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Mapping U.S. long-haul truck drivers' multiplex networks and risk topography in inner-city neighborhoods

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Abstract

This article illustrates how urban inner-city trucking milieux may influence STI/BBI/HIV acquisition and transmission risks for U.S. long-haul truckers, as well as their social and risk relationships. Using mixed methods, we collected ethnoepidemiological and biological data from long-haul truck drivers and their risk contacts in inner-city trucking milieux in Atlanta, Georgia, United States. Key findings indicate that within the risk-endemic environment of distressed inner-city areas, diverse trucking risk milieux can amplify STI/BBI/HIV risk for multiplex networks of truckers. Inner-city neighborhood location, short geographic distance among risk contacts, and trucker concurrency can potentially exacerbate transmission via bridging higher-risk individuals with lower-risk populations at disparate geographic and epidemiological locations.

Keywords

Geography of risk; long-haul truck drivers; networks; STIs; drugs

Introduction

A multitude of spatial and relationship domains, such as physical and human geography and social networks, can play a pivotal role in facilitating or inhibiting influences on population health (U.S. Department of Health & Human Services, Rothenberg et al., 2005). The health risk and prophylactic behaviors of particularly vulnerable populations engaged in substance misuse and high-risk sexual activity in distressed urban locales are heavily influenced by characteristics of the space and context of their occurrence (Centers for Disease Control and Prevention, 2011).

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Empirical evidence from diverse trucking settings indicates that some North American regional and long-haul truckers engage in risk-laden sexual encounters with women and men that are often combined with illicit substances (Apostolopoulos et al., 2012, Stratford et al., 2007). Although the number of truckers who engage in these behaviors might be proportionally small, their interstate perpetual mobility and engagement in risky sexual behaviors pose risks to others. Truckstop location (i.e., urban), type of sexual transaction (i.e., concurrent sex partnerships), type of sex-cruising setting (i.e., intersection of Internet venues with actual highway rest areas), drug use (i.e., illicit substances particularly combined with sex), geographic and social proximity of sex contacts (i.e., within the same inner-city area), and bridging (i.e., truckers having unprotected sex with casual partners of differential risk while on the road) can have deleterious consequences on truckers' sexually transmitted (STI) and bloodborne infection (BBI) and transmission risk patterns (Apostolopoulos et al., 2011b, Apostolopoulos et al., 2012, Apostolopoulos and Sonmez, 2006).

In the context of drug misuse and STI/BBI/HIV risk, and grounded in syndemics theoretical frameworks (Singer, 2009), this paper intends to: (1) ascertain the risk endemicity of enclaves of U.S. inner cities where long-haul trucking milieux are often located; (2) delineate the spatial and social topography of U.S. inner-city trucking milieux; and (3) discuss how these risk-endemic contexts may render truckers vulnerable to substances and infection, thereby amplifying potential pathogen spread to lower-risk populations and geographies due to truckers' constant mobility. It is worth noting that, while we examine how some metropolitan inner-city locales can facilitate and even amplify STI/BBI/HIV risk for long-haul truckers, we do not assert that most trucking settings share the same risk-conducive characteristics (Apostolopoulos et al., 2012).

How geography and social networks can influence drug misuse and STI/BBI/HIV risk

Contextual and social domains can play a critical role in mediating or moderating influences on population health, while sexual, substance use, and prophylactic behaviors are influenced by the physical and social space in which they unfold (Roux, 2007). Scant attention has been paid to the ways that proximity to risk-laden environments can affect drug misuse and STI/BBI/HIV risk (Macintyre et al., 2002). In the case of long-haul truckers and their social and risk contacts, commercial sex environments (CSEs) public sex environments (PSEs), and relevant Internet sites comprise domains connected with their broad occupational milieux that provide opportunities for both sexual activity and exposure to potential risks (Apostolopoulos et al., 2011b). In recent years, rising STI/HIV prevalence, especially among homosexual and bisexual men, has been partially attributed to increases in unprotected sexual activity at CSEs and PSEs, as well as the emerging role of Internet sex-seeking (Frankis and Flowers, 2006). The Internet has evolved into a social space in its own right, providing opportunities for sexual encounters with persons from geographically and epidemiologically disparate areas (McLelland, 2002).

In the 1990s, a paradigm shift occurred in STI/HIV epidemiology through the incorporation of network dynamics, which facilitated behaviors leading to exposure (Morris, 2004). Key determinants in STI/HIV spread include who partners with whom, how partnerships are

maintained, and the larger networks partners and partnerships are embedded in and are affected by (Laumann et al., 1994). Given that STIs/HIV are predominantly transmitted by behaviors involving intimate contact between infectious and susceptible individuals, the pattern of disease diffusion through populations follows the structure of social networks, as diseases travel along different structural routes (Wasserman and Galaskiewicz, 1994). Social relationships contextualize how susceptible and infectious individuals arrive at sexual contact, as well as individuals' pattern of STI/HIV exposure and transmission and individuals' risk or protective behaviors (Wasserman and Galaskiewicz, 1994). When compared with serial monogamous relationships, concurrent relationships that involve simultaneous contacts with two or more partners who are at high risk for infection are characterized by a higher risk for disease transmission (Morris, 2004). This structural feature of networks presents an important element of the effect they may exert on infection risk (Morris, 2004).

As evidence supports links between substance misuse, multi-partner sexual engagement, unprotected sex, and STIs (Centers for Disease Control and Prevention, 2003), scientists continue to grapple with intricate overlaps among sexual behavior, drug misuse, and STI/BBI/HIV risk patterns. Key explanations for unsafe sex may include psychological distress, need for cognitive escape, sensation seeking, sexual compulsivity, and inadequate social capital, all of which are exacerbated by substance use (Clatts et al., 2001, Mansergh et al., 2002, Galea et al., 2004). These explanations are directly relevant to truckers and their diverse contacts on the road (Apostolopoulos and Sonmez, 2007).

Trucking operations and work-related risks for drivers

Regional and long-haul truckers in North America are susceptible to multiple hazards, which are mainly attributable to their work environment (Apostolopoulos et al., 2011a). Trucking is replete with interconnected stressors for drivers which, not only exacerbate endemic risks associated with the transport sector, but also define driver health (Apostolopoulos et al., 2011a). Key stressors are excessively long workhours, overall strenuous work context, erratic driving schedules and disrupted sleep patterns, chronic social isolation, limited healthcare access, and intense work-life conflicts (Apostolopoulos et al., 2011a, Krueger et al., 2007). These stressors result in chronic and often acute health problems such as psychological distress, depression, hypertension, hyperlipidaemia, cardiometabolic disease, musculoskeletal and pulmonary disorders, and highway accidents and vehicle crashes (Apostolopoulos et al., 2010). Truckers' life expectancy is 16 years lower than the general U.S. male population (Ferro, 2011).

Embedded within a hypermasculine trucking subculture, these interacting strains may induce or exacerbate substance use, sexual risk-taking, and gambling among truckers (Apostolopoulos and Sonmez, 2007). Despite references to men cruising for sex with truckers along U.S. highways in the 1970s (Corzine and Kirby, 1977), the possible connection between truckers, substance use, and sexual risk-taking was not empirically established until a study describing a syphilis outbreak along North Carolina highways in the 1990s (Cook et al., 1999). Evidence from recent research at truckstops in Alabama, Arizona, Florida, Georgia, North Carolina, and New Mexico supports that some long-haul truckers

engage in risk-laden sexual encounters with female sexworkers (FSWs), and other women and men, which are often combined with substances used for relaxation, recreation, or staying awake during long drives (Apostolopoulos and Sonmez, 2006, McCree et al., 2010, Lichtenstein et al., 2008). Truckers at New Mexico truckstops were found positive for HCV (8.5%), anti-HBc (10.4%), chlamydia (1.3%), gonorrhea (0.2%), syphilis (0.2%), and HIV (0.2%), with self-reported marijuana (18.1%), methamphetamine (9.1%), and crack (4.1%) use (Valway et al., 2009).

Methods

Data collection

Grounded in a synergy of ecosocial and syndemics theoretical frameworks (Krieger, 2011, Singer, 2009), we conducted a three-phase ethnoepidemiological research study in Atlanta, Georgia, United States. The overall aim of the study was to delineate the potential role of trucker network dynamics in the acquisition and dissemination of STIs/BBIs.

First, formative research was conducted to reduce fieldwork barriers and ascertain potential pathways of truckers' STI/BBI risk (Sonmez et al., Under review). Using conventional ethnoepidemiological methodological approaches (Schensul et al., 1999, Singer et al., 2000, Sonmez et al., Under review), four observers at various times between 10:00am and 11:00pm conducted non-participant observation, including social and spatial mapping, in and around the four largest inner-city Atlanta truckstops. Social mapping helped to assess the social drivers of risk and populations at risk by collecting information on socioeconomic conditions, risk behaviors, and factors influencing a broad gamut of risks. These activities were also instrumental in identifying key segments of truckers' multiplex (social and risk) networks. Spatial mapping allowed us to delve into the drivers' spatial characteristics of risk, locations, and characterization of locales where risk transactions of members of trucker networks unfold. Spatial mapping helped us understand the geographic distribution of risk settings, establish the physical, social, and economic characteristics of each type of setting, and generate a baseline to examine possible changes in the distribution of settings that may occur as drug- and sex-related risks evolve. Interrater reliability was established by generating consensus between observers on interpretations of raw data and generation of themes. As a result of these procedures, we created physical maps which included key settings, locations, and categories of populations, as well as their location in the physical topography.

Second, four separate focus-group discussions were conducted with 10 long-haul truckers, five FSWs, six drug suppliers, and seven gatekeepers. These individuals constituted the most important population segments vis-à-vis trucker risk. Focus groups themes and questions were pilot tested with one individual from each group. Using systematic and snowball sampling, these individuals were selected based on their intimate knowledge of risk-laden activities involving truck drivers. They were recruited from two of the selected four truckstops (as a result of theme saturation and redundancy in all four settings and truckstop size) for the purpose of uncovering prevalent risk domains and helping to develop interview guides to be used in the final phase of the study. Interview guides were pilot tested with one trucker, one FSW, and one gatekeeper.

Lastly, we conducted in-depth, face-to-face interviews with three key population groups to collect network-informed data. We identified one person from one group in each location as a “seed” (initial respondent) to start a connected chain of persons and their contacts using chain-link sampling, a type of respondent-driven sampling (Heckathorn, 1997, Morris, 2004). This was necessitated by the hidden and elusive nature of the population, a characteristic that precludes “top down” sampling (Sonmez et al., Under review). The sample included 60 long-haul truckers, 24 FSWs, and six intermediaries (individuals who facilitate risk transactions between truckers and their multiplex contacts such as pimps and drug dealers), totaling 90 individuals clustered into 11 chains. From these 90 individuals, we also collected blood, urine, and vaginal swab samples. Blood specimens were tested for HIV, HCV, HBV, and syphilis. Urine specimens were tested for chlamydia and gonorrhea; THC, cocaine metabolites and opiates; and pregnancy. Vaginal swabs were given to all FSWs to test for trichomoniasis. Trichomoniasis was not tested in the remaining sample. Informed consent was obtained with participant signatures for which all participants were permitted to use aliases to protect their anonymity, including street names or CB (Citizen's Band) radio “handles.” All serological samples were identified with the aforementioned aliases and assigned study participant numbers. Reports of completed assay results were returned to the project office with the same aliases and numbers; therefore, no legal names were used at any time in order to protect participants' anonymity. The research team delivered STI/BBI/HIV results in-person to local participants and communicated these results via telephone with the drivers who were on the road.

Data analysis

Key categories of collected data include: (a) individual background characteristics such as sociodemographics and trucking, health, and cruising history; (b) sexual and substance-use history and current behaviors; (c) psychosocial factors such as professional pressures, life traumas, coping mechanisms, and mental health challenges; (d) trucker network properties such as dyadic sexual partnerships and relationships with drug contacts; bridging; concurrency of sexual partnerships; and type and strength of relationships and patterns; (e) spatial domains such as truck driving pathways, trucking and cruising milieux, and locales around truckstops; (f) sociostructural issues such as healthcare access, trucking operations, and occupational stressors; and (g) biological specimens.

Ethnographic data were transcribed and entered into NVivo 7 (QSR, 2007) for textual analysis. Preliminary thematic coding was used to establish measures of relationships between truckers and their contacts within various trucking settings. An open coding approach was used to bracket key text sections into themes (Emerson et al., 2011). The nature of the data warranted multilayered coding of text into several themes following the establishment of inter-coder reliability and validity (Manning et al., 1994), which was repeated as new coding categories of inquiry (themes) emerged.

Once preliminary thematic bracketing was completed, analysis aimed to complete four tasks: (1) axial coding and memoing to explore themes and relationships between them for: trucking milieux; engagement of trucker networks with these milieux; sexual behaviors of network members; sexual scripts; relationships and interactions between and among network

members and their consequences; and sexual identity and homophobia; (2) thick descriptions of sexual network settings; (3) explanations of how trucking milieu and conditions influence sexual interactions and drug transactions and expose populations to risk; and (4) conceptual mapping to graphically explore relationships among foregoing factors.

Results and discussion

Production and endemicity of risk in inner-city Atlanta

Social and economic conditions of inner-city areas, such as those in urban Atlanta, may contribute to a risk-enabling environment (Curley, 2005), not only for its permanent inhabitants but also for transient populations, such as long-haul truckers (Apostolopoulos and Sonmez, 2006). Adults living in impoverished areas of inner-city Baltimore with high rates of heterosexual HIV transmission were found to have high rates of partner or suspected partner concurrency, multiple sex partners over the previous year, and spatially assortative sexual partnerships (Gindi et al., 2011). Inner-city African-American adolescents, also living in Baltimore, revealed attitudes accepting of men's participation in concurrent sexual partnerships, even though women preferred monogamous male partners (Andrinopoulos et al., 2006). Tolerance of non-monogamous male partners was promoted by social conditions which encouraged men's involvement in the drug trade, high rates of male incarceration leading to reduced availability of sex partners, and elevated social status of men with multiple female partners (Andrinopoulos et al., 2006).

Research on street sexwork, drug dependence, and elevated STI/HIV risk (Romero-Daza et al., 2003, Strathdee et al., 2008, Surratt, 2007) has highlighted the existence of mutually-reinforcing epidemics in contexts of poverty and powerlessness (Singer, 2009). This research has drawn marked associations between sexwork and experiences of violence, life traumas, exploitation and abuse, homelessness, and mental illness (Baker et al., 2001, Potterat et al., 1998). Homelessness in particular exacerbates vulnerability: homeless or marginally-housed FSWs are more likely than FSWs with more stable housing to engage in riskier sexual activities, with a higher risk associated with those with simultaneous drug use (Kushel et al., 2003, Surratt and Inciardi, 2004).

The geographic proximity of individuals within a risk network in urban Atlanta, regardless of whether individuals know each other or not, along with an increased likelihood of choosing a sexual- or drug-sharing partner from within the network, contributes to HIV endemicity in urban settings (Rothenberg et al., 2005). Compared to less urban areas, heterosexual HIV transmission in low-income, inner-city environments disproportionately affects racial and ethnic minorities, and may be exacerbated by reduced healthcare access, underutilization of HIV prevention and testing resources, as well as high rates of substance use and incarceration (Centers for Disease Control and Prevention, 2010). In the Atlanta zip codes with the highest HIV prevalence, the use of public transportation (implying longer geographic distance) was a protective factor for men (Rencher, 2012)—corroborating the importance of social and geographic distance in STI/HIV acquisition.

The state of Georgia ranks sixth highest in cumulative AIDS and gonorrhea cases, third highest in syphilis cases, and thirteenth highest in chlamydia cases among all U.S. states (STD Testing Atlanta, 2012). Seventy seven percent of all reported Georgia STI cases involved urban residents of metropolitan Atlanta (Georgia Department of Public Health, 2008). The Atlanta HIV epidemic is concentrated in one geographic cluster consisting of 157 census tracts centralized in the downtown area. This cluster has characteristics of a generalized epidemic and concentrates more than 60% of existing HIV cases, with 1.34% HIV prevalence rate as compared to 0.32% outside the cluster (Hixson et al., 2011). It is worth reiterating that this inner-city cluster is marked by excess poverty along with high proportions of African-American inhabitants, injecting drug-users, and men who have sex with other men (Apostolopoulos and Sonmez, 2006).

Topography of trucking risk milieux in inner-city Atlanta

Trucking milieux encompass intertwined institutional, policy, cultural, socioeconomic, and physical factors, and these may render truckers and their social contacts vulnerable to multiple risks (Apostolopoulos et al., 2012). Interactions of truckers who frequently use substances and have unprotected and concurrent sexual encounters with multiple partners unfold predominantly within complex highway and trucking milieux (Apostolopoulos and Sonmez, 2006). These environments are polymorphous, consisting of physical or virtual settings with conjoined but distinct topographic, cultural, psychosocial, drug, and sexual cultures; properties; and shared meanings; which are associated with specific contexts, temporal factors, types of risk exchanges and populations, and distinct positions within the broader geography of risk (Apostolopoulos and Sonmez, 2006). Many of these milieux operate as multifactorial risk-enabling environments for truckers and their contacts. The trucking risk milieux in economically-depressed inner-city areas of Atlanta include truckstops and various poverty-stricken locales in their vicinity—all situated in close proximity to interstate highways 20, 85, and 75.

The inner-city neighborhoods around truckstops in this study are situated along Moreland Avenue, Bankhead, and Fulton Industrial Boulevard areas. Such socioeconomically distressed areas are marked with social disorganization and pronounced, racially-driven, economic bifurcation: poverty and joblessness; violence, crime, arrests and incarceration; residential segregation, low-income housing, and homelessness; life traumas, social exclusion, and marginalization; drug trade and abuse; and need-based sex transactions (Curley, 2005). Within this context, settings conducive to sex and drug exchanges are commercial outlets catering to truckers, among others, and include low-budget motels, bars, adult entertainment establishments (video- and book stores, strip- and night clubs, sexshops); fastfood establishments, convenience and liquor stores, and gas stations. At these locations, drug and sex transactions unfold between truckers, drug dealers, pimps, FSWs, and others. Further, dilapidated and abandoned buildings, homeless shelters, vacant lots, and heavily wooded areas often serve as homeless shelters and are regularly frequented by truckers during these transactions. Figures 1 and 2 provide a schematic map and actual photographs of risk-enabling areas surrounding truckstops in inner-city Atlanta neighborhoods. The photographs in Figure 2 depict strip clubs and motels where commercial sex activity takes place, a syringe lying on the ground of the motel's parking lot, and a chain-

link fence bordering a vacant lot, where a hole has been opened in the wire next to the “no trespassing” sign for homeless individuals to enter for shelter or lead to a hidden area for illicit transactions and exchanges (i.e., drug use, sex).

Truckstops, where a gamut of risk exposures for and behaviors of truckers unfold, include tractor-trailer parking lots, several types of food establishments, weigh and brake stations, truck-repair shops, truck washes, video arcades, movie theaters, locker rooms, showers, toilets, laundromats, convenience stores, and other trucker-related amenities. These same amenities are available across most truckstops spanning the U.S.; however, drivers seeking commercial sex and drugs stop strategically at selected truckstops known to offer these—either from prior experience or through word-of-mouth on the Citizens' Band (CB) radio (Apostolopoulos and Sonmez, 2006).

Within specific inner-city Atlanta truckstops characterized by lax security and inadequate police presence, most sex and drug transactions are negotiated, produced, and consumed among various trucker-centered populations in parking lots designated only for trucks—oftentimes the rear and out-of-sight rows and adjacent areas, as well as inside parked trucks. The actual sex acts with FSWs usually take place in the sleeper berths of cabs of trucks parked in these same rear rows of parked trucks, often referred to as the “party row,” or at nearby motels where rooms are rented hourly (Apostolopoulos et al., 2012). Figure 3 presents photographs from a typical truckstop in inner-city Atlanta.

A stark contrast to the risk-enabling trucking milieu in inner-city Atlanta, there also exist other trucking settings that may facilitate or exacerbate truckers' STI/BBI risks. Near the town of Casa Grande, Arizona, two rural truckstops at the junction of Interstates 10 and 8 were adjacent to vacant lots, fast-food restaurants, and motels, with commercial sex and drug activities involving truckers having occurred mainly in a run-down motel and around two parking lots across from the truckstops (Apostolopoulos and Sonmez, 2007). Highway rest areas with public toilets and picnic areas surrounded by wooded areas have also been implicated in sex cruising for truckers by truckchasers, which are known as “lollipop havens” by both groups (Apostolopoulos et al., 2011b, Hollister, 1999). Highway weigh-stations and fuel-stops, urban trucking terminals and warehouses, and various legitimate (e.g., mechanical services) and dubious (e.g., adult entertainment) off-road establishments catering to truckers have also been associated with drug and STI/HIV risk among long-haul truckers (Apostolopoulos and Sonmez, 2007). Finally, since late 1990s, the Internet has provided long-haul truckers with a new risk space as the result of increasing connectivity from trucks and other road establishments. Sexual encounters initiated in virtual space offer male sex cruisers unprecedented opportunities to arrange in-person meetings with them that are further facilitated by truckers' mobility (Apostolopoulos et al., 2011b).

Multiplex networks of truckers in inner-city Atlanta

This paper introduces a multimodal, multiplex urban network of interlinked groups, with long-haul truck drivers as hubs, expanding an earlier trucker typology (highway cowboys, old hands, Christian truckers, and old-married men) (Stratford et al., 2000), while corroborating other trucker network studies (Apostolopoulos et al., 2011b, Apostolopoulos et al., 2012). Within this urban and social geography of trucking risk space of Atlanta,

trucker networks can be sorted into four broad, loose categories—risk suppliers, risk consumers, intermediaries, and peripheral players.

These are not fixed classifications; especially for suppliers and consumers in particular, there exists a fluidity and oftentimes bidirectionality of risk (Apostolopoulos et al., 2012). In such cases, especially in the case of interactions between truckers and FSWs, issues of gender relations and gender inequality are also relevant; as a result, truckers may be perpetrators of risk themselves. Gender relations of power are the root causes of gender inequality, which are harmful for both men's and women's health (Sen & Östlin, 2008). Gender inequality influences who is exposed or vulnerable to disease (Sen & Östlin, 2008). For example, in the United States, masculinity is related to risk-taking, as men are less likely to engage in risk-mitigating health behaviors and more likely to hold beliefs and engage in behaviors that increase risks (Courtenay, 2000). Health-supportive behaviors and beliefs are construed by some men as aligning with feminine ideals; thus, by rejecting them, these men are imposing their own masculinity (Courtenay, 2000). In the context of female sex workers, risk is frequently imposed upon the sex workers themselves, particularly from male customers who do not engage in condom use. Asserting individual agency to ensure that male customers use condoms during sex transactions is critical in protecting sex workers from health risks, and circumstances may render female sex workers vulnerable to non-condom use, such as being new to a community or lack of awareness of worker protocols, such as agreeing to any requests from customers (Shannon et al., 2008). Further, the customer-sex worker dyad constitutes a forum for men to affirm their own masculinity, sexual ability, and sexual desirability to women (Huysamen & Boonzaier, 2014).

Female sex workers described this bidirectional risk among consumers and suppliers in the current study. One sex worker explained, “I've met a few truckers ... who don't want to use condoms, they won't have sex with if you use ... some of them don't want to have sex with condoms.” Another sex worker described their ability to assert individual agency to ensure condom use during sex transactions:

It's when they go to offering to pay not to use a condom, that I have a problem, okay. I had a guy offer me \$2000, and I'm gonna tell you exactly what I told him. Just what I told him is if you're willing to pay me \$200, you're already sick, you know it, and you're trying to take me with you. \$200 is not worth my life sugar ... When they're willing to offer you that much money, there's a reason.

Risk suppliers peddle or offer sex services or illicit substances to truckers in inner-city Atlanta and include two key groups: (a) *female sexworkers*, who work at truckstops (often referred to as “lot lizards” due to their movements between parked tractor-trailers), out of nearby motels or bars, or as street walkers and hustlers, and mainly solicit truckers because they are known to have money; and (b) *drug suppliers*, who work primarily out of surrounding neighborhoods and sell to truckers, FSWs, and others. Other risk suppliers include men who have sex with truckers. These individuals, who may identify as gay, bisexual or straight, include primarily *truckchasers*, who cruise for truckers mainly at highway rest areas, adult bookstores, Internet sites, bars and motels. These individuals also include *male sexworkers* and *Internet sex cruisers* (Apostolopoulos and Sonmez, 2006).

Risk consumers are mainly truckers who purchase illicit substances and sex services to consume, either alone or with locals when they seek company. They fall into three key groups: (a) *straight truckers*, who engage in risk-filled sex transactions with FSWs in their truck cabs or nearby motels, or with local “regular girlfriends,” oftentimes accompanied by wide-ranging substances; (b) *straight-identified closeted truckers*, who have sex with other men but show great care to avoid these behaviors in these trucking settings due to overt homophobia among drivers; and (c) *bisexual truckers*, who, due to overt homophobia among drivers, may engage in sex transactions with FSWs demonstrate heterosexuality,. *Openly gay* and *bisexual truckers* have also been identified as members of sexual networks of long-haul truckers in the continental U.S. (Apostolopoulos et al., 2011b), but were not encountered in this study.

Intermediaries hustle and hawk various services and goods and link risk suppliers and consumers by facilitating, negotiating, mediating, or brokering exchanges of drugs and sex services (Apostolopoulos and Sonmez, 2007) in inner-city Atlanta locales. They include five key groups: (a) *pimps*, who broker and negotiate sex transactions with FSWs and oftentimes other services in and around truckstops; (b) *polishers*, predominantly male transient homeless persons, who buff and polish the chrome details of trucks; (c) *lumpers*, who load and unload trucks and sometimes travel with drivers for certain periods; (d) truckstop *hustlers*, who are regularly involved in facilitation and consumption of illicit substances and other risk transactions; and (e) *drug pushers and runners*, who broker drug sales and make drug deliveries. While intermediaries bring these populations together, they also function in various capacities among themselves and with peripheral players in risk-related capacities. Other studies have also shed light on *MSM-site webmasters and moderators* who create and promote virtual fora to bring together truckers and sex cruisers (Apostolopoulos et al., 2011b).

Finally, **peripheral players** serve various functions within the risk geography of inner-city Atlanta trucking milieu. They include: (a) *local and transient homeless persons* and *migrant workers*, who hustle and develop symbiotic relationships with truckstop operations for their survival, including drug and sex services; and (b) *trucking and warehousing employees*, such as individuals working in trucking and shipping companies (dispatchers), truckstops (waitresses, security guards), rest areas (attendants), and other highway settings. In addition to these groups found in inner-city Atlanta trucking milieu, *hitchhikers*; *other social, sexual, and drug contacts of truckers at home and along road settings*; *relationship partners of truckers* in disparate geographic settings; *female truckchasers*; and *even female truckers*, have been identified as members of long-haul truckers' multiplex networks (Apostolopoulos and Sonmez, 2006).

While this taxonomy conveys the archetypal trucker multiplex categorization within inner-city Atlanta trucking milieu, in reality several of these populations, simultaneously or interchangeably, serve multiple roles that are distinct, partial, or multiple. The features of these roles hold potential to exacerbate STI/BBI/HIV risk transmission to other populations (e.g., truckers' spouses) and geographic locations (e.g., inner-city trucking settings in other cities). Figure 4 presents the interlinked social and risk networks of long-haul truckers identified in Atlanta trucking settings (populations in boxes denote the full gamut of trucker

multiplex networks identified in other settings but not encountered in the Atlanta trucking milieu).

Risk-enabling locales, trucker networks, and disease risk

Of the entire network of 90 individuals from the 11 trucker-centered chains (networks) sampled in the inner-city Atlanta trucking milieu, the majority were men, and the majority were African-American. Over 80% of all participants were aged 30-50. Among these 90 individuals, HCV (13.3%) was the most prevalent STI. For both the 60 truckers and 24 FSWs, HCV (10% and 16.6%, respectively) was the most prevalent STI. The overall HIV rate (4.4%) for all 90 network members was higher than the rate for inner-city Atlanta (1.34%) (Hixson et al., 2011), but much lower than HIV rate found in the same overall neighborhoods (13.3%) (Rothenberg et al., 2004). While 2.1% of heterosexuals living in high-poverty U.S. urban areas are infected with HIV, within low-income urban areas in particular, individuals living below poverty line have greater prevalence of HIV than those living above it (2.4% vs. 1.2%, respectively) (Centers for Disease Control and Prevention, 2010). All 90 members of these trucker-centered networks were using one or multiple substances, with crack cocaine (primarily smoked) as the drug of choice. Overall, network members' drug use did not differ markedly based on their STI/BBI/HIV status. These findings have been corroborated by Valway and colleagues (2009), the only other study that has reported U.S. truckers' STI/BBI/HIV prevalence: of 591 male drivers, overall trends were along these lines. This equivalency is profound when taking into account that the data in the current study come from high-risk inner-city environments. Table 1 presents STI/BBI/HIV screening data for truckers, FSWs, and intermediaries.

While Figure 4 presents an illustration of the gamut of truckers' multiplex networks in the risk-enabling trucking milieu of inner-city Atlanta, Figure 5 focuses on one of the 11 actual networks to provide some indicative detail. A description of key properties of this network is provided in Figure 5, as additional detail is beyond the scope of this paper. The seeds (or indexes) for each of the 11 networks were either FSWs or intermediaries because (a) truckers would never have agreed to discuss their illicit tractions without having been referred by their drug or sex contacts (seeds); and (b) they most accurately represented trucker-centered risk exchanges that were the focus of the study (Sonmez et al., Under review). In this sample chain, the seed is a male intermediary, who serves the dual roles of pimp and drug runner working mainly at Fulton Industrial Boulevard, using the street name "Flavor." His 18 social and risk contacts include 13 truckers and five FSWs. One of the FSWs (Contact 11) links this network to another independent network of 14 individuals (through her sexual contact with a truck driver in that network). "Flavor" has sexual, social, and drug-related contacts with FSWs: one FSW (Contact 17) is a regular relationship partner of his while two others (Contact 3 and 13) also sell or run drugs for him.

Tables 2 and 3 present key demographic and attributes of this sample network. Of the 19 individuals comprising this network, five were women, 15 were African-Americans, 11 were in their forties, and five were local inhabitants without stable housing, while all truckers were in a state of constant mobility due to their occupation. All members of this network used various substances. As a result of the network seed's functions, transactions

among members involved only drugs in eight of the cases, only sex in three, and a combination of both in eight. Over the previous three-month period, truckers reported between one and 10 sex partners, while FSWs' partners ranged from 25 to about 200. Only one of the 19 people of the network reported consistent use of condoms. Fifteen people had concurrent sex partnerships, 12 of whom were truckers with sex contacts in different geographic locations. Five individuals (26.3%), all of whom were truckers, tested positive for an STI. The relationship between drug use and STI risk is described by one female sex worker:

I feel like this... get high, get stupid, catch AIDS. 'Cause when you get high, you don't give a fuck what it takes, you gonna do it to get the most of it...' specially when they start stuffin'; a lot of smoke in your face...

Conclusions

With about five million regional and long-haul truckers, the configuration of multiplex networks of North American long-haul truckers (including Canadian truckers since they also drive in the continental U.S.) and their infection and transmission risk comprise an epidemiological, methodological, and analytical challenge. Little is known about differences between truckers and other individuals who use trucker-centered settings for risk-laden sex and drug transactions and the degree to which these risk-enabling, inner-city environments trigger or facilitate certain psychosocial or physiological mechanisms.

Trucking space is heavily subject to geographic and situational influences, as well as contextual variations. This baseline assessment has attempted to elucidate the impact of geographic and social factors on STI/BBI/HIV risk, as truckers' sexual and drug exchanges are clearly shaped and constrained by their broad working milieux. High rates of concurrent sexual mixing of truckers sampled in these inner-city trucking milieux, as well as the occupation-induced bridging, have the potential to amplify initial (possibly few) infections as they link individuals of disparate social and epidemiological settings, potentially creating larger connected components that may function like a road network enabling pathogens to travel efficiently to multiple destinations.

The multiplex networks of long-haul truckers in inner-city Atlanta are exposed to multiple risk exposures and sources within and around these urban milieux. Geographic and social proximity of truckers' risk partners—closely connected in depressed urban areas—appears to be another contributing factor to maintaining endemicity of risk and infections within the area. These findings lend themselves to the development and potential utilization of a spatial risk index (Rothenberg et al., 2005) with respect to risk influences associated with trucking contexts. The Trucking Milieux Risk Index, a composite construct of the relative risk in trucking milieux, may incorporate variables such as location type (e.g., urban vs. rural), police and security presence, presence of FSWs and pimps, availability of and ease of access to drugs, presence of low-income housing, and presence of hourly-rate motels.

Insights from this baseline assessment can also shed light on pathways that may link trucking operations, social and spatial environment of truckers, and STI/HIV outcomes. As trucker behavior alone does not explain infection risk and must be examined within wider

mutually-reinforcing contexts, a relatively small proportion of truckers and their contacts who practice risk behaviors, frequently change partners, and demonstrate high STI rates can contribute disproportionately to infection dissemination. A syndemic approach can enhance the understanding of determinants of risk, which may assist in the development and implementation of risk reduction interventions that incorporate the entire risk network of truckers, as well as situational and structural influences.

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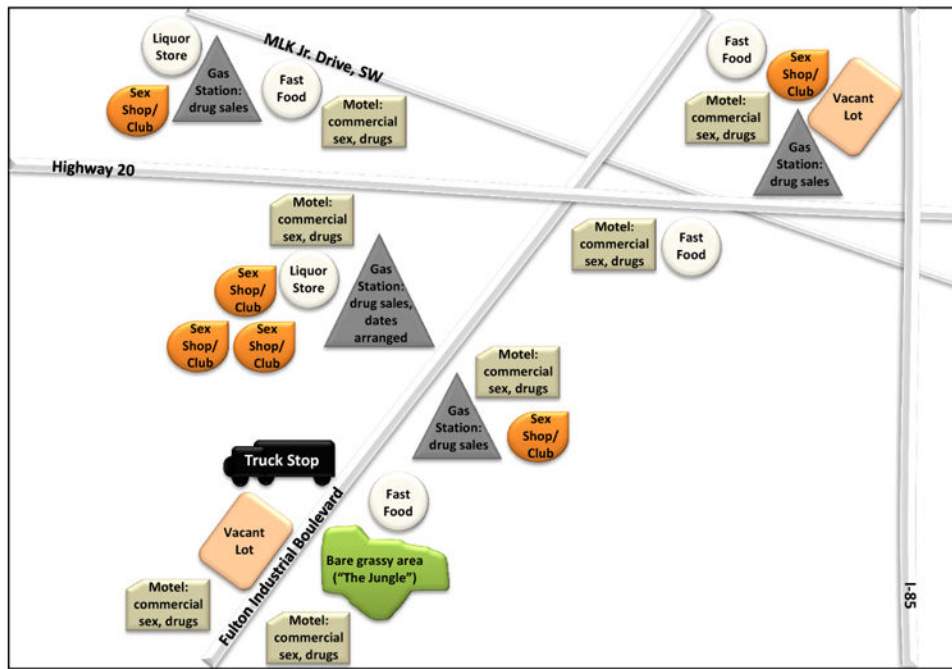


Figure 1. Schematic illustration of trucking risk milieux in inner-city Atlanta, Georgia.

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Figure 2.
Actual risk-enabling trucking milieux in inner-city Atlanta, Georgia.



Figure 3.
Trucking settings near Moreland Avenue, Atlanta, Georgia.

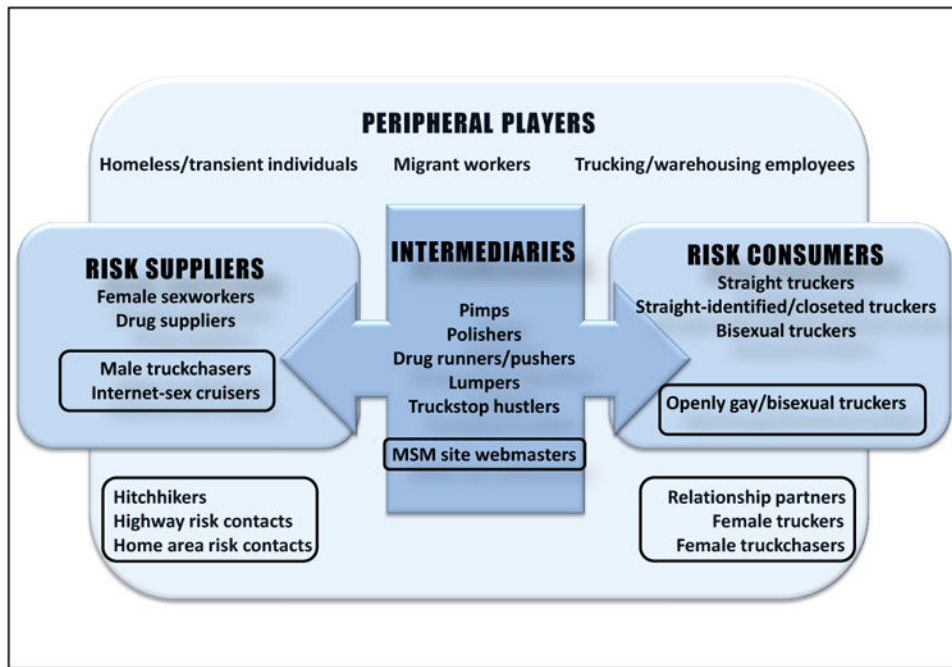


Figure 4. Truckers' multiplex networks in inner-city Atlanta, Georgia (roles noted in boxes exist beyond the Atlanta study sites).

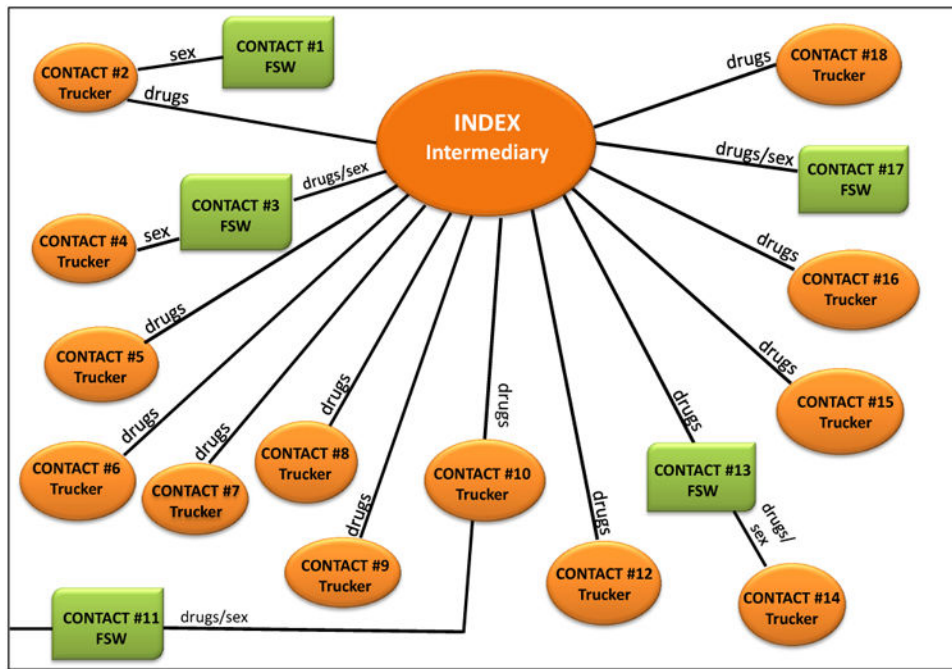


Figure 5. Single cluster within actual multiplex network of truckers in inner-city Atlanta.

Table 1
STI/BBI Prevalence among Trucker Network Members in Inner-City Atlanta Trucking Milieux

Serological Tests	Truckers (N = 60)	Female Sexworkers (FSWs) (N = 24)	Intermediaries (N = 6)	Total Infection Prevalence (N = 90)
Hepatitis B Virus (HBV)	1 (1.7%)	0 (0%)	0 (0%)	1 (1.1%)
Hepatitis C Virus (HCV)	6 (10%)	4 (16.7%)	2 (33.3%)	12 (13.3%)
Syphilis	2 (3.3%)	2 (8.3%)	1 (16.6%)	5 (5.5%)
Chlamydia	1 (1.7%)	1 (4.1%)	0 (0%)	2 (2.2%)
Gonorrhea	0 (0%)	1 (4.1%)	0 (0%)	1 (1.1%)
Human Immunodeficiency Virus (HIV)	2 (3.3%)	2 (8.3%)	0 (0%)	4 (4.4%)
Trichomoniasis	N/A	1 (4.1%)	N/A	1 (4.1%)
Herpes Simplex Virus Type 2 (HSV-2)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Table 2
Key Demographics of Sample Trucker Network, Fulton Industrial Boulevard, Atlanta

Contact (C)	Role	Gender	Race	Age	Life Traumas	Health Insurance	Location/Mobility
Index ("Flavor")	P/DR	M	AA	40	Divorce, Financial	Yes	Local/Motel
C1	SW/DR	F	AA	47	Incarceration	Free Clinic	Local/Motel
C2	TR	M	AA	47	Child Death	Yes	↑ Mobility
C3	SW	F	AA	34	Child Death	Yes	Local/Motel
C4	SW	M	AA	39	Physical Assault	No	Local/Motel
C5	TR	M	White	33	None	No	↑ Mobility
C6	TR	M	AA	42	None	No	↑ Mobility
C7	TR	M	AA	41	Parent Death	Yes	↑ Mobility
C8	TR	M	AA	44	Death in Family, Financial	Yes	↑ Mobility
C9	TR	M	White	35	Divorce, Financial	Yes	↑ Mobility
C10	TR	M	AA	45	No	Yes	↑ Mobility
C11*	SW	F	AA	40	Death in Family	No	Local/Motel
C12	TR	M	AA	48	Death in Family	Yes	↑ Mobility
C13	SW	F	Mixed	36	Mental Health	Yes	Local/Motel
C14	TR	M	White	50	Financial	Yes	↑ Mobility
C15	TR	M	AA	41	Separation	Yes	↑ Mobility
C16	TR	M	AA	47	Death in Family, House Fire	No	↑ Mobility
C17	SW	F	AA	59	Separation, Violence	Yes	Local/Motel
C18	TR	M	AA	33	Separation	Yes	↑ Mobility

Note: TR = Trucker, P = Pimp, DR = Drug Runner, AA = African American

* Links to another network cluster

Table 3
Partner and Relationship Attributes of Sample Trucker Network, Fulton Industrial Boulevard, Atlanta

Contact (C)	Sex Partners	Transactions in Network	Drug Use	Type of Sex	Condom Use	STI Status	Concurrent Relationship
Index ("Flavor")	1	Sex/Drugs	CC	N/A	N/A	Negative	No
C1	48	Sex/Drugs	CC	V, A, O	Inconsistent	Negative	Yes
C2	4	Sex	CC, C, A	V	Inconsistent	Negative	Yes
C3	25	Sex	C, M	V, A, O	Inconsistent	Negative	Yes
C4	~100	Sex/Drugs	CC	V, A	Inconsistent	Negative	Yes
C5	1	Drugs	CC	V	Inconsistent	Negative	No
C6	1	Drugs	CC	A	No	HIV, Syphilis	No
C7	2	Drugs	CC	O	No	HCV	Yes
C8	3	Drugs	CC	V, O	All	Negative	Yes
C9	1	Drugs	CC, M	N/A	No	HSV1, HSV2	No
C10	3	Sex/Drugs	CC, M	O	Inconsistent	Negative	Yes
C11*	~200	Sex	CC	V, O	Inconsistent	Negative	Yes
C12	3	Sex/Drugs	CC, M	V, O	Always	Negative	Yes
C13	~60	Sex/Drugs	CC, A	V, O	Always	Negative	Yes
C14	3	Sex/Drugs	CC	V, A, O	Inconsistent	HCV	Yes
C15	3	Drugs	CC	V, O	Inconsistent	Negative	Yes
C16	2	Drugs	CC, PC	V	No	Negative	Yes
C17	10	Sex/Drugs	CC	V, O	Inconsistent	HCV	Yes
C18	~20	Drugs	CC, S	N/A	Inconsistent	Negative	Yes

Note: CC = Crack Cocaine, C = Cocaine, PC = Powder Cocaine, M = Marijuana, A = Alcohol, S = Speed

Note: V = Vaginal Sex, A = Anal Sex, O = Oral Sex

* Links to Another Network Cluster