Occupational health risks and intervention strategies for US taxi drivers

Kate E. Murray^{1,2,*}, Abdimalik Buul³, Rasheed Aden^{4,5},
Alyson M. Cavanaugh⁶, Luwam Kidane⁷, Mikail Hussein⁸,
Amelia Eastman², and Harvey Checkoway²

¹School of Psychology and Counselling, Queensland University of Technology, Brisbane, Australia, ²Department of Family Medicine and Public Health, University of California San Diego, La Jolla, California, USA, ³Rossier School of Education, University of Southern California, Los Angeles, California, USA, ⁴School of Counseling, Southwestern College, Chula Vista, California, USA, ⁵Community Based Block Program, San Diego State University, San Diego, California, USA, ⁶Joint Doctoral Program in Public Health (Epidemiology), San Diego State University/University of California San Diego, San Diego, California, USA, ⁷School of Public Health, University of Washington, Seattle, Washington, USA and ⁸United Taxi Workers of San Diego, San Diego, California, USA

*Corresponding author. E-mail: kate.murray@qut.edu.au

Summary

Research has shown that taxi drivers are at risk for numerous health concerns, such as low back and leg pain, linked to their highly sedentary occupation, long work hours and stressors related to the job (e.g. low income, safety threats). The goal of this study was to explore occupational health risks and opportunities for health interventions with taxi drivers using community-based participatory research (CBPR) methods. A mixed methods approach included first a convenience sample of 19 East African taxi drivers participating in focus group discussions. Second, a convenience sample of 75 current taxi drivers (M age = 45.7 years) and 25 non-driver comparison participants (M age = 40.3 years) were recruited to complete a structured self-reported questionnaire and objective measures of health. Health education was provided alongside the research to address common health concerns and to ensure mutual benefit and an action orientation. The focus groups described numerous health concerns that drivers attributed to their occupation, including chronic pain, sleep deprivation, cardiovascular disease, diabetes, kidney disease and eye problems, as the most common. Participants offered ideas for health interventions that include workplace reform and driver education. Quantitative data indicate that 44% of drivers reported their health as 'fair' or 'poor'. Drivers were more likely to report musculoskeletal pain, less sleep, more fatigue and less physical activity as compared to non-drivers. The majority of drivers reported financial and job dissatisfaction. The research provides data to inform targeted health interventions that support the health and safety of taxi drivers.

Key words: inequalities, health promoting environments, community based participatory research, community health promotion, determinants of health

INTRODUCTION

Globally, the travel and tourism industry is estimated to generate \$6 trillion dollars and 120 million jobs (Blanke and Chiesa, 2013). Taxi drivers are a large group of workers in this sector, with 233 000 drivers in the US in 2014 (Bureau of Labor Statistics, 2014). This number is projected to increase by 16% between 2012 and 2022 (Bureau of Labor Statistics, 2014). Given the size and anticipated growth of the sector, driver health and health care disparities have substantial public health implications as the health and safety of taxi drivers is directly linked to the health and safety of passengers, pedestrians and others on the road.

Research has found that drivers are at high risk for a range of health concerns and poor health behaviors. A convenience sample of 751 taxi drivers in Chicago identified numerous health risk factors, including low prevalence of health insurance, limited physical activity and low levels of fruit and vegetable consumption (Apantaku-Onayemi *et al.*, 2012). International epidemiological studies of taxi drivers in Taiwan and Japan have identified elevated prevalence of knee pain (Chen *et al.*, 2004), low back pain (Chen *et al.*, 2005), hypertension (Ueda *et al.*, 1992), gastrointestinal disorders, fatigue and musculoskeletal system disorders (Ueda *et al.*, 1989) as compared to the general population. Long hours of work at a sedentary job are likely contributing factors for these conditions.

The harmful effects of sedentary behavior, above and beyond a lack of physical activity, are documented (Bauman *et al.*, 2013). Sedentary behavior is therefore an important target in health interventions (Chau *et al.*, 2010), although optimal interventions are undetermined. Workplace interventions may be important since a large proportion of sedentary behavior occurs during work hours. Previously identified workplace interventions such as treadmill desks and height adjustable desks are proven to reduce sedentary behaviors (Neuhaus *et al.*, 2014), but are not applicable to taxi drivers. Taxi drivers have unique occupational physical demands. Effective programs in sedentary but non office-based work settings are needed.

In the US, most drivers lease their vehicles, and are therefore considered independent contractors with limited protection provided by federal and state agencies. Specifically, taxi drivers who lease cars are often excluded from accessing health care through the Workers' Compensation System (California Labor Code § 3350-3371, 1937). Furthermore, there is no regulation for working hours for taxi drivers who lease their vehicles. Lease vehicle drivers frequently work long hours and

face stressors related to financial insecurity (Safe Cab San Diego, 2014), which have implications for public safety and the health of the driver. Previous research indicates that San Diego taxi drivers work a median of 71 h per week and take home a median income of less than \$5 per hour after subtracting work-related expenses (e.g. lease payments; Esbenschade *et al.*, 2013).

Long hours at a sedentary job may impose limited opportunities for physical activity. Safety concerns depending on a driver's geographic location and night shift hours have implications for safely engaging in standing or physical activity breaks. Taxi drivers have elevated risk for being victims of homicide while on the job, particularly in cities where safety mechanisms like video cameras are not in place (Menéndez *et al.*, 2013), including San Diego. Therefore, health interventions for taxi drivers must fit within this challenging work schedule and context.

Another important consideration for planning interventions is that the taxi industry workforce typically does not mirror the general population's demographic characteristics, with immigrant men frequently overrepresented (Apantaku-Onayemi *et al.*, 2012). In San Diego, there are approximately 2050 taxi drivers, 70% of whom are East African men (Safe Cab San Diego, 2014). African immigrant men have been largely under-represented in epidemiological research due to aggregated data analyses and limited data collection on country of birth (Venters and Gany, 2011). Furthermore, there are few health programs developed, adapted and/or evaluated specifically for African immigrants.

Efforts are needed to ensure that the community's voice is included in program development and delivery (Murray *et al.*, 2017). Community-based participatory research (CBPR) provide tools and methods to ensure that interventions are culturally meaningful and effective in reaching and improving health in diverse populations (Israel *et al.*, 2005). CBPR approaches emphasize the importance of equitable partnership founded upon mutual respect and benefit throughout the research process (Wallerstein and Duran, 2010). In this way, there is active collaboration from the initial planning, throughout the action phase and into follow-up steps based upon results (de Toledo and Giatti, 2014). In the area of health promotion, such collaborative practices are necessary to ensure programs address shared priorities and support community capacity building and, in turn, address inequalities amongst marginalized populations (Laverack and Keshavarz Mohammadi, 2011). CBPR approaches attempt to overcome shortcomings identified in other research paradigms, such as the privilege afforded to academic knowledge and processes, the lack of sustainability of short-term funding cycles and the limited translation of

programs into real-world settings (Wallerstein and Duran, 2010).

Taxi drivers are a high-risk group for whom there are limited evaluated interventions. This study aimed to use CBPR approaches to effectively engage the community in identifying, prioritizing and implementing health programs within the taxi driver workplace. This article documents the methods utilized to engage the taxi driver workforce and steps taken to integrate public health interventions into the study design to ensure co-benefit during the research process, a fundamental component of CBPR approaches (Israel *et al.*, 2005). There are three primary research aims: (1) identify the health concerns of San Diego taxi drivers; (2) identify perceived barriers to healthy living and, (3) gather recommendations for interventions within this unique work context.

METHODS

The project was initiated by bi-cultural research team members to address the pressing health concerns among the drivers. The research team was formed to include the United Taxi Workers of San Diego [UTWSD; a 501(c) 4 advocacy organization that represents hundreds of taxi drivers in San Diego], bi-cultural researchers, academic researchers with experience in CBPR and occupational health, and an occupational health physician. In establishing the research agenda, the research team met with leadership from UTWSD numerous times to engage representatives from the local taxi workforce to identify topics for inquiry, ensure cultural competency and establish research processes and outcomes. This process included review of the project proposal by the UTWSD's Board of Directors and a vetting process of the study design and materials to ensure that the questions were culturally appropriate and relevant to the taxi workforce. After collaboratively developing the research materials and procedures, Institutional Review Board approval was obtained from the University of California, San Diego's Human Research Protections Program (Protocols 130713 and 140586).

STUDY 1: FOCUS GROUP DISCUSSIONS

A total of 19 male taxi drivers were recruited to participate in focus group discussions in 2013. Focus groups lasted approximately 1.5 h. Drivers were recruited through UTWSD's established networks for communication and dissemination of information. A semi-structured interview guide was followed and the primary questions included items such as 'What changes in your health have you noticed since becoming a taxi driver?',

'What are the challenges that make it difficult to stay healthy on the job?' and 'What are some ways that you currently try to stay healthy?' Guidelines were followed for focus group facilitation and analysis (Krueger and Casey, 2000).

Additionally, drivers completed a brief 1-page survey that elicited basic demographic and occupational information, such as age, years working as a taxi driver, years lived in the US and typical shift worked (i.e. day, night, rotating shift). The three focus groups were conducted at the UTWSD office and scheduled based on preferred days and times for the taxi drivers. Compensation in the form of a \$25 voucher was given to all who participated. Food was provided and selected based on recommendations by UTWSD to ensure it was culturally appropriate (e.g. halal, East African cuisine). A bi-cultural male research team member, fluent in English and Somali, facilitated the focus groups. The focus groups were audio-recorded and subsequently transcribed and translated into English. The preliminary findings from Study 1 were utilized to develop the research questions and to develop health programs delivered in Study 2.

STUDY 2: QUANTITATIVE STUDY

Prior to initiating Study 2, a health fair was held in June 2014 for taxi drivers to provide free health screening services, health education materials, information about enrolling in health insurance programs related to expanded access through the Affordable Care Act, as well as information about the study. The health fair utilized local health clinics and health professional training programs with the University of California San Diego's School of Medicine. Attendees were able to indicate if they were interested in participating in Study 2 and following the health fair, active recruitment for Study 2 began. In this way, the health fair served as a kick-off for Study 2 and illustrates the research team's commitment to mutual benefit throughout the collaborative process.

Seventy-five taxi drivers and twenty-five non-driver comparison participants completed a 30-min questionnaire that was verbally administered by bi-cultural research team members. The questionnaire assessed demographic information, work history (e.g. years as a driver, average hours worked, shift worked), health behaviors (e.g. physical activity, smoking) and self-reported health (e.g. musculoskeletal pain, fatigue, diabetes, mental stress). Height, weight and blood pressure were measured objectively by the research team. At the end of each individual assessment, participants received a \$25 gift-card and picture-based handouts that demonstrated simple stretches that could be done in or near

their taxicab and ergonomic adjustments to support a healthy posture while seated in the taxicab. Research staff reviewed the materials with participants and demonstrated stretches for participants. Driver participants were asked to identify a non-driver peer as a potential participant in the comparison group. After all data collection was completed and preliminary data were analyzed, additional health interventions were developed and disseminated to drivers based on key findings.

DATA ANALYTIC PLAN

Two bi-cultural research team members independently reviewed the final English transcriptions to ensure accuracy. A systematic approach was used to analyze the qualitative data generated from the focus groups (Huberman and Miles, 1994). The systematic analysis of the qualitative data was categorized into two central themes: (1) health concerns linked to occupational hazards; and, (2) barriers to health. The research team developed preliminary coding schemes of recurring themes found in the transcriptions of the focus groups. Following the independent coding into primary themes and sub-themes, the codes and themes were further reviewed and revised by the research team through an iterative process.

For quantitative data, SAS statistical software (v9.3) was used to summarize data distribution, which included frequencies and means for categorical and continuous variables, respectively. For both studies, preliminary findings were shared with UTWSD leadership for review, and ultimately, one-page handouts were prepared for dissemination to participants and UTWSD networks highlighting findings from each study.

RESULTS

Table 1 provides demographic and occupational data available for both studies. The taxi drivers were slightly older in Study 2 (M age = 45.7 years) than the drivers in the focus groups of Study 1 (M age = 40.6 years). Most drivers reported driving for between 6 and 10 years (M years in study 2 = 7.53 years).

Study 1 results

A total of 19 taxi drivers participated in one of three focus groups. The data was categorized into two central themes relating to occupational hazards: (1) chronic disease concerns; and, (2) regulatory and environmental barriers to health. Recommendations by the drivers for health interventions are also discussed.

Chronic disease concerns linked to occupational hazards

Participants identified numerous chronic health conditions linked to their work. The most frequently reported outcome was chronic pain resulting from prolonged sitting. Each of the three focus groups discussed chronic pain as a prominent issue and it was the most frequently referenced health concern in two of the three groups. Participants stated that pain (primarily back and knee pain, and headaches) was something they all experienced at some point as drivers. One driver stated: *'As the driver you're sitting in the same position for hours at a time. Not moving your legs brings about all types of joint pain. You're sitting for 11 h. I'll catch myself walking awkwardly after my shifts end. I'll walk crooked.'*

Another driver reported the stiffness extends beyond work hours. He said: *'At the end of my shift I feel physically tired. By the time I get home I can't even walk around my own house. I experience back pain, fatigue, and headaches.'*

Sleep deprivation was the second most cited occupational health concern and frequently connected to the long hours of work (M = 11.4 h per shift). One driver said: *'I speak for everyone in here when I say that we don't get enough sleep, we are sleep deprived.'* Another driver highlighted how the long hours, financial insecurity and sleep deprivation are inter-related. He said:

'I can work for eight hours, spend time with my family, after that walk or exercise... but with the lease I must work for twelve hours. Sometimes I don't make anything and when I go home, sometimes I am half dead. I am mentally and physically tired. I don't get enough sleep, I don't have any energy. I work those first 8 hours to pay off my lease and gas. The remaining hours in my shift is for whatever goes into my pocket.'

Cardiovascular disease, including strokes and hypertension, were mentioned in all three focus groups. Participants reported multiple deaths within the local taxi workforce being linked to cardiovascular disease. One participant stated that: *'Three Somali men have died in the last two years because of strokes.'* Participants linked their sedentary behavior to issues with blood clotting and stroke as well as increased prevalence of hypertension among drivers.

Similarly, diabetes was raised in all three groups as a health concern that arose after starting to work as a taxi driver. One driver said: *'After a year of starting taxi [driving], I got diabetes.'* Other drivers agreed that high numbers of drivers have diabetes, with one participant referring to a report that the majority of taxi drivers have diabetes. Several drivers linked their increase in sedentary behavior after starting as a taxi driver to weight gain and the onset of diabetes and hypertension.

Table 1: Characteristics of participants in Studies 1 and 2

Focus group participants		
Age, <i>mean</i> $\pm$ <i>SD</i>	40.6 $\pm$ 11.3	
Years driving a taxi		
<2	2 (12.5)	
2–5	4 (25.0)	
6–10	8 (50.0)	
>10	2 (12.5)	
Average work hours per shift, <i>mean</i> $\pm$ <i>SD</i>	11.5 $\pm$ 1.3	
Average work hours per week, <i>mean</i> $\pm$ <i>SD</i>	65.1 $\pm$ 24.9	
Normal work shift		
Day	12 (63.2)	
Night	6 (31.6)	
Rotating	1 (5.3)	
Frequency of exiting cab between fares		
Almost always	1 (5.9)	
Occasionally	9 (52.9)	
Rarely	7 (41.1)	
Survey participants		
	Taxi Drivers (<i>n</i> = 75)	Population controls (<i>n</i> = 25)
Age, <i>mean</i> $\pm$ <i>SD</i>	45.7 $\pm$ 11.9	40.3 $\pm$ 15.8
Education		
Did not complete high school	10 (13.7)	2 (8.3)
High school diploma	30 (41.1)	2 (8.3)
Some college/vocational	23 (31.5)	10 (41.7)
College graduate	10 (13.7)	10 (41.7)
BMI, <i>mean</i> $\pm$ <i>SD</i>	25.8 $\pm$ 4.0	25.2 $\pm$ 3.3
Self-perceived health		
Excellent	7 (9.3)	4 (16.0)
Very Good	15 (20.0)	11 (44.0)
Good	20 (26.7)	8 (32.0)
Fair	24 (32.0)	2 (8.0)
Poor	9 (12.0)	0 (0)
Hypertension, <i>no.</i> (% <i>yes</i>)	19 (26.4)	3 (12.5)
Diabetes, <i>no.</i> (% <i>yes</i>)	18 (25.0)	4 (16.0)
High cholesterol, <i>no.</i> (% <i>yes</i>)	21 (28.4)	5 (20.0)
Musculoskeletal pain, <i>no.</i> (% <i>yes</i>)	53 (74.7)	3 (12.5)
Performs 150 min PA per week, <i>no.</i> (% <i>yes</i>)	10 (14.3)	14 (73.7)
Hours slept per night, <i>mean</i> $\pm$ <i>SD</i>	6.0 $\pm$ 2.2	7.3 $\pm$ 1.7
Smoking status		
Current	11(14.7)	0 (0)
Former	7 (9.3)	2 (10.0)
Never	57 (76.0)	18 (90.0)
Job satisfaction		
Satisfied	5 (6.7)	14 (63.6)
Neutral	10 (13.3)	2 (9.1)
Dissatisfied	60 (80.0)	6 (27.3)
Financial satisfaction		
Satisfied	4 (5.4)	12 (54.6)
Neutral	6 (8.1)	4 (18.2)
Dissatisfied	64 (86.5)	6 (27.3)

(continued)

Table 1: (Continued)

Frequency of depressive feelings		
Not at all	52 (73.2)	22 (88.0)
Several days per month	14 (19.7)	3 (12.0)
More than half of the month	5 (7.0)	0 (0)
Frequency of excessive fatigue		
Not at all	10 (14.5)	18 (78.3)
Several days per month	30 (43.5)	4 (17.4)
More than half of the month	29 (42.0)	1 (4.4)

All values are expressed as number (%) unless otherwise specified.

Abbreviations: PA, physical activity; SD, standard deviation; no., number.

Other health issues raised by participants were dehydration and risk of kidney disease. The drivers reported disincentives to stay hydrated due to the challenges of locating public restrooms and an inability to be away from their cabs. These issues stem from regulations and are discussed in further detail below.

Another health concern reported was related to eye problems and vision loss. Participants stated deterioration in their vision related to their occupation. One driver said: *‘A lot of drivers complain about their eyes. I am not sure if it’s being driving [sic] in the dark or sun-rays. But they are always complaining about their eyes when they get off of work.’* Eye/vision concerns were raised in two of the groups.

Regulatory and environmental barriers to health and occupational hazards

Focus group discussion identified high lease costs, lack of health policies and regulatory policies as occupation-specific barriers to health. When asked about barriers to staying healthy, the most cited theme related to industry regulations. The drivers cited lack of health policies for sick days or other time off work, and high lease costs as the primary contributors to the long hours. In turn, the long work hours resulted in more health problems such as sleep deprivation (described above). Drivers reported that they frequently had to work 7 days per week and 12 h per day in order to meet their lease costs and earn money to take home.

As independent contractors, drivers reported that most were not enrolled in health insurance due to lack of employer-sponsored programs. One driver stated: *‘I don’t have health insurance at the moment. Sometimes I have no choice but to go to the emergency room because I don’t have insurance. After this, the bill is around \$15,000 or \$20,000. When you arrive at the emergency they ask to fill out a sheet. In it are questions that pertain to your insurance status and who your doctor is. Since we*

don’t have insurance or personal doctors, they just give us pain relievers and send us on our way. They don’t diagnose our issues.’

The lack of available bathroom facilities for taxi drivers was mentioned in all three focus groups. It underscores an absence of essential infrastructure for accommodating basic needs during work hours. Participants linked bathroom access to dehydration as well as regulatory policies and discrimination by various businesses. One driver said: *‘If you see some drivers they have water but are afraid to drink it because the line is running, if you drink water you have to leave the cab... the police will give you a ticket.’* Another driver identified a related issue saying: *‘We cannot use the restroom. Also, the [hotels], they bother the taxi drivers. It happened to me. They told me they were going to kick me out if I used their restroom...’*

Issues related to police and ticketing were frequently connected to the city of San Diego’s Ordinance 11, which prohibits taxi drivers from moving away from their vehicle more than a 12-foot radius while in a taxi stand or passenger loading zone ([Codified Ordinance No. 11., 2012](#)). The drivers reported that this restriction instills fear of getting a ticket. One driver said: *‘This still allows drivers to get out and stretch, however. But the thing is, if you cannot walk around you are pretty much sitting in the car.’* Ordinance 11 was mentioned in all three groups as limiting opportunities to reduce sitting as well as other health behaviors, such as using the bathroom.

Recommendations for health interventions

The participants identified two levels for intervention to address their occupational health concerns: individually targeted health programs and education; and, industry-targeted reforms. Several intervention programs were identified, including increasing driver awareness and access to health resources, such as community gyms and

nutrition information for staying healthy on the job. The focus groups highlighted a need for a broader knowledge of health. One driver said: *'One thing is we need public awareness. There are hundreds and hundreds of drivers on the road and they don't have any education. Some people don't think an hour in the gym can have any benefits. We need public awareness for the taxi drivers concerning health.'* Most drivers reported an interest in committing more time to their health and in learning more about healthy eating and physical activity. They recommended partnerships with community-based organizations to provide health education programs and to develop community exercise and healthy eating opportunities.

Industry-based interventions were suggested to promote essential health behaviors. In particular, drivers reported that the 12-foot restriction on leaving the taxi inadvertently prohibits the use of public bathrooms and should be reassessed. Drivers linked this regulation to chronic diseases, such as diabetes and kidney disease, which they felt were prevalent among drivers. One participant stated: *'You aren't allowed to use the bathrooms. Ordinance 11 states that you will be ticketed and fined if you are more than twelve feet away from your vehicle. ... you have to leave the line that you've been waiting in and go to a bathroom that you are allowed to use. You have two choices. Either get out of line or urinate inside your car. If you decide to urinate in your vehicle and get caught, X [the local public transport regulatory body] will reprimand you. It's a dilemma. Either don't make any money by getting out of line or pee inside your vehicle using a bottle.'* Drivers identified other cities where taxi cabs can park for limited periods of time in order to attend to their basic needs (i.e. food, water, toilets). Another city was also cited for alternative leasing systems that reduce financial pressures for drivers.

This discussion highlights disincentives for drivers for engaging in health behaviors while on the job if it comes at the cost of missing a fare or being fined by regulatory bodies. The disincentives frequently highlighted the lack of power and control drivers have over their workplace. These are critically important points for designing health interventions and working toward occupational reform.

Study 2 results

Table 1 shows the characteristics of the drivers and comparison group. Only 13.7% of drivers as compared to 41.7% of non-drivers reported completing a college education. The two groups reported similar ages, and

doctor-diagnosed diabetes, hypertension and hypercholesterolemia. The groups were similar in objective measures of BMI and blood pressure. However, taxi drivers had poorer ratings of their health status, with 44% of drivers reporting their health was 'fair' or 'poor.' The two groups were similar in their self-reported levels of having health insurance, with 23% of the sample reporting no current health insurance coverage. Drivers also slept less and reported higher rates of fatigue than individuals in the comparison group. On average, taxi drivers slept 1 h less per night than the control group. Fewer drivers were meeting physical activity (PA) recommendations of participating in 150 min of PA per week (14.3% of drivers compared with 73.7% of non-drivers). Drivers reported that they spent the majority of their shifts sitting ($M = 72\%$ of shift spent seated; $SD = 21.56\%$), and a minority reported 'usually' or 'almost always' getting out of their taxi cab while waiting in a taxi stand (34.7%) or when taking a new fare (44.4%).

Drivers were more likely to report recurrent musculoskeletal pain than non-drivers (74.7% of drivers compared with 12.5% of non-drivers). Drivers were more likely to report neck, shoulder/upper arm, low back and knee leg pain than non-drivers. Table 2 details report of chronic pain across different parts of the body for the two groups. Eighty percent of drivers reported dissatisfaction with their job and 86.5% reported dissatisfaction with their financial situation, as compared to non-drivers (27.3% reported dissatisfaction in each domain).

In line with the principles of CBPR and based upon the preliminary findings, at the end of Study 2 additional health interventions were delivered to participants and made available to taxi drivers more broadly. These included distributing lumbar supports and information about ergonomic alignment while seated in the taxicab. In addition, the research team printed and distributed water bottles with health information (e.g. drink 4 of these water bottles each day), and developed 1 page policy briefs related to workplace safety and physical activity for UTWSD to use in their work.

DISCUSSION

Taxi drivers experience numerous health concerns related to their occupation. The research in this study corroborates prior research showing taxi drivers are at risk for a range of health concerns. As the taxi workforce continues to grow (Bureau of Labor Statistics, 2014), there is substantial need to identify cost-effective methods for promoting health and safety. This cross-sectional study revealed that taxi drivers in San Diego

Table 2: Reported musculoskeletal pain by anatomical location

	Taxi drivers (<i>n</i> = 75)	Non-drivers (<i>n</i> = 25)
Neck	18 (24.0)	0 (0.0)
Shoulder, upper arm	21 (28.0)	1 (4.0)
Forearm, wrist or hand	7 (9.3)	1 (4.0)
Low back	38 (50.7)	2 (8.0)
Hip	7 (9.3)	0 (0.0)
Knee/leg	26 (34.7)	2 (8.0)

All values are expressed in number (% yes).

have worse self-reported health than non-drivers, which may be related to their higher incidence of musculoskeletal pain and sleep deprivation compared to non-drivers; two potentially safety impairing conditions. Self-reports of other health conditions such as hypertension, diabetes and hypercholesterolemia were similar across the two groups. These similarities may be due to a small sample size, the age of participants, the years spent in a sedentary job and the need for more detailed assessment of the non-drivers' occupational conditions.

Several industry-specific regulations were identified, including restrictions on taxi driver movement and a lack of health insurance coverage and health policies. These regulatory concerns highlighted the need for multi-level interventions to address taxi driver health disparities. There may be a need for regulations to promote driver health, including opportunities to stand, stretch, and take breaks throughout their shift in safe locations and schedules that support healthy sleep patterns. A focus on workplace conditions is necessary to effect change and create an environment that removes barriers to healthy lifestyles and health. The data highlighted the power imbalances that exist within current systems and the lack of perceived opportunities for drivers to change their workplace environment. Such systemic factors underscore the critical need for CBPR approaches that directly address socio-economic factors that contribute to health disparities (Wallerstein and Duran, 2010). By partnering with UTWSD, a 501c (4) advocacy organization, ongoing efforts aim to translate the research findings into policy change that support driver health. Alongside a report that was provided to participants and the broader UTWSD community, policy briefs were developed to support further action to bring about policy change. Such action-oriented strategies and political engagement are highlighted as important foci of health promotion programs to

effect long-term change (Laverack and Keshavarz Mohammadi, 2011).

In addition to industry reform, several driver-specific initiatives are recommended to address chronic musculoskeletal pain. Taxi driver education programs are needed to provide information on ergonomic adjustments, standing breaks, stretches and exercises to reduce chronic pain. Driver awareness could be raised through healthy living leaflets or roundtable discussions. A 15-min segment in regular taxi meetings can also be used to discuss the many health issues raised by participants in the focus groups. The interventions utilized in the research design, including pictorial handouts and brief in-person demonstration/discussion of stretches and ergonomic adjustments to taxicabs, seemed to be acceptable and were quite feasible to implement within the non-traditional workplace setting. These health education programs were developed based on the focus group data in study one alongside ongoing discussion between the researchers and UTWSD, thus providing opportunities to effectively tailor the materials. Other research has found that health promotion programs can be effective with similar populations such as truck drivers (e.g. Ng *et al.*, 2015), and in workplace settings (Goetzel, *et al.*, 2014). Taken together, this suggests that programs can be tailored and successfully implemented in non-traditional work settings.

In addition, active outreach to drivers to increase enrollment in health insurance programs and utilization of preventive medical services is needed. Targeted outreach, in particular to immigrant and underserved communities, is essential to ensure individuals are aware of their health insurance enrollment options and the long-term benefits of preventive health services. Issues related to lack of insurance coverage were identified in the focus groups, and in 2014 for Study 2, 21.3% of participants reported not having health insurance. These findings coincide with national surveys that indicate immigrants (lawfully residing in the US and not) are much less likely to be insured than US citizens (Artiga, *et al.*, 2016). Even migrants with insurance coverage have lower rates of access and utilization of care than US citizens, thus suggesting additional barriers to care (Artiga, *et al.*, 2016).

Given potential changes to U.S. federal legislation for health care being discussed in 2017, high risk populations such as taxi drivers will likely see a reduction in coverage and availability of free preventive screening services if Affordable Care Act programs are reduced. Further work is needed to ensure (1) driver awareness of occupational health risks; (2) the availability of

programs that are effective within the taxi driver work context and with the diverse populations often working as taxi drivers and (3) that drivers have access to cost-effective preventive and early intervention health care services for the chronic disease issues identified in this and other research. Given barriers to care for both insured and uninsured immigrants (Artiga *et al.*, 2016), targeted approaches are likely needed to help overcome those barriers.

An unexpected finding that was not previously known about taxi drivers is the sedentariness of the job. In contrast to other driver populations, such as long-haul truck drivers where forced sedentariness has been well defined, the PA habits of taxi drivers have limited research (Apantaku-Onayemi *et al.*, 2012). There may be a public perception that taxi drivers have a flexible job and can leave their vehicles between fares. However, the results of this study show drivers are less likely to meet PA recommendations than the non-driver comparison group, and the majority of drivers reported that they typically did not get out of their cars (i.e. never, rarely, or occasionally) when taking a new fare (56%) or while waiting in a taxi stand (65%). Such data suggest there is an opportunity to provide education around the use of standing breaks and periods of light-intensity activity to support cardiometabolic health (Chastin, *et al.*, 2015). Although the incidence of obesity, hypertension, hypercholesterolemia and diabetes were similar across the driver and comparison groups, the low levels of self-reported PA would put drivers at risk to develop these conditions. Further objective assessment of health beyond BMI and blood pressure is warranted in future studies.

LIMITATIONS

This research is limited by the use of a small convenience sample with primarily self-reported health data. The small size is a clear limitation and a larger sample overall and a more rigorous assessment of the comparison group is needed to draw further comparisons. Nonetheless, the findings do provide substantive guidance for planning future, larger-scale investigations. The research design also provides an exemplar of how research can augment data gathering with the provision of health education for known health concerns, thereby ensuring mutual benefit during the research process. However, the lack of program evaluation prohibits the empirical evaluation of the effectiveness of those programs within this dataset. Future research should continue to explore ways in which action-oriented designs may address known health issues alongside the rigorous evaluation of new areas of inquiry.

CONCLUSION

There are well-documented problems of prolonged sitting and shift work (Healy *et al.*, 2008; Katzmarzyk *et al.*, 2009; Caruso, 2014) and taxi drivers perform safety sensitive tasks. Our study showed that taxi drivers sleep less and are more fatigued than their non-taxi driving peers. Public safety depends on quick reaction times, and good judgment that is impaired with sleep deprivation (Lorenzo *et al.*, 1995). Thus, effective driver education programs and policy changes are needed to protect driver and public health.

The current findings are consistent with prior international studies on health risks and highlight multiple occupational barriers to health within the taxi industry. In an area where there are clear health needs, the research employed an action-oriented CBPR design that can indicate methods to improve health conditions among taxi drivers. Such an approach is critical given the unique characteristics of the taxi workplace and their history of limited protections and engagement. Further research is needed that systematically evaluates the cost-benefit of such designs that allow for mutual benefit and enable both short- and long-term deliverables for research participants and the broader community.

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