & Stroke-Free: A Social Environment Handbook*. Atlanta, GA: Centers for Disease Control and Prevention; 2007.
21. Glanz K, Yaroch AL. Strategies for increasing fruit and vegetable intake in grocery stores and communities: policy, pricing, and environmental change. *Prev Med*. 2004;39:75-80.
22. Whitfield Jacobson P, Prawitz A, Lukaszuk J. Long-haul truck drivers want healthful meal options at truck-stop restaurants. *J Am Diet Assoc*. 2007;107:2125-2129.
23. Ogden CL, Carroll MD, Kit BK, et al. Prevalence of childhood and adult obesity in the United States, 2011–2012. *JAMA*. 2014;311:806-814.
24. Sieber WK, Robinson CF, Birdsey J, et al. Obesity and other risk factors: the National Survey of U.S. Long-Haul Truck Driver Health and Injury. *Am J Ind Med*. 2014;57:615-626.
25. Robinson CF, Burnett CA. Truck drivers and heart disease in the United States, 1979–1990. *Am J Ind Med*. 2005;47:113-119.
26. Ferro AS. Remarks by Anne S. Ferro, FMCSA Administrator. Paper presented at: Sleep Apnea and Trucking Conference; May 11, 2010; Baltimore, MD.
27. Nagler EM, Viswanath K, Ebbeling CB, et al. Correlates of fruit and vegetable consumption among construction laborers and motor freight workers. *Cancer Causes Control*. 2013;24:637-647.
28. Shimotsu S, French SA, Gerlach A, et al. Worksite environment physical activity and healthy food choices: measurement of the worksite food and physical activity environment at four metropolitan bus garages. *Int J Behav Nutr Phys Act*. 2007;4:1-8.
29. Belzer M. *Sweatshops on Wheels: Winners and Losers in Trucking Deregulation*. New York, NY: Oxford University Press; 2000.
30. Partnership for Prevention. Healthy Workforce 2010 and Beyond: an essential health promotion sourcebook for both large and small employers. www.prevent.org/downloadStart.aspx?id=18. Published 2009. Accessed March 9, 2011.
31. Ellin A. A hard turn: better health on the highway. *The New York Times*. December 17, 2011:D1.
32. Apostolopoulos, Y, Lemke, MK, Sönmez, S. Risks endemic to long-haul trucking in North America: Strategies to protect and promote driver well-being. *New Solutions: J of Environ and Occup Health Policy*. 2014;24:57–81.
33. Hammond RA. Complex systems modeling for obesity research. *Prev Chronic Dis*. 2009;6:1-10.
34. Luke DA, Stamatakis KA. Systems science methods in public health: dynamics, networks, and agents. *Annu Rev Public Health*. 2012;33:357-376.
35. Miller JH, Page SE. *Complex Adaptive Systems: An Introduction to Computational Models of Social Life*. Princeton, NJ: Princeton University Press; 2009.
36. Gallup-Healthways. *State of American Wellbeing*. Washington, DC: Gallup, Inc/Healthways, Inc. 2014.