UNIVERSITY OF CALIFORNIA,
IRVINE

Psychological Occupational Strain and its Association with Cardiovascular Risk Factors in Bus Drivers

THESIS

submitted in partial satisfaction of the requirements
for the degree of

MASTER OF SCIENCE

In Environmental Health Sciences

By

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Thesis Committee:
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2019

DEDICATION

To

Neeraj Mathrani, the Mody family, and the Mathrani family

for their unwavering support and commitment.

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LIST OF ABBREVIATIONS

AHA	American Heart Association
BMI	Body Mass Index
BP	Blood Pressure
CHD	Coronary Heart Disease
CI	Confidence Interval
CVD	Cardiovascular Disease
CVH	Cardiovascular Health
ES-MBI	Exhaustion Scale of the Maslach Burnout Inventory
GHQ	General Health Questionnaire
HPA	Hypothalamic-Pituitary-Adrenal
LACMTA	Los Angeles County Metropolitan Transportation Authority
LS7	Life’s Simple 7
MBI	Maslach Burnout Inventory
MI	Myocardial Infarction
OR	Odds Ratio
PC-PTSD	Primary Care Post-traumatic Stress Disorder
PTSD	Post-traumatic Stress Disorder

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ACKNOWLEDGEMENTS

I would like to thank my review committee chair, Professor BongKyoo Choi, and the members of my review committee, Professor Ulrike Luderer and Emeritus Professor Dean Baker, for their guidance in this research project and for their mentorship throughout the Environmental Health Sciences graduate program and the Occupational and Environmental Medicine residency program at UC Irvine. I would also like to thank Dr. Alya Khan, the residency program director, for her ongoing mentorship and support.

ABSTRACT OF THE THESIS

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By

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Master of Science in Environmental Health Sciences

University of California, Irvine 2019

Professor BongKyoo Choi, Chair

Numerous studies performed in various countries consistently find urban bus driving among the unhealthiest of modern occupations. Urban bus drivers have higher rates of mortality and morbidity compared to other occupational groups, particularly with respect to cardiovascular disease. Psychological occupational strain is also prevalent among bus operators due to the nature of their job conditions, which include high job demands and low control, an imbalance in effort-rewards, and low social support from supervisors. Although extensive literature shows that job strain arising from the work environment is an etiological agent in the poor cardiovascular health and mental health of bus drivers, the relationship between mental health and cardiovascular disease with its risk factors has not been studied in this occupation.

This is the first study to investigate whether poor mental health indicators are associated with cardiovascular risk factors in bus drivers, specifically those that make up the American Heart Association (AHA) Life’s Simple 7 predictors of cardiovascular health. In this study, a cross-sectional analysis was performed on self-reported data from 280 bus drivers in Los Angeles County. Psychological strain indicators in the form of mental health, emotional exhaustion, and post-traumatic stress disorder were measured through the General Health Questionnaire (GHQ), Exhaustion Scale of the Maslach Burnout Inventory (ES-MBI), and the Primary Care Post-traumatic Stress Disorder (PC-PTSD) screening questionnaires, respectively. Measures of cardiovascular disease risk was based on data relating to the AHA Life's Simple 7 (LS7) cardiovascular health metrics, which include blood pressure (BP), cholesterol, diabetes, body mass index (BMI), diet, physical activity, and smoking.

The prevalence of bus drivers meeting each LS7 metric criteria was approximately 21% for BP, 11% for cholesterol, 8% for diabetes, 51% for BMI, 21% for physical activity, 9% for diet, 17% for smoking, and 2.5% for inadequate cardiovascular health (CVH) based on overall LS7 score. Statistically significant relationships were found between ES-MBI and BMI, GHQ and BMI, GHQ and BP, GHQ and cholesterol, GHQ and diabetes, and GHQ and inadequate CVH even after controlling for covariates of age, gender, race, education, and socioeconomic status. To investigate whether sex differences exist between associations, stratified analysis by sex was performed. For males, statistically significant relationships between ES-MBI and BMI, GHQ and cholesterol, GHQ and diabetes, and GHQ and inadequate CVH were found even after controlling for covariates combined. For females, statistically significant relationships between GHQ and physical activity and GHQ and BMI were found.

This study reveals possible associations with indicators of psychological occupational strain and cardiovascular disease and its risk factors. Further investigation is important to address the limitations of this study and to inform policy and programs that aim to reduce cardiovascular risk in bus drivers by improving their working conditions and promoting their mental health.

CHAPTER 1: INTRODUCTION AND PURPOSE

There are currently about 700,000 bus drivers in the United States, of which about 180,000 are transit and intercity bus drivers. Employment of transit and intercity drivers is projected to grow 9% from 2016 to 2026. This projection takes into account the increased demand for transportation due to a growing and aging population and the expansion of transit and intercity bus transit systems (Bureau of Labor Statistics, 2019). The main responsibility of bus drivers is to transport people between various places, which can include across state and national borders. Other duties of a bus driver typically involve the following: abiding to a time schedule when following a planned route, helping disabled passengers get on and off the bus, obeying traffic laws, ensuring passenger safety, and performing basic bus maintenance. Additionally, local transit and intercity bus drivers must collect bus fares and manage fare box transactions, provide information about routes and transfer points, and ensure that all passengers have a valid ticket to ride the bus (Bureau of Labor Statistics, 2019).

When driving vehicles that range from 15-passenger buses to 60-foot buses that carry more than 100 passengers, bus drivers have a large impact on road and public safety and the performance of the transit system. Given that the bus is one of the most popular modes of public transport worldwide, the health status of bus drivers is a determinant factor in the incidence of fatal road accidents (Useche et al., 2017). Thus, the physical and psychological health of bus drivers is a critical factor in driving performance. Any impairment can have undesirable consequences for passengers and bus operators alike. Therefore, in order to ensure that bus drivers are fit for their duties, they must have a commercial driver's license, possess a clean driving record, and are frequently required to pass a background check. They must also meet physical, hearing, and vision requirements. Federal and state regulations do not allow people to become bus drivers if they have a medical condition, such as uncontrolled blood pressure, which may interfere with their operation of a bus. In fact, federal regulations require interstate bus drivers to pass a physical exam every 2 years (Bureau of Labor Statistics, 2019).

Despite these rigorous precautions, transit and intercity bus drivers have one of the highest rates of injuries and illnesses of all occupations. Epidemiological data from samples in several different countries consistently have found urban bus drivers to be among the unhealthiest of modern occupational groups, with substantially higher rates of mortality and morbidity in comparison to many other occupational groups, particularly with respect to cardiovascular disease (CVD). For example, in studies of young myocardial infarction (MI) patients, for whom profession was determined, an unexpectedly high percentage (up to 40%) comprised professional drivers (Belkić et al., 1994). In addition to ischemic heart disease, hypertension and obesity are prevalent cardiovascular risk factors in this profession. Bus drivers are also at risk for various occupational mental health conditions from significant work stress. The major psychological health outcomes typically associated with bus drivers are anxiety, depression, burnout and post-traumatic stress disorder (PTSD). As a consequence, the bus driving industry is plagued with high rates of premature disability retirement, with cardiovascular problems as one of the leading causes. Research also indicates high rates of absenteeism in the urban transit industry, along with high attrition rates within the first few months of driving. Bus drivers in the United States alone miss in excess of four million work days each year, which is three times the national average for blue-collar workers. Not surprisingly, over one-fourth of the total operating costs of public transit districts are attributable to driver absenteeism (Evans, 1994; Evans & Johansson, 1998).

In a qualitative study by Dobson et al. (2017), transit operators in Southern California believed that the stress from their working conditions negatively impacted their overall health. The constellation of psychosocial job characteristics, of high job demands, low control, effort-reward imbalance, and low social support, give rise to job strain and portend to ill effects based on the predictions of Karasek's demand-control-support (DCS) model and Siegrist's effort-reward imbalance (ERI) model (Karasek, 1979; Siegrist, 1996). Bus drivers experience high job demands, which include time pressures that clash with their ability to provide customer service, long driving and work hours, and potential violence from passengers (Dobson et al., 2017). They can have work and family conflict, as frequent, rotating shifts can disrupt scheduled family activities and strain interpersonal relationships at home. Additionally, bus drivers have little decision latitude or discretion in how they carry out their jobs, and when and where they work. Transit districts often have hierarchical, top-down management styles with little or no employee input into the management or organization of work. Bus driving also tends to be a socially isolating job, with little opportunity for meaningful social networking with one's customers or fellow drivers (Evans & Johansson, 1998). In terms of rewards, bus drivers receive little pay and esteem, despite their high extrinsic demands and intrinsic overcommitment (Tse et al., 2007).

There is substantial evidence from literature to support that job strain arising from the work environment increases the risk of both CVD and poor psychological health in the urban transit service. However, the existing data on cardiovascular health and psychological strain also warrant exploring whether poor mental health indicators are contributing to cardiovascular risk factors in bus drivers. In a study that identified the causes of deaths in 376 New York City bus drivers, it was found that the number of deaths caused by ischemic heart disease exceeded the number expected from deaths due to ischemic heart disease in the national population. Many of the drivers also had mental, psychoneurotic, and personality disorders (Michaels & Zoloth, 1991). Could there be a relationship between these two domains of health? In the general literature, there does seem to be support that mental health disorders, such as PTSD, depression, and burnout, are linked to CVD. Given that the job characteristics of bus driving can lead to high levels of occupational stress, there is a plausible association between mental health indicators and cardiovascular health in bus drivers. Such an association would merit the promotion of mental health among bus drivers as an even higher priority to reduce cardiovascular morbidity and mortality and to maintain the health and function of the transit service.

The primary objective of this study is to investigate the effects of psychological occupational strain on multiple cardiovascular risk factors in bus operators, specifically those that make up the American Heart Association (AHA) Life's Simple 7 predictors of cardiovascular health. Developed by the AHA in 2010, the Life's Simple 7 (LS7) cardiovascular health metric has been used to assess and monitor overall cardiovascular health in both the general and working populations by identifying seven modifiable cardiovascular risk factors. The primary hypothesis of this study is that a higher level of psychological occupational strain is associated with increased cardiovascular risk factors, and thus an increased risk of adverse cardiovascular outcomes.

CHAPTER 2: LITERATURE REVIEW

Cardiovascular Disease in Bus Drivers

Extensive literature corroborates that the job characteristics of the bus driving occupation contribute to an excess risk of cardiovascular disease. One of the earliest studies researching bus drivers was a well-known cross-sectional study on 31,000 London bus drivers and conductors conducted by Morris et al. (1953). They found that mortality from coronary heart disease was two times higher among drivers than conductors; however, they attributed this to the sedentary nature of a bus driver's job compared to that of a conductor. Rosenman and Friedman (1958) suspected, instead, that the effects were due to higher levels of occupational stress experienced by drivers in comparison to conductors. They reanalyzed the data from Morris and his team, and in support of their hypothesis, they found that drivers on London suburban routes had much lower levels of coronary heart disease than their downtown counterparts even though they had similar levels of exertion. Since then, a flood of studies have confirmed that the environmental characteristics of urban bus driving appear to play a major role in elevating risk for stress and eventual cardiovascular morbidity. Rosengren et al. (1991) conducted a prospective study in Sweden comparing the incidence of coronary heart disease (CHD) for 6699 men in 30 occupational groups over a mean of 11.8 years. They found that bus and tram drivers had the highest incidence of CHD, with the risk nearly double that of other occupations.

Many studies have focused on specific cardiovascular risk indicators, such as obesity. The prospective study by Rosengren et al. (1991) also found that drivers were more obese than men of other occupations. Another Swedish study evaluated 440 male professional bus and truck drivers compared to a reference group from the general population and found that not only did more drivers than referents have work situations characterized by high demands, low decision latitude, and low social support, but they also were more overweight, sedentary in their leisure time, smokers, and consumed a higher proportion of fat per day (Hedberg et al., 1993). Indeed, in a nationally representative sample of workers in United States, motor vehicle operators were ranked first in obesity prevalence among 41 male and female occupational groups (Caban et al., 2005; Gu et al., 2014). The excess proportion of overweight drivers could be a consequence of their eating habits and their low physical activity both at work and during their leisure time. Long work hours, shift work, lack of scheduled breaks or meals, and lack of healthful food and physical activity options on the transportation routes or in the transportation hubs can make healthful food choices and physical activity difficult for transportation workers (Hedberg et al., 1998; French et al., 2007; French et al., 2010; Choi et al., 2017). It is also thought that adverse working conditions increase the risk for weight gain/obesity directly through chronic strain and hypothalamic dysfunction, and indirectly through health-related behaviors and injuries/chronic pain (Choi et al., 2017).

Additionally, urban transit operators have high rates of hypertension compared to other occupational groups. Ragland et al. (1987) compared 1500 white and black male bus drivers working for the San Francisco Municipal Railway System (MUNI) to the following control groups: a sample of employees from different occupations in the U.S., a sample of employees from the same geographical area, and a sample of individuals who had applied and been accepted to be bus drivers. After adjustment for age, race, and employment status, a significantly higher prevalence of hypertension was found among the bus drivers when compared to each of the three control groups. In a study by Shin et al. (2013) that was conducted among 433 male bus drivers in a big city of Korea, 53.3% of bus drivers experienced hypertension (blood pressure [BP] ≥140/90 mmHg), which was two times higher than in "crafts and machine operators" of the same occupation. Similarly, Wang and Lin (2001) found that hypertension rates for bus drivers (56%) were significantly greater than skilled workers (30.6%) from the Taipei Municipal Bus Administrative Bureau. There were also significant differences in obesity, hypercholesterolemia, hypertriglyceridemia and ischemic heart disease.

One study of 275 San Francisco urban transit (bus and train) operators found that both observer-based job barriers and time pressure and self-reported intensity of job problems were independently and significantly associated with hypertension (BP ≥160/90 mmHg). Job barriers were defined as observable job stressors that required drivers to perform extra work or engage in risky behavior to overcome a barrier (i.e. unruly passengers requiring extra attention from the operator during driving). Self-reported job problems referred to 19 common job issues related to organizational and technical difficulties during the past 12 months, such as unruly passengers, equipment problems, and problems with supervisors (Greiner et al., 2004).

Furthermore, the longer people work as bus drivers, the stronger the association between job characteristics and ill health. A series of studies by Belkić and colleagues found that drivers on the job for 1-5 years did not differ in either rates of hypertension or resting blood pressure in comparison to workers on other jobs for 1-5 years. However, comparisons made at 6-10 years revealed a sharp upturn in both of these cardiovascular risk factors (Evans & Johansson, 1998). These studies have remained consistent with studies around the world evaluating the duration of bus driving exposure and CVD risk factors. A prospective longitudinal study in Stockholm, Sweden examined the relationship between the number of hours of driving a bus and blood pressure among 88 male and female bus drivers, with follow ups from pre-employment to 5 years. Controlling for sex and baseline health outcomes prior to becoming a bus driver, the study revealed that the greater the average number of hours of bus driving per week, the higher the diastolic blood pressure, which is a stronger predictor of cardiovascular risk than systolic blood pressure (Gunn et al., 2012). Based on the Framingham risk scoring system for 10-year risk of CVD events, Shin et al. (2013) also found that the odds ratio (OR) of CVD events was 2.58 for bus drivers who worked more than 12 hours every other day compared to bus drivers who worked 8 hours per day. Lastly, Bigert et al. (2003) found that there was an almost two-fold adjusted OR of myocardial infarction among bus drivers who had been working for more than 10 years and only slightly increased OR among those who had been working 1 to 10 years. These studies suggest that the longer one is engaged in professional driving and the longer one's driving hours per day are, the higher the risk of developing CVD.

American Heart Association's Life's Simple 7 and Cardiovascular Health

In response to the increasing CVD burden both epidemiologically and economically in the United States, the American Heart Association introduced its 2020 Strategic Impact Goals to target a 20% relative improvement in overall cardiovascular health. To assess and monitor cardiovascular health (CVH), the AHA proposed seven modifiable risk factors that are often referred to as Life's Simple 7. The LS7 metrics include 4 health behaviors (smoking, diet, physical activity, and body mass) and 3 health factors (blood pressure, cholesterol level, and fasting glucose level). Each metric is categorized into ideal, intermediate, and poor levels, and can be scored and combined to determine overall cardiovascular health. Ideal cardiovascular health is defined by the presence of never smoking or quit smoking ≥12 months, body mass index (BMI) <25 kg/m^2, leisure-time physical activity at goal levels, diet meeting 4 to 5 target components of current guideline recommendations, untreated total cholesterol <200 mg/dL, untreated BP <120/<80 mm Hg, and fasting blood glucose <100 mg/dL. Specifically, goal levels of physical activity are either ≥150 min/week of moderate intensity or ≥75 min/week of vigorous intensity. Diet components include ≥4.5 cups per day of fruits/vegetables, ≥2 servings of fish per week (3.5-oz servings), <1500 mg/d of sodium, ≤450 kcal (36 oz) per week of sweets/sugar-sweetened beverages, and ≥3 servings per day of whole grains. Poor cardiovascular health is defined by the presence of current smoking, BMI ≥30 kg/m^2, no physical activity, diet meeting 0 to 1 target components, fasting blood glucose ≥126 mg/dL or diagnosed diabetes mellitus with HbA1c ≥7%, total cholesterol ≥240 mg/dL or treated cholesterol >200 mg/dL, and treated or untreated BP >140/>90 mm Hg (Lloyd-Jones et al., 2010; Huffman et al., 2012).

Recent evidence reveals that the presence of more ideal cardiovascular health factors from the LS7 metric is associated with lower CVD and all-cause mortality. Younus et al. (2016) performed a systematic review to aggregate the available data on outcomes associated with ideal LS7 metrics in both US and non-US populations, and found six studies investigating mortality. Compared with persons with 0 to 1 ideal metrics, persons with 5 to 7 metrics had a 23% to 79% reduction in the risk of all-cause mortality and a 42% to 90% reduction in the risk of CVD mortality. Nine studies assessed the relationship between CVH metrics and incident CVD, which included MI, stroke, incident heart failure, and venous thromboembolism. Again, meeting an increasing number of ideal LS7 metrics was associated with a reduced risk of CVD. Similar findings have been reported in a national cross-sectional study using data from the National Health and Nutrition Examination Survey from 1988 to 2016. The study revised the LS7 metrics with modified criteria regarding weight (for example, using waist to hip ratio for central obesity rather than BMI), blood pressure, and diet. Compared with participants who met 0 to 1 of the ideal revised LS7 metrics, the adjusted hazard ratios of participants who met at least 5 metrics were 0.46 for all-cause mortality and 0.37 for CVD mortality (Han et al., 2019).

The AHA asserts that employers can use the LS7 to assess the cardiovascular health of employees and to monitor progress toward improved health. Incorporation of modifiable risk factors in the LS7 metric was intentional to encourage translation into prevention programs that promote healthy lifestyle behaviors. One study examined the impact of favorable cardiovascular health on direct medical expenditures for a large, ethnically diverse health care employee population that included 9097 participants. After adjusting for demographic factors and comorbid conditions, annual employer healthcare costs were on average $2,021 less for employees with at least six ideal LS7 metrics compared to employees with two or fewer ideal metrics (Osondu et al., 2017). This suggests that improving CVH to optimal levels can result in important savings in health care expenditures for employers. In addition, organizations that engage in lifestyle promotion programs may also realize unintended benefits in the form of lower employee turnover, higher employee engagement, and higher job satisfaction. So far, no studies have investigated the LS7 metric in the urban bus driver population.

Psychological Health in Bus Drivers

Many studies have shown that work stressors can affect mental health and job satisfaction in bus drivers. Using the Crown-Crisp Experiential Index, a validated tool used to measure neurotic symptoms and traits, Duffy and McGoldrick (1990) found that 13% of 376 male British bus drivers had mental well-being similar to psychoneurotic outpatients, which is higher than what is expected among the normal population (5-10%). Bus drivers who expressed greater job satisfaction tended to exhibit better mental health. Reduced mental health in the study was suspected to be connected to characteristics of the job. Around a quarter of the drivers had experienced significant problems with or worries regarding health, difficulty in sleeping or unwinding at home, or shift work problems and long hours that affected their family life. Particularly at risk were younger drivers, many of whom had greater family responsibilities and felt the need to accept extra duties due to financial constraints, but by doing so increased home tensions (Duffy & McGoldrick, 1990). This is consistent with other research that has shown bus drivers, especially those on split shifts, often complain about disruptions of home life, particularly social activities and leisure time, and that these disruptions contribute to marital strain and inadequate parenting. Residual fatigue and irritability stemming from occupational stress is seen as one major cause of these disruptions. Bus driver often report excessive fatigue and exhaustion following work, and, in one study, took more than 1.5 hours on average to relax and unwind upon returning home after work (Evans, 1993). Bus drivers on irregular shifts tend to show greater subjective fatigue and physiological stress than drivers on regular shift patterns (Tse et al., 2006).

Emotional exhaustion, characterized by emotional depletion and loss of energy, can manifest as decreased job performance, reduced morale, absenteeism, and a decline in mental health (Jeung et al., 2018). Emotional exhaustion is a component of burnout, which also consists of depersonalization and reduced personal accomplishment. Burnout is associated with increased substance use and accidents among bus drivers. In a study of 1,231 San Francisco MUNI transit operators, operators with alcohol problems had significantly higher burnout scores based on the Maslach Burnout Inventory (MBI) emotional exhaustion subscale than operators without alcohol problems (Cunradi et al., 2009). Male city bus drivers in Colombia who had high job strain/burnout profile (65.7% of drivers) reported significantly more accidents than those with low job stain/burnout profile (Useche et al., 2017). Some studies show that stress intensity from job hassles is directly, strongly, and positively related to burnout symptoms. Job hassles refer to problems related to traffic, passengers, vehicles, colleagues, hours, and schedule. Other problems identified with stress and consequently burnout include equipment problems, problems with fares and transfers, problems with supervisor, long or odd hours, poor access to restrooms, unfairly written up for rule violation, as well as ergonomic problems (Chen & Cunradi, 2008; Cunradi et al., 2009).

More research has pursued the trauma-related psychological outcomes of being assaulted. PTSD, though rare among bus drivers, is an anxiety disorder comprised of feelings of intense fear, helplessness accompanied by nightmares, flashbacks, irritability, hyperarousal and startled responses that persist beyond a month after onset of trauma. Transport services are prime sites for workplace violence, with bus drivers often being the targets of robberies and assaults. In the study by Dobson et al. (2017), nearly all the bus drivers interviewed (approximately 45 drivers) experienced verbal abuse or insults on a daily basis. Many anticipated some kind of physical assault daily. They describe two causes of confrontation: 1) dealing with the public who often blame them for running late, and 2) dealing with passengers who have been taking drugs or who are mentally ill and acting out of control. In addition, in many countries, fare evasion is one of the most important causes of violence against transport employees (Essenberg, 2003). Indeed, the highest reported stressor in the study of male British bus drivers by Duffy and McGoldrick (1990) was the risk of physical assault from passengers, which had been a reality for almost a third of the men and was scored as a serious problem by over two-thirds of respondents. Blau (1981) examined different job stressors and found that the threat of crime was the best predictor of job performance (i.e. accidents). The greater the perceived threat from crime, the lower the levels of job performance. Moreover, the longer the driver had been on the job, the greater the association possibly due to the greater probability that drivers with more seniority had actually encountered criminal behavior while on the bus. Those who had not yet experienced physical assault had significantly higher job satisfaction (Duffy & McGoldrick, 1990). Unfortunately, physically assaulted bus drivers are also more likely to develop PTSD and mild depression than non-assaulted bus drivers (Fisher & Jacoby, 1992).

Work-family imbalance is another work stressor that is also associated with burnout, anxiety and depression. In the qualitative study by Dobson et al. (2017), women bus drivers reported more conflict between long and irregular work schedules and caring for children or other domestic responsibilities. Long household work hours combined with long working hours may place additional burden on women that is often not considered in studies of occupational stress. Other studies have found that female bus drivers report more difficulties in meeting the service demands of customers, more stress from irritated and aggressive passengers, and are more sensitive to the demands of congested traffic than males. It is thought that perhaps female bus drivers have to expend more psychological effort to manage these demands. Indeed, female drivers also report more headaches, sleep disturbances, fatigue, and minor mental disturbances (depressive mood, restlessness, uneasiness). They also have higher absenteeism rates. The potential interaction between paid and unpaid work is necessary to consider for further research on gender differences in occupational psychological stress (Aronsson & Rissler, 1998; Choi et al., 2017; Dobson et al., 2017).

Interventions to Improve Bus Driver Health

There have been a few intervention studies conducted to improve the well-being of bus drivers by mitigating their work stressors. Rydstedt et al. (1998b) evaluated an intervention project by the Stockholm municipal transit agency on one of the most heavily congested urban city bus lines; the hope was to reduce traffic congestion, improve passenger service, and thus reduce the workload demands imposed on the drivers. Some of the key elements of the intervention included broadening some street segments, reconfiguring routes to minimize known bottlenecks, reducing the number of bus stops, changing the design of bus stops to facilitate access, and automating visual and verbal announcements of all approaching bus stops and transfer routes. Drivers in the intervention group compared to those who did not work on the intervention line reported significantly reduced workload and job hassles, with improvements in the traffic environment, "control in the driving situation", and "opportunity to give service to passengers". Systolic blood pressure was also significantly reduced, as well as heart rate. However, perceived health complaints and spillover of fatigue from work to leisure were not affected despite the physiological benefits (Rydstedt et al., 1998b; Evans et al., 1999).

There have been two similar intervention studies targeting cardiovascular risk factors in bus drivers. These studies focused on worksite health promotion efforts that increase exercise and encourage healthier eating. The study by French et al. (2010) included improvements in physical activity facilities, increased availability of and lower prices on healthy vending machine choices, and group competitions that promoted healthy activities. Unfortunately, after 18 months of environmental intervention, changes in BMI, eating behaviors and physical activity were not significantly different between the intervention and control groups. In the study by Hedberg et al. (1998), regular information about healthy habits and individual and group behavioral activities were implemented in the intervention group. Although self-reported exercise habits and the eagerness to practice proper dietary habits improved in the intervention group, total serum cholesterol and tobacco use did not improve compare to the control group. Both studies concluded that work schedule constraints and variable working hours were the main obstacles to changing health behaviors and reducing cardiovascular risk factors. Prevention strategies may need to include policy changes that address larger infrastructure issues, such as work schedules, to reduce job strain and subsequent CVD risk.

Kompier et al. (2000) performed comprehensive research to compare and analyze interventions and preventive actions from international bus companies; 13 “natural experiments” were identified from countries in Europe, United States, and Canada. Most project initiatives in these countries were taken up by management, but in some cases, other parties played a role, such as company social workers, university teams, and health insurance companies. Motives for interventions were to strengthen the company’s market position, reduce costs and improve productivity, improve service and quality, as well as improve the situation of disabled drivers and bus drivers’ motivation and satisfaction. Given the variety of interventions, many of which combined strategies, and different outcome measures, it was difficult to determine if these cases were successful. However, Kompier et al. (2000) concluded that in many cases, there were decreases in sickness absenteeism, turnover, work disability, and improvement in health, well-being, and satisfaction. Several programs were successful even from a financial perspective, since there were cost reductions due to health improvement and reduced absenteeism. Their study suggests that stress prevention that combines adequate interventions and proper implementation may be beneficial to both the bus driver and the company.

Association between Psychological Health and Cardiovascular Health

The association between measures of psychological strain and CVD and its risk factors in bus drivers has not been reported in the literature. In one somewhat related study that correlated job satisfaction with CVD, there was an unexpected strong association between self-assessed job satisfaction and risk of death from ischemic heart disease. But it was thought that those who reported a high degree of job satisfaction might have had a particular cardiovascular risk factor profile. Indeed, these men had a higher prevalence of smokers, significantly higher body mass index, and a higher systolic blood pressure (Netterstrøm & Suadicani, 1993).

In the general and occupational medicine literature, there does seem to be support that mental health disorders, such as depression, PTSD, and burnout are linked to CVD. Studies suggest that the presence of depression doubles the risk of developing new CVD. A longitudinal study of Danes demonstrated that depression, assessed in 1964 and 1974, predicted a highly significant 70% increase in myocardial infarction and a 60% increase in all-cause mortality at follow-up 17 years later (Hare et al., 2014). Depression also has a well-established association with earlier mortality in people with existing heart disease. The Sertraline Antidepressant Heart Attack Randomized Trial (SADHART) found that baseline Major Depressive Disorder (MDD) severity and failure of MDD to improve during treatment with sertraline or placebo were strongly associated with long-term mortality (Scott, 2014; Whooley & Wong, 2013).

Although depression has been most intensively studied, there is burgeoning research on the connection between PTSD and onset of CHD. Aside from its association with cardiovascular risk behaviors such as smoking, alcohol abuse, and non-adherence to medications, PTSD has been cross-sectionally associated with hypertension, dyslipidemia, obesity, and diabetes in young veterans of Operations Iraqi Freedom and Enduring Freedom (Edmondson et al., 2014). It has also been found that Vietnam veterans with PTSD exhibited elevated rates of CVD relative to combat-exposed veterans without PTSD. Police officers, who also have high psychological burden from PTSD, exhibit exaggerated blood pressure increases in response to trauma scripts relative to traumatized individuals without PTSD (Pacella et al., 2013). The first meta-analysis of the prospective association of PTSD with incident CHD in initially healthy populations consisted of six studies with a total of 402,274 individuals. The review found that PTSD was associated with a 27% increase in risk for incident CHD after adjustment for numerous demographic, clinical, and psychosocial factors including depression (Edmondson et al., 2014).

More recently, burnout is increasingly being recognized for its effect on cardiovascular health. For example, in a 4.2-year follow-up of apparently healthy men, burnout was predictive of future MI, even after controlling for blood pressure, smoking, cholesterol levels, age, and use of antihypertensive drugs (Melamed et al., 2006). The first comprehensive systematic review on the effects of burnout included 62 prospective studies conducted from 2005-2016. Most studies measured burnout by the MBI or the Shirom-Melamed Burnout Measure. The review found that burnout was a significant predictor of hypercholesterolemia and diabetes mellitus type 2, which are both risk factors for cardiovascular disease. Two studies in the review confirmed a higher incidence of CHD among those with burnout. A significant association between burnout and hospitalizations due to cardiovascular diseases was also observed in a cohort study of industrial employees that lasted 10 years (Salvagioni et al., 2017). Hence, even if not yet demonstrated in occupational health studies among bus drivers, there has been research that has shown associations between mental health and cardiovascular disease in the general population and in other occupations. However, studies have yet to examine the association between mental health indicators and cardiovascular health using the AHA LS7 metric.

Biological Mechanisms Linking Psychological Strain to Cardiovascular Disease

The biological mechanisms responsible for an association between mental health and cardiovascular disorders are not clear because of the complexity and bidirectional nature of this relationship. However, many biological factors have been implicated in the association between psychological strain and cardiovascular disease. Candidate pathways include autonomic nervous system dysfunction, inflammation, activation of the hypothalamic-pituitary-adrenal (HPA) axis, platelet activation or other disruptions to the clotting cascade, subclinical vascular changes (endothelial dysfunction), and common genetic factors. In addition to biological factors, psychological strain has been linked to unhealthy behavioral factors (i.e. physical inactivity, smoking, dietary indiscretion, medication nonadherence) that can further increase the risk of CHD (Whooley & Wong, 2013). Contributing factors that may explain the relationship between stress, psychological strain and CVD are depicted in the conceptual model of Figure 1.

The autonomic nervous system is divided into the opposing sympathetic and parasympathetic divisions that act to control heart rate, cardiac contractility, vasodilation, and other critical functions. Exposure to stress activates the sympathetic nervous system, leading to higher levels of catecholamines (noradrenaline and adrenaline), which cause increases in heart rate and blood pressure while at the same time decreasing coronary blood flow and increasing systemic vascular resistance. The chronically elevated sympathetic cardiac response can lead to a number of deleterious downstream effects, which include the development of hypertension, left ventricular hypertrophy, coronary vasoconstriction, and cardiac arrhythmia. Chronic mental stress is one of the many cognitive symptoms that people with mental health suffer from. Depressed patients tend to have higher levels of circulating catecholamines, which may contribute to the excess risk of CVD associated with depression (Dhar & Barton, 2016; Whooley & Wong, 2013). Elevated levels of cortisol as a result of enhanced activity of the HPA axis in response to psychological stress have also been documented in states of depression, anxiety, hostility and work stress. The oversecretion of cortisol may result in dysregulation to the

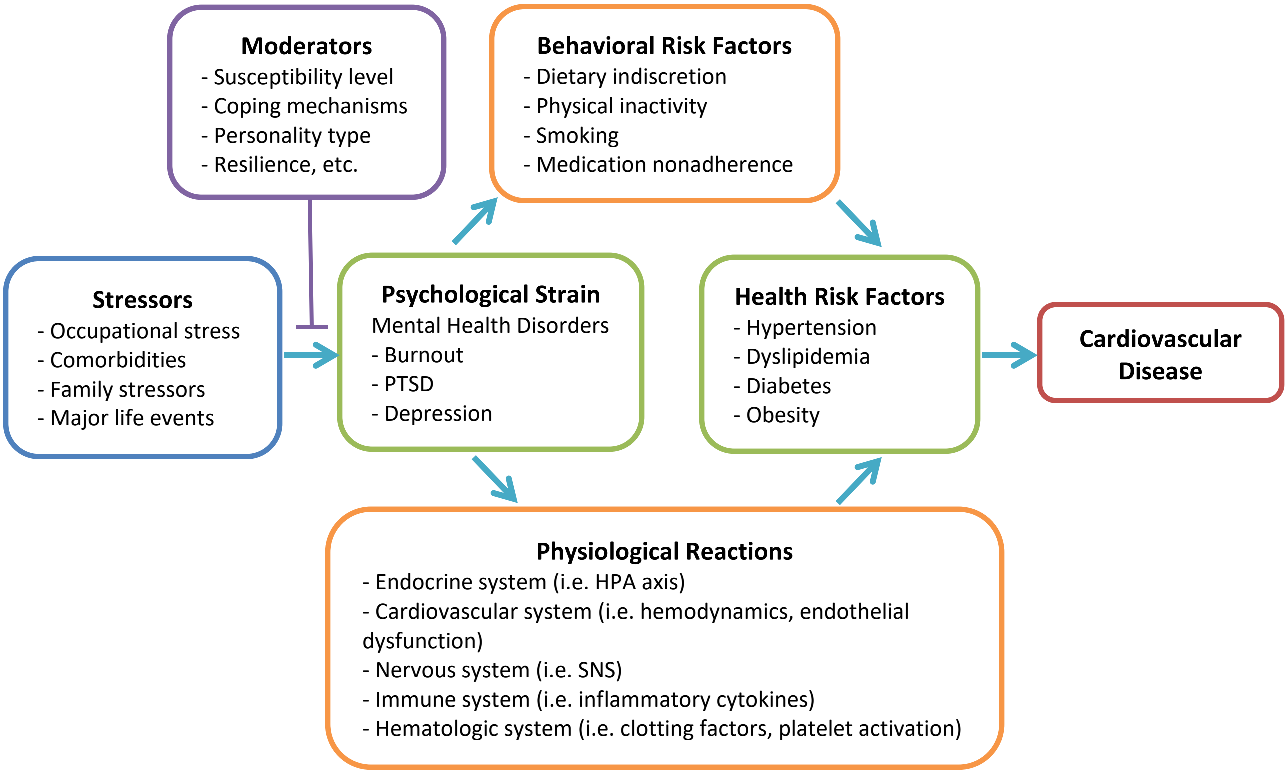

Figure 1: Proposed pathway of psychological strain resulting in cardiovascular disease. The lists of stressors, moderators, behavioral risk factors, and physiologic reactions are not all inclusive (Dhar & Barton, 2016; Choi et al., 2017; Hare et al., 2013; Lee, 2019; Sara et al., 2018; Tse et al., 2006; Whooley & Wong, 2013). HPA: hypothalamic-pituitary-adrenocortical; SNS: sympathetic nervous system.

negative feedback system of the HPA axis, perpetuating elevations in cortisol and rendering the body vulnerable to inflammatory disorders, such as atherosclerosis. For example, high job demand has been associated with more rapid progression of carotid atherosclerosis (Sara et al., 2018). Chronic exposure to stress that results in psychological strain can increase the risk of damage to the cardiovascular system through mental stress-induced ischemia, the activation of platelets and coagulation factors, and the upregulation of inflammatory cytokines, all mediated in part by cortisol and catecholamine release (Sara et al., 2018; Whooley & Wong, 2013). The biological mechanisms proposed in stress pathophysiology and CVD are represented in Figure 2.

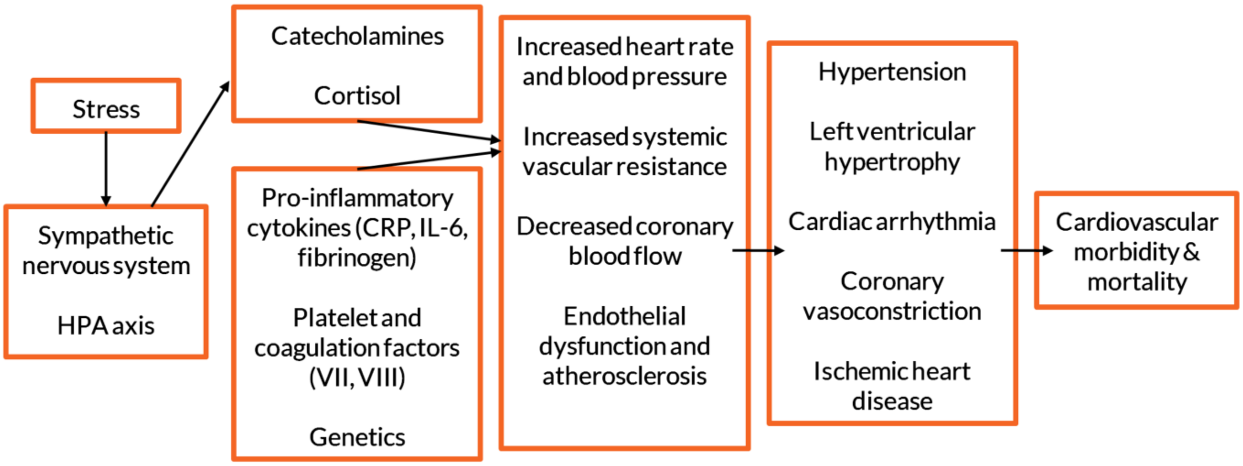

Figure 2: Pathophysiology of stress leading to cardiovascular disease (Dhar & Barton, 2016; Hare et al., 2013; Sara et al., 2018; Whooley & Wong, 2013). HPA: hypothalamic-pituitary-adrenocortical; CRP: C-reactive protein; IL-6: interleukin-6.

Catecholamine excretion is consistently reported to be elevated during exposure to driving among professional drivers. Evans et al. (1987) found large elevations in urine adrenaline and noradrenaline among U.S. bus drivers on the job. Traffic congestion in particular was associated with elevations of urinary adrenaline and noradrenaline while on the job (Evans & Carrère, 1991). These findings are congruent with research showing that city bus drivers who felt the most time pressure at work due to time-schedule demands and traffic congestion had the highest levels of stress hormones (Evans, 1993). Bus drivers who experienced high objective workload estimated from traffic intensity had almost twice the incidence of acute myocardial infarction than those who experienced low workload (Netterstrøm & Juel, 1988; Netterstrøm &

Suadicani, 1993). Additionally, bus drivers with perceived job strain had greater workday elevations in catecholamines compared to co-workers with low strain and had increased odds of developing myocardial infarction compared to the general population (Carrère et al., 1991; Bigert et al., 2003). Another study found that when job hassles were frequent (i.e. observer-based frequency of traffic congestion, road obstructions, hostility from passengers, slow embarking of passenger, etc.), driver perceived strain (perceived effort, time pressure, and traffic congestion) and cardiovascular "activation" of increased blood pressure and increased heart rate were higher than when hassles were less frequent (Johansson et al., 1998).

However, the effects of stress on an individual are dependent on an individual's level of susceptibility, ability to cope and/or adapt to stressors, personality type, and overall resiliency (Tse et al., 2006). For example, bus drivers with high levels of reappraisal coping, which is associated with positive cognitions of the driving experience (i.e. viewing driving as a learning experience), had low levels of burnout even when their job hassles were high (Chen & Kao, 2013). The tendency of some individuals to use denial and repressive coping might also be responsible for the inconclusive results of studies that have failed to find a significant positive association between subjective reports of occupational stress and prevalence of hypertension (Albright et al., 1992). Hence, exposure to work stress does not necessarily result in strain in some individuals. Interventions that target psychological occupational strain, rather than only work stressors, may further reduce the incidence of CVD and its risk factors.

CHAPTER 3: METHODOLOGY

The Transit Operator Work Stress and Health Survey Background

To investigate the relationship between cardiovascular risk factors and psychological strain in bus drivers, data from The Transit Operator Work Stress and Health Survey were utilized. The survey was built upon on-going research collaboration between the University of California, Irvine, Center for Occupational and Environmental Health (UCI COEH), the Los Angeles County Metropolitan Transportation Authority (LACMTA) management, the Sheet Metal Air Rail Transportation (SMART) Locals, and the SMART-MTA Trust Fund. This survey project was partially supported by a UCI Office of Research Seed Grant. The aims of the survey project are to examine the current mental and physical health conditions, health-related behaviors, and working conditions of LACMTA transit operators and other employees, and to examine the interrelationship between adverse working conditions, health-related behaviors, mental health, and obesity among transit operators. The ultimate goals of the project are to improve the health and productivity of transit operators, strengthen transit workplace health promotion programs, and to reduce work stress and obesity risk by conducting sustainable workplace intervention programs among transit operators (Choi, 2019).

The survey was conducted from April to October 2017. A total of 390 LACMTA employees participated in the survey, of which 280 employees were bus operators. About 190 LACMTA employees were recruited for the survey at health fairs at LACMTA divisions organized by the SMART-MTA Trust Fund. An additional 200 questionnaires from LACMTA bus operators across all divisions were collected with the help of the LACMTA Trust Fund and division wellness ambassadors; at that time, a gift card of $20 was provided as a token of appreciation to each of the bus drivers who participated in the survey.

Measures of Psychological Occupational Strain

The Transit Operator Work Stress and Health Survey collected data on several measures of psychological strain, such as the Exhaustion Scale of the Maslach Burnout Inventory (ES-MBI), Primary Care Post-traumatic Stress Disorder (PC-PTSD) Screen, and the General Health Questionnaire (GHQ) (Choi, 2019). In this study, these measures of psychological occupational strain are the categorical variables that are hypothesized to be predictors of CVD risk.

Exhaustion Scale of the Maslach Burnout Inventory (ES-MBI). The most widely used burnout measurement tool is the MBI. The MBI is designed to assess the three components of the burnout syndrome: emotional exhaustion, depersonalization, and reduced personal accomplishment. It was selected due to its reliability, validity, and practicality in measuring the extent of burnout found in service professions (Maslach et al., 1997). Research on burnout reveals that exhaustion may be the most important indicator of stress-related health outcomes than the other two components and is a necessary criterion for burnout (Maslach & Leiter, 2016). In fact, emotional exhaustion has been observed to be more strongly associated with "classical" depressive symptoms than with the other two dimensions of burnout (Bianchi et al., 2015).

The full MBI consists of 22 items with three subscales: 5 items for emotional exhaustion, 5 items for cynicism, and 6 items for professional efficacy. A high degree of internal consistency and reliability is evident from the Cronbach's coefficient alpha of the ES-MBI, which is the highest of all three subscales at 0.90 compared to 0.79 for depersonalization and 0.71 for personal accomplishment (Maslach et al., 1997). Due to known time constraints of bus drivers to be able to complete a study questionnaire, only 3 of the 5 item questionnaire that make up the ES-MBI were included in the survey, with the answer choices for each question being never, a few times a year, once a month, a few times a month, once a week, a few times a week, or everyday:

"Please read the following items and decide if you ever feel this way about your job. If you have never had this feeling, check box for 'Never.' If you have had this feeling, indicate how often you feel this way:

1. I feel emotionally drained from my work.
2. I feel used up at the end of the workday.
3. I feel tired when I get up in the morning and have to face another day on the job" (Choi, 2019).

The cut off score for a positive ES-MBI screen is ≥ 3.20 based on the grading scale of the original questionnaire, which used a zero to six response set (Maslach et al., 1997). A corresponding equivalent cut off score of ≥ 4.33 was used for the survey project due to a one to seven response set where the total score, which has a maximum possible score of 21, is divided by three or the number of questions (Choi, 2019).

Primary Care Post-traumatic Stress Disorder (PC-PTSD) Screen. The PC-PTSD Screen was selected to screen for PTSD. Not only has this screen outperformed other PTSD measures, such as the PTSD Symptom Checklist, but it also is easy to administer, complete and score. The screen can be delivered without an interview, is the shortest PTSD screening questionnaire at 4 items, and is the only questionnaire with a binary yes-no answer format (Prins et al., 2003). The following PC-PTSD Screen was included in the survey, with the answer choices for each question being yes or no:

"Have you ever had any experience that was so frightening, horrible, or upsetting that, in the past month, you:

1. Have had nightmares about it or thought about it when you did not want to?
2. Tried hard not to think about it or went out of your way to avoid situations that reminded you of it?
3. Were constantly on guard, watchful, or easily startled?
4. Felt numb or detached from others, activities, or your surroundings?" (Choi, 2019).

Each yes answer contributes a value of one and each no answer contributes a value of zero for a possible maximum score of 4. A score of ≥ 3 is shown to be the most efficient in terms of diagnostic accuracy at 85%, which is comparable to other commonly used PTSD screening tools (Prins et al., 2003).

General Health Questionnaire (GHQ). The full GHQ is a 60 item psychological stress screening test used to measure the risk of developing psychiatric disorders. The GHQ screens for psychological morbidity by assessing several factors associated with psychiatric disorders, such as anxiety and depression, social dysfunction, and loss of confidence. Thus, it can detect potential cases that may be diagnosed as psychiatric disorders upon further assessment. The GHQ-12 is a shortened screening tool that is found to work just as well as the longer instrument, making it attractive for use in busy clinical settings (Goldberg et al., 1997). However, due to the restricted time of bus drivers to respond to a questionnaire, 6 of the 12 item questionnaire that make up the GHQ-12 were included in the survey, with the answer choices for each question being not at all, no more than usual, rather more than usual, much more than usual:

"We want to know how your health has been in general <u>over the last few weeks</u>. Please read the questions below and each of the four possible answers. Check the response that best applies to you.

1. Lost much sleep over worry?

2. Felt constantly under strain?
3. Felt you couldn't overcome your difficulties?
4. Been feeling unhappy or depressed?
5. Been losing confidence in yourself?
6. Been thinking of yourself as a worthless person?" (Choi, 2019).

The answers are scored on a 0, 0, 1, 1 scale, where a score of zero is given for answer choices "not at all" and "no more than usual" and a score of one is given for answer choices "rather more than usual" or "much more than usual". A positive GHQ is when the total score totals ≥ 2 (Goldberg, 1972).

Measures of Cardiovascular Disease Risk

The outcome of interest was the AHA Life's Simple 7 metric to predict overall cardiovascular health. The LS7 is comprised of seven modifiable cardiovascular risk factors that are defined by specific criteria for blood pressure, cholesterol, diabetes, obesity, physical activity, diet, and smoking. Significant modifications of the LS7 criteria were undertaken for this study since the data available from the survey project were self-reported; no objective measurements were taken. Typically, each LS7 component is given a point score of either 0, 1, or 2 depending on if it is categorized as poor, intermediate, or ideal. An overall LS7 score ranging from 0 to 14 is calculated as the sum of the LS7 component scores (Huffman et al., 2012). However, data to qualify as intermediate or ideal cardiovascular health were not available based on the design of the questionnaire. Thus, only metrics meeting definitions for poor cardiovascular health were included.

Definitions for some of the LS7 components were modified to reflect the data gathered from the survey. The following questions were asked for each component:

Blood Pressure, Cholesterol, & Diabetes. "Do you suffer from any of the following or are taking medication for the following? (Check all that apply)". Answer choices were "high blood pressure", "high cholesterol", "diabetes" (Choi, 2019). Because no objective data were gathered, self-reported history of high blood pressure, high cholesterol, and diabetes served as proxy for elevated total cholesterol ≥240 mg/dL or treated total cholesterol >200 mg/dL, treated or untreated blood pressure >140/>90 mm Hg, and diagnosed diabetes mellitus with HbA1c ≥7%. The effect of treatment in controlling each health condition within goal range was not asked, hence each self-reported health condition was considered as meeting the definition of poor cardiovascular health.

Diet. "How many servings of food do you eat (per day) that are high in fiber, such as whole grain bread, high fiber cereal, fresh fruits or vegetables? (a serving size: 1 slice of bread, ½ cup vegetables, 1 medium fruit, ¾ cup cereal)". Answer choices were "never/rarely", "1-2 servings/day", "3-4 servings/day" and "5-6 servings/day" (Choi, 2019). Thus, this study defined diet by the number of servings per day of food high in fiber, with answer choice "never/rarely" qualifying as 0 servings per day and as poor dietary pattern.

Smoking. "Do you currently smoke or use tobacco products?" Answer choices were "yes" and "no" (Choi, 2019). The answer choice "yes" qualified as the presence of current smoking and met the definition of poor cardiovascular health. No distinction was made between cigarette smoking and other forms of smoking, and no distinction was made between smoking tobacco products and chewing or ingesting tobacco products.

Physical Activity. "On average during the past year, how many days a week have your aerobic and cardio EXERCISE (work outs) met the following two criteria:

- 30 minutes or more in duration
- Medium (work up a sweat and slight heart rate increase) to vigorous intensity (work up a good sweat and rapid heart rate increase)".

Answer choices were "0 days/week", "1 day/week", "2 days/week" and "3 or more days/week" (Choi, 2019). There was no emphasis that respondents consider strictly leisure-time physical activity when answering the question. Nevertheless, the answer choice "0 days/week" qualified as no physical activity and met the definition of poor cardiovascular health.

BMI. BMI was computed from self-reported measurements of height and weight. "What is your height? _________Feet _________Inches" and "What is your weight? _________Lbs" (Choi, 2019). Height was converted into total inches. The following formula was used to compute BMI and to convert units to kg/m^2: (weight (lb) / [height (in)]^2) x 703. A calculated BMI of ≥ 30 kg/m^2 was defined as obese and met the definition of poor cardiovascular health.

Each LS7 component criteria met for poor cardiovascular health was given a point score of 1, and each LS7 component criteria not met for poor cardiovascular health was given a point score of 0. An overall LS7 score ranging from 0 to 7 was calculated from the sum of the LS7 component scores. Overall LS7 scores from 5 to 7 were classified as inadequate cardiovascular health, inferring increased risk for adverse cardiovascular outcomes.

Table 1: Definitions of poor cardiovascular health for each metric, modeled after the LS7.

Metric	Definition
Blood pressure	Blood pressure >140/>90 mm Hg or taking antihypertensive medication
Cholesterol	Total cholesterol ≥240 mg/dL or taking antihyperlipidemic medication
Diabetes	Elevated fasting glucose ≥126 mg/dL or diagnosed diabetes mellitus with HbA1c ≥7%
BMI	Body mass index ≥30 kg/m^2
Physical activity	No physical activity
Diet	0 number of servings per day of food high in fiber
Smoking	Presence of current smoking

Measures of Covariates

The covariates included in the analysis were age, sex, race, educational level, and household income. Sex, race, educational level and household income were analyzed as categorical variables. The categories for each variable used for the analysis are detailed in Table 2. Household income served as a proxy for socioeconomic status. Age was analyzed as a continuous variable. Age was also analyzed as a categorical variable, with age greater than or equal to 42 years based on the median age. Since controlling for age as a categorical variable revealed similar results as controlling for age as a continuous variable, the data for age as a categorical variable were not presented in the results section.

Statistical Analysis

Descriptive statistics were analyzed to characterize the LACMTA bus driver population. The results of the psychological screening tests, which included the GHQ, ES-MBI, and the PC-PTSD screens, were examined and recorded as either positive or negative according to the aforementioned scoring criteria. Data on each of the AHA LS7 components were also gathered and determined to be either positive by meeting the LS7 component criteria or negative by not meeting the LS7 component criteria as described in Table 1.

The prevalence and association between psychological screening tests and LS7 components was determined using a Chi-square analysis. Further statistical analysis using logistic regression with and without controlling for covariates was then performed between each psychological screening test and for each individual LS7 component and the LS7 score for inadequate cardiovascular health. The 95% confidence intervals (CI's) were calculated for each resulting odds ratio.

A stratified analysis by sex was performed to investigate whether sex differences exist in associations between measures of psychological strain and cardiovascular risk factors. The same approach using logistic regression was performed between each psychological screening test and for each individual LS7 component and the LS7 score for inadequate cardiovascular health, with and without controlling for covariates.

All statistical analysis was performed using IBM SPSS Statistics Version 26.0.

CHAPTER 4: RESULTS

The demographic characteristics of the bus driver study population are shown in Table 2. Most of the bus drivers were male (67%), reported their race/ethnicity as Hispanic/Latino/Chicano (48%) and Black (34%), achieved some college education (52%), were married or living with a partner (54%), and had household incomes between $50,000 to $75,000. Both the mean and median age was 42 years.

Table 2: Demographic characteristics of the bus driver study population (N=280).

Study Variable	**Subcategory**	**N (%)**
Age	Mean (range)	42 years (22-69)
Sex	Male	183 (67%)
	Female	90 (33%)
Race/Ethnicity	Hispanic/Latino/Chicano	133 (48%)
	Black	96 (34%)
	White/Non-Hispanic	17 (6%)
	Asian/Pacific Islander	20 (7%)
	Other (including Multi-racial/ethnic)	20 (7%)
Education	Some high school	17 (6%)
	High school diploma	92 (34%)
	Some college	141 (52%)
	Bachelor's degree or higher	24 (9%)
Marital Status	Married/Living with partner	150 (54%)
	Divorced or separated/Widowed	43 (16%)
	Never married/single	83 (30%)
Household Income	< $25,000	17 (7%)
	$25,000 to 49,999	76 (29%)
	$50,000 to 74,999	111 (43%)
	$75,000 to 124,999	55 (21%)

The prevalence of each LS7 component and indicators of psychological occupational strain are displayed in the following Figures 3 and 4. In Figure 3, the prevalence of each LS7 metric and the LS7 score for inadequate cardiovascular health are outlined for the study population totaling 280 subjects. The prevalence of those meeting the LS7 component criteria is 21.1% for the blood pressure criteria, 11.4% for the cholesterol criteria, 7.5% for the diabetes criteria, 51.1% for the BMI criteria, 21.4% for the physical activity criteria, 8.9% for the diet criteria, and 17.1% for the smoking criteria. Approximately 2.5% of bus drivers met the criteria for inadequate CVH based on overall LS7 score.

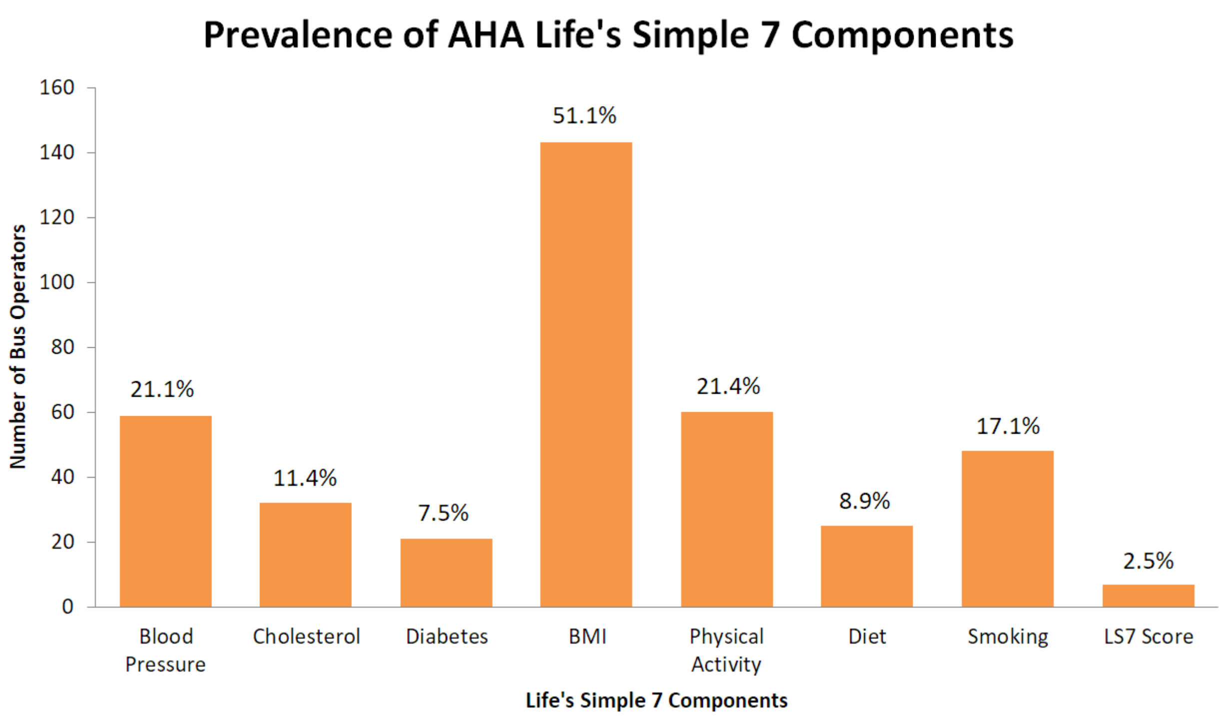

Figure 3: Prevalence of bus drivers satisfying criteria for LS7 components and overall LS7 score for inadequate cardiovascular health. The histogram displays the number of bus drivers who meet each criteria and the corresponding percentage of bus drivers of the total study population (N=280).

In Figure 4, the prevalence of those with positive psychological screening questionnaires are 55%, 15.7%, and 27.5% for the ES-MBI, PC-PTSD, and GHQ screens in the study population of 280 subjects.

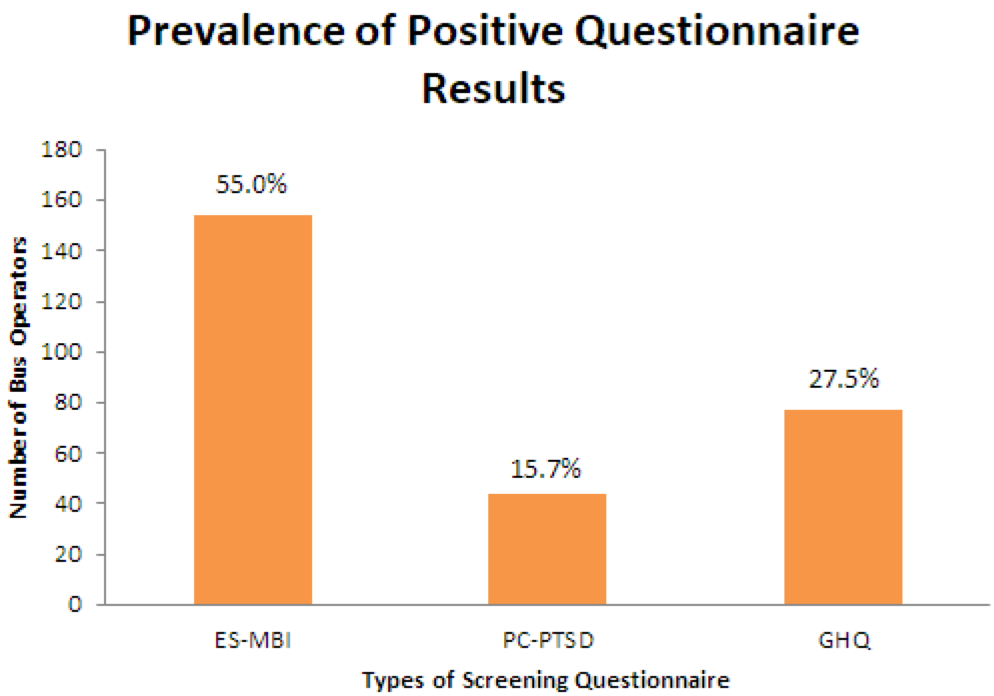

Figure 4: Prevalence of positive screening questionnaire results for the ES-MBI, PC-PTSD, and GHQ with the corresponding percentages of positive results of the total study population (N=280).

Results of Bivariate Analysis. Initial bivariate analysis with Chi-square testing examined the prevalence of each psychological screening test with the LS7 score for inadequate CVH. The overall prevalence of those meeting criteria for inadequate CVH was calculated at 2.5%. As shown in Table 3, all the psychological screening tests were associated with a higher than expected number of those with inadequate CVH at 3.2% for ES-MBI, 4.5% for PC-PTSD, and 6.5% for GHQ.

Table 3: Screening test results by LS7 component criteria and overall LS7 score for inadequate cardiovascular health (N=280).

Screening Test	**Test Result**	**BP (%)**	**Cholesterol (%)**	**Diabetes (%)**	**BMI (%)**	**Physical Activity (%)**	**Diet (%)**	**Smoking (%)**	**LS7 (%)**
ES-MBI	**Yes:** 154	18.2	12.3	7.8	**60.8****	22.9	9.2	16.6	3.2
	No: 126	25.4	10.7	7.4	**44.5****	20.0	9.2	18.3	1.6
PC-PTSD	**Yes:** 44	25.0	6.8	6.8	61.9	14.3	14.0	23.3	4.5
	No: 236	21.0	13.7	8.8	50.8	25.4	8.4	17.2	2.4
GHQ	**Yes:** 77	28.6	15.6	10.4	**63.5***	28.0	10.8	13.5	**6.5****
	No: 203	18.2	9.9	6.4	**49.5***	19.6	8.6	19.2	**1.0****

In Table 3, the percentages of study subjects meeting the criteria for each LS7 component and the LS7 score for inadequate CVH were calculated by using the total number of subjects in each test results category. Relationships with statistically suggestive associations based on significant Chi-square test results are denoted by "*" for p <0.05 and "**" for p <0.01.

The Chi-square analysis also reveals statistically significant associations between certain psychological screening tests and individual components of LS7 as well as LS7 score for inadequate CVH. These associations are ES-MBI and BMI, GHQ and BMI, and GHQ and inadequate CVH. There was a higher prevalence of those meeting criteria for BMI in those with positive ES-MBI and GHQ screens than in those with negative respective psychological screens.

There was also a higher prevalence of those meeting the LS7 score criteria for inadequate CVH in those with positive GHQ screens than in those with negative GHQ screens. These results were anticipated when formulating the hypothesis.

Results of Logistic Regression Analysis. Multivariate analysis was performed and odds ratios were calculated through a logistic regression analysis for each LS7 component with and without controlling for covariates. The results are displayed in Table 4.

Statistically significant OR's were found for GHQ, ES-MBI, and PC-PTSD with some components of LS7. Without significant change upon controlling for covariates, statistically significant results were found between the GHQ and BMI (adjusted OR 1.95, 95% CI 1.03-3.66) and ES-MBI and BMI (adjusted OR 1.99, 95% CI 1.11-3.58). Upon controlling for covariates, statistically significant results were demonstrated between GHQ and BP (adjusted OR 2.76, 95% CI 1.22-6.24), GHQ and cholesterol (adjusted OR 2.40, 95% CI 1.01-5.73), and GHQ and diabetes (adjusted OR 4.39, 95% CI 1.19-16.25).

The other LS7 components, which include diet and smoking, did not reveal any statistically significant associations with any of the three psychological screening tests. Although not statistically significant, negative associations were found between PC-PTSD and physical activity and PC-PTSD and cholesterol. These relationships indicate that a positive PC-PTSD screen was associated with a lower likelihood of meeting the physical activity criteria and the cholesterol criteria for LS7, which is the opposite of what was expected considering the current literature. However, the relationships revealed could have been due to chance alone, especially given the small sample size and the large confidence intervals.

A logistic regression was also performed for each screening test and the overall LS7 score for inadequate cardiovascular health. Without controlling for covariates, a statistically significant association was found with GHQ and LS7 score for inadequate CVH (OR 7.62, 95% CI 1.44-40.27). This association persisted even after controlling for covariates in combination (adjusted OR 11.27, 95% CI 1.42-89.76). Otherwise, no other statistically significant relationships were found between each of the screening tests as predictors for inadequate CVH.

Table 4: OR results of logistic regression analysis for psychological screening tests as predictors for inadequate cardiovascular health defined by overall LS7 score and LS7 components with and without controlling for covariates (N=280).

	Screening Test					
LS7 Component	**ES-MBI** OR (95% CI)		**PC-PTSD** OR (95% CI)		**GHQ** OR (95% CI)	
	Unadjusted	Adjusted+	Unadjusted	Adjusted+	Unadjusted	Adjusted+
BP	0.65 (0.37-1.16)	0.80 (0.37-1.72)	1.26 (0.59-2.69)	1.30 (0.44-3.79)	1.80 (0.98-3.30)	**2.76 (1.22-6.24)**
Cholesterol	1.18 (0.56-2.50)	1.38 (0.59-3.27)	0.46 (0.13-1.60)	0.55 (0.15-2.05)	1.69 (0.78-3.65)	**2.40 (1.01-5.73)**
Diabetes	1.06 (0.43-2.61)	2.14 (0.63-7.23	0.76 (0.21-2.70)	2.27 (0.47-11.05)	1.70 (0.67-4.26)	**4.39 (1.19-16.25)**
BMI	**1.93 (1.18-3.15)**	**1.99 (1.11-3.58)**	1.58 (0.80-3.12)	1.25 (0.56-2.77)	**1.78 (1.03-3.08)**	**1.95 (1.03-3.66)**
Physical Activity	1.19 (0.66-2.13)	1.24 (0.63-2.45)	0.49 (0.12-1.23)	0.41 (0.14-1.18)	1.60 (0.86-2.95)	1.82 (0.90-3.66)
Diet	1.00 (0.44-2.28)	1.02 (0.39-2.65)	1.77 (0.66-4.80)	2.13 (0.67-6.84)	1.29 (0.53-3.13)	1.30 (0.49-3.50)
Smoking	0.88 (0.47-1.66)	1.13 (0.52-2.43)	1.46 (0.66-3.22)	1.89 (0.73-4.91)	0.66 (0.31-1.40)	0.79 (0.33-1.89)
LS7 Score	2.06 (0.39-10.8)	4.35 (0.54-35.25)	2.05 (0.38-10.99)	2.46 (0.29-20.76)	**7.62 (1.44-40.27)**	**11.27 (1.42-89.76)**

+ Adjusted for age, sex, race, socioeconomic status, and education.

Results of Sex-Stratified Analysis. A better understanding of the role of occupational stress on women drivers is needed, particularly as more women throughout the world enter the paid workforce; however, the vast majority of bus driver research to date has examined men. Bus driving is one of the few occupations in the labor market where men and women perform the same work requirements, with the same salary, which eliminates gender-specific roles as one of the complicating methodological factors in occupational stress research. In addition, the vast majority of stressors faced by urban bus drivers are objective, physical hassles such as traffic congestion or delays that are completely independent of the driver. Even so, male and female bus drivers may interpret their work conditions differently (Aronsson & Rissler, 1998; Rydstedt et al., 1998a; Tse et al., 2006). Given that about one-third of the study population is female, sex differences in associations between psychological health indicators and individual components of LS7 as well as overall cardiovascular health may be detected. Thus, logistic regression analysis was performed stratified by sex with and without controlling for covariates. The results for males are displayed in Table 5. The results for females are displayed in Table 6.

For males, statistically significant OR's were found between ES-MBI and BMI (adjusted OR 2.45, 95% CI 1.18-5.10) and GHQ and LS7 score for inadequate CVH (adjusted OR 20.87, 95% CI 1.15-378.70) without significant change upon controlling for covariates. Statistically significant results were also revealed between GHQ and cholesterol (adjusted OR 3.04, 95% CI 1.03-8.99) and GHQ and diabetes (adjusted OR 5.32, 95% CI 1.01-27.98) upon controlling for age, race, socioeconomic status, and education combined. The other LS7 components, which include physical activity, diet and smoking, did not reveal any statistically significant associations with any of the three psychological screening tests. Additionally, no other statistically significant relationships were found between each of the screening tests as predictors for inadequate CVH.

For females, statistically significant OR's were found between GHQ and physical activity (adjusted OR 3.33, 95% CI 1.13-9.76) without significant change upon controlling for covariates. Upon controlling for covariates combined, statistically significant results were revealed between GHQ and BMI (adjusted OR 4.68, 95% CI 1.32-16.60). The other LS7 components, which include blood pressure, cholesterol, diabetes, diet and smoking, did not reveal any statistically significant associations with any of the three psychological screening tests and no statistically significant relationships were found between each of the screening tests as predictors for inadequate CVH.

Table 5: OR results of logistic regression analysis for psychological screening tests as predictors for inadequate cardiovascular health defined by overall LS7 score and LS7 components with and without controlling for covariates in males (N=183).

	Screening Test					
LS7 Component	**ES-MBI** OR (95% CI)		**PC-PTSD** OR (95% CI)		**GHQ** OR (95% CI)	
	Unadjusted	Adjusted+	Unadjusted	Adjusted+	Unadjusted	Adjusted+
BP	0.69 (0.35-1.36)	0.81 (0.34-1.91)	0.92 (0.36-2.34)	0.79 (0.22-2.85)	1.90 (0.92-3.95)	2.53 (0.96-6.64)
Cholesterol	1.16 (0.47-2.83)	1.33 (0.49-3.59)	0.44 (0.10-2.02)	0.68 (0.13-3.50	1.79 (0.70-4.58)	**3.04 (1.03-8.99)**
Diabetes	1.29 (0.43-3.87)	2.47 (0.57-10.62)	0.74 (0.16-3.51)	2.46 (0.32-18.96)	1.68 (0.53-5.29)	**5.32 (1.01-27.98)**
BMI	**2.37 (1.30-4.33)**	**2.45 (1.18-5.10)**	1.34 (0.59-3.01)	1.02 (0.37-2.79)	1.45 (0.74-2.85)	1.18 (0.53-2.61)
Physical Activity	1.01 (0.47-2.14)	0.87 (0.33-2.25)	0.62 (0.20-1.93)	0.51 (0.12-2.07)	0.78 (0.31-1.94)	1.22 (0.42-3.54)
Diet	0.82 (0.32-2.11)	0.78 (0.25-2.44)	1.97 (0.64-6.04)	2.57 (0.64-10.26)	0.76 (0.24-2.42)	0.66 (0.18-2.49)
Smoking	0.73 (0.36-1.51)	0.61 (0.25-1.46)	1.52 (0.61-3.81)	2.21 (0.69-7.02)	0.51 (0.20-1.31)	0.61 (0.19-1.94)
LS7 Score	0.94 (0.13-6.84)	1.37 (0.15-12.45)	1.71 (0.17-17.08)	5.08 (0.29-88.16)	9.85 (1.00-97.37)	**20.87 (1.15-378.70)**

+ Adjusted for age, race, socioeconomic status, and education.

Table 6: OR results of logistic regression analysis for psychological screening tests as predictors for inadequate cardiovascular health defined by overall LS7 score and LS7 components with and without controlling for covariates in females (N=90).

	Screening Test					
LS7 Component	**ES-MBI** OR (95% CI)		**PC-PTSD** OR (95% CI)		**GHQ** OR (95% CI)	
	Unadjusted	Adjusted+	Unadjusted	Adjusted+	Unadjusted	Adjusted+
BP	0.48 (0.14-1.64)	0.69 (0.06-8.70)	2.90 (0.73-11.47)	36.58 (0.46-2895.37)	1.61 (0.46-5.58)	4.29 (0.30-60.88)
Cholesterol	1.08 (0.25-4.64)	1.48 (0.24-9.24)	0.56 (0.06-4.86)	0.29 (0.01-6.71)	1.79 (0.44-7.24)	1.54 (0.29-8.17)
Diabetes	1.07 (0.19-6.22)	3.71 (0.10-135.66)	0.94 (0.10-8.72)	4.60 (0.10-210.84)	2.23 (0.42-11.80)	5.15 (0.20-134.20)
BMI	1.26 (0.52-3.07)	1.60 (0.50-5.08)	2.18 (0.61-7.82)	2.13 (0.48-9.44)	2.41 (0.91-6.37)	**4.68 (1.32-16.60)**
Physical Activity	1.19 (0.45-3.19)	1.40 (0.45-4.31)	0.31 (0.06-1.51)	0.32 (0.06-1.79)	**3.00 (1.16-7.79)**	**3.33 (1.13-9.76)**
Diet	2.94 (0.33-26.38)	8.07 (0.49-132.09)	1.17 (0.12-11.37)	1.12 (0.07-17.23)	5.13 (0.88-29.95)	4.60 (0.53-40.04)
Smoking	4.80 (0.57-40.29)	24.81 (0.80-436.78)	1.41 (0.26-7.61)	1.01 (0.13-7.81)	1.79 (0.44-7.24)	2.27 (0.45-11.59)
LS7 Score	2.50 (0.27-23.44)	3.07 (0.16-58.02)	2.50 (0.21-29.83)	3.43 (0.04-290.04)	5.36 (0.46-62.15)	7.17 (0.12-433.80)

+ Adjusted for age, race, socioeconomic status, and education.

CHAPTER 5: DISCUSSION

Statistically significant associations were found between certain positive psychological strain questionnaire scales and LS7 components in this study. These results suggest the possibility of association between psychological occupational strain and cardiovascular risk factors. Specifically, statistically significant results were found between ES-MBI and BMI, GHQ and BMI, GHQ and BP, GHQ and cholesterol, GHQ and diabetes, and GHQ and LS7 score for inadequate cardiovascular health after controlling for covariates of age, gender, race, education, and socioeconomic status combined. The different relationships found between different measures of psychological occupational strain, assessed by the GHQ, ES-MBI, and PC-PTSD, may be due to the unique pathophysiological processes associated with the type of mental health diagnoses screened by each questionnaire.

Not all relationships revealed positive associations, which is contrary to what was expected. Consistent negative relationships were found between PC-PTSD and physical activity, indicating that a positive PC-PTSD screen was associated with a lower likelihood of bus drivers performing no physical activity. These results conflict with the current literature on PTSD. A recent systematic review investigating whether PTSD is associated with behavioral risk factors found 12 studies reporting associations between PTSD and physical activity; six of those studies found no association and the other six studies showed PTSD is linked to less physical activity (Berk-Clark et al., 2018). Other studies have reported that as PTSD symptoms increased, physical activity levels decreased, or that only hyperarousal symptoms of PTSD were significantly and negatively associated with exercise (Hall et al., 2015). Additionally, consistent negative relationships were found between PC-PTSD and cholesterol, indicating that a positive PC-PTSD screen was associated with a lower likelihood of bus drivers meeting the LS7 cholesterol criteria. However, research has shown that PTSD is associated with abnormal serum lipid concentrations, although most of these studies were investigated in military veterans and in police officers. It is thought that to fuel states of elevated arousal, such as in individuals with PTSD, the sympathetic nervous system stimulates the process of lipolysis, whereby free fatty acids are released into the blood stream thereby increasing concentrations of serum-lipid levels (Dennis et al., 2015).

These results may be in part due to this study's use of self-reported data on dyslipidemia and physical activity level with single-item measures, rather than use of data from objective measurements or from a validated physical activity questionnaire. As part of a baseline assessment for a worksite intervention in metropolitan transit workers, French et al. (2007) used both self-reported physical activity measures through questionnaires and objective measures of physical activity via an Actigraph accelerometer, which is shown to be a valid and reliable measure of physical activity in adults. It was found that levels of self-reported moderate and vigorous physical activity were unrealistically high compared to the levels measured by the accelerometer. Over-reporting of physical activity has also been reported in other population-based studies, and the reason for this may be due to the inclusion of other activities, such as home chores, transportation-related physical activity, and work activity, compared with the strictly leisure-time physical activity that is asked about in questionnaires (French et al., 2007; Hedberg et al., 1993). In addition, the AHA LS7's physical activity criterion only considers levels of physical activity during leisure-time. However, the survey question did not ask about exercise levels specifically during leisure-time, allowing bus drivers to regard their labor during work hours as exercise as well, leading to an overestimate of actual physical activity in the sample population. The negative relationship between PC-PTSD and cholesterol is more difficult to explain. Perhaps objective measurements of cholesterol levels could have assisted in corroborating the self-reported information, especially since drivers may be undiagnosed or are uncertain because they have not sought recent health care due to their busy schedules. Even though all LACMTA bus drivers are unionized and have health insurance, this information about whether bus drivers regularly visit their primary care provider was not asked in the survey. Moreover, it is important to consider that these apparent associations could be due to chance, since other screening tests did not have corresponding negative relationships.

Sex-stratified analysis revealed mostly similar results for males as in the general bus driver population, perhaps because males compose the majority of the sample population and are more likely to reflect comparable results. However, females revealed unique relationships that were not seen in males or in the general bus driver population sample. A statistically significant positive association was found between GHQ and physical activity, without much change upon controlling for covariates individually or combined. This relationship between psychological strain and poor levels of physical activity in women is supported in literature. For women bus drivers, changes in workload are strongly associated with perceived effort to carry out work and with fatigue spillover from work to leisure time and home life (Rydstedt et al., 1998; Aronsson & Rissler, 1998). Several LACMTA women operators in the qualitative study by Dobson et al. (2017) reported more work-family conflict when they worked long and irregular shifts. Long work hours, combined with greater domestic demands at home compared to men, may reduce leisure-time exercise for women operators. This is confirmed by a study in a large population of active workers in Brazil, which found that women with frequent strain-based work interference with family, frequent family interference with work, or frequent lack of time for personal care and leisure had lower prevalence of physical activity at goal levels (Rocco et al., 2019). These factors are more likely to be experienced by minority women operators given the more common single female-headed families among African Americans (43% vs. 13% among Whites) and the limited access to healthy environments in minority communities (i.e. parks and supermarkets providing healthy foods); most of this study's sample population is comprised of minorities (Dobson et al., 2017; Choi et al., 2017).

Of all the LS7 components, the prevalence of obesity in the sample population was the highest at 51.1%. This is approximately 1.7 times higher than the prevalence of obesity in US working populations and approximately 1.3 times higher than the prevalence of obesity among U.S. adults (Gu et al., 2014; Hales et al., 2017). Associations between certain measures of psychological strain and obesity persisted even after stratifying the analysis by sex. In the general bus driver population, both ES-MBI and GHQ revealed positive associations with BMI, with and without controlling for covariates. However, the sex-stratified analysis revealed different patterns of statistically significant associations between psychological screening tests and BMI. Whereas the analysis in males showed an association between ES-MBI and BMI, the analysis in females showed an association between GHQ and BMI. Again, these different relationships may be due to the unique pathophysiological pathways and perceived type of psychological strain screened by each questionnaire. Contrary to the results found in this study, many studies have not found significant gender differences among poor mental health in the form of emotional exhaustion or burnout as measured by the ES-MBI, or psychological distress and increased risk of psychiatric disorders as measured by the GHQ, with obesity (Fezeu et al., 2015; Melamed et al., 2006; Armon et al., 2008). In fact, one longitudinal study found that burnout was not a significant positive predictor of subsequent obesity in both men and women, although this study used a different measurement tool rather than the MBI to assess burnout

(Armon et al., 2008). The results of this study and its discrepancy with existing literature point to the need for further research on the possibility of gender differences in the mechanisms of the link between psychological strain measures, obesity, and other cardiac risk factors.

Lastly, unlike in the analysis of males where GHQ was significantly associated with inadequate CVH, no statistically significant relationships were found between each of the screening tests as predictors for inadequate CVH in females. These non-associations could have been due to the very small sample size of women who met the criteria for inadequate CVH defined by overall LS7 score, since only 2.5% of the general bus driver population met the criteria for inadequate CVH. A larger bus driver sample population is needed to provide adequate statistical power when stratifying the sample by sex.

Health and Policy Implications

Overwhelming evidence from literature review supports the belief that bus driving is an unhealthy occupation. Bus drivers are more likely to experience psychological stress in the form of PTSD, emotional exhaustion, and depression, and are more likely to experience morbidity from cardiovascular disease. Yet, the health of drivers is an important issue in public health, occupational health, and transport policy. Poor medical outcomes among operators result in high rates of absenteeism and disability and in increased costs from labor turnover and disability claims. Operators also have a large impact on the performance of the transit system, and overseeing the safety of travelers and other road users is of prime importance in preventing motor vehicle accidents. Therefore, the implications of bus driver health cannot be ignored.

This study reveals that poor mental health indicators can contribute to cardiovascular risk factors and ultimately cardiovascular illness in the bus driver population. These findings merit the promotion of mental health among bus drivers as an even higher priority to reduce cardiovascular risk and can inform future research and policy. Moreover, early recognition and treatment of mental health disorders may be crucial to prevent the poor health outcomes in the transit industry and to maintain the function of its workforce. Utilizing psychological strain screening tools can help identify those bus drivers at high risk of developing CVD.

Some countries have recognized the importance of stress in cardiovascular disease and have introduced campaigns to limit work stress. Some have even published guidelines that include stress management as part of a coronary heart disease prevention plan. Yet no definitive recommendations have emerged in the United States for the primary prevention of CHD in bus drivers by means of mental health prevention and preservation (Sara et al., 2018). Future research evaluating the effectiveness of interventions targeting psychological well-being with cardiovascular outcomes can potentially strengthen the linkage between mental health and CVD and lend further support for public policy measures designed to promote mental health among bus drivers in the United States.

Study Limitations and Strengths

There are a number of limitations in this study, in addition to those mentioned earlier in the discussion section. This study was cross-sectional in nature, and therefore, no conclusions can be drawn regarding the temporality and causality of any observed associations. There was also the possibility of selection bias when recruiting study participants. Despite efforts to design the questionnaire to be relatively short, to recruit more participants across divisions, and to provide monetary incentives, the sample size of the study population remained small. The LACMTA employs over 4,500 bus operators to over 9 million Los Angeles County residents, and yet, only 390 LACMTA employees participated in this study. Those bus drivers who were willing to respond to the survey project may have been systematically different to those who did not respond. Maybe those who responded had more time and were thus less stressed than non-responders, or maybe they were more health-conscious since half the participants were recruited at health fairs. However, the study participants appeared to represent all LACMTA transit operators in terms of age, sex, and race/ethnicity (Choi, 2019). Additionally, with the small sample size, there may not have been adequate power to detect associations in this study, increasing the probability of a type II error.

This study also relied on self-reported data to assess outcomes. Even though robust evidence from literature demonstrates that bus drivers have higher rates of cardiovascular disease and its risk factors than other occupational groups, this study found similar levels of hypertension and diabetes and lower levels of cholesterol than in the general U.S. working population (Shockey et al., 2016). There may have been underreporting of health status since some of these conditions are screened and evaluated during bus driver medical examinations as required by the Department of Transportation. This could have led to an underestimate of associations between mental health and CVD risk factors and inadequate CVH. Perhaps objective measurements for outcomes could have provided a better assessment of the prevalence and severity of CVD risk factors. Objective measurements would also have provided the data to classify blood pressure, cholesterol, and diabetes metrics as poor, intermediate, or ideal according to the LS7 criteria intended by the AHA (Huffman et al., 2012).

Instead, definitions for the AHA LS7 metrics had to be modified for this study based on the self-reported data available. For example, any reported medical condition was classified as poor cardiovascular health, regardless of the severity of the condition or whether the condition was under control with use of medication. Thus, even individuals who have been diagnosed with a medical condition but who are treated to within goal range were grouped in the same category as those who have uncontrolled disease, even though their risk for developing cardiac disease is likely lower. These individuals would be differentiated under the LS7 criteria as defined by the AHA. Other LS7 component definitions had to be modified according to the data gathered from the survey. For example, diet was defined as the number of servings per day of food high in fiber, rather than the number of target dietary components met by current guideline recommendations. And physical activity did not solely refer to the leisure-time physical activity specified in the AHA criteria. These adjustments in definitions may not meet evidence-based guideline recommendations for health behaviors that can reduce CVD risk according to the AHA; however, physical activity defined as “no physical activity” and diet defined as “0 number of servings per day of food high in fiber” in this study still serve as useful determinants of poor cardiovascular health.

The AHA-proposed LS7 metrics have their own shortcomings as well. For example, central obesity, which is defined by waist to hip ratio or waist circumference, is a more sensitive marker of body fat distribution and obesity and is associated with higher mortality than BMI (Han et al., 2019). However, BMI is still heavily used in large-scale studies because it is the only obesity measure routinely collected by medical providers. In addition, the LS7 focuses exclusively on conventional cardiovascular risk factors, which in themselves account for 75% of all incident cases of CHD. Alternative nonconventional risk factors may account for the rest of this gap, such as excessive alcohol intake, family history of cardiac diseases, and genetics (Beaglehole & Magnus, 2002). These risk factors are becoming increasingly important and are usually not accounted for in traditional CVD risk prevention models.

In this study, exposure was not assessed directly through measures of work stress but by measures of strain through psychological screening questionnaires. Research suggests that work stressors, such as length of shifts, can affect CVD risk factors even if the conditions do not cause psychological strain (Hanson et al., 2019). Thus, it would be relevant to assess the effect of work stressors as well. However, this analysis could not be performed due to limited scope of this study, which focused specifically on the role of psychological strain reactions. This unique focus was determined since it may be possible to design workplace interventional programs that reduce psychological strain even if work stressors cannot be fully addressed.

Measuring psychological strain via the GHQ, ES-MBI, and PC-PTSD screening tests also presents a few limitations. First, there is the possibility of response bias because the use of these questionnaires involves a subjective component that may be influenced by the interpretation of each question. Second, although these devices are designed as screening instruments for use in community settings, the GHQ in particular is not a measure of a clinically recognized psychiatric disorder, and thus cannot be used as a diagnostic tool. Findings of associations with GHQ may not be directly transferable to individuals meeting the criteria for specific mental disorders, such as major depressive disorder. Third, the symptom scales of these questionnaires do not measure severity (Kivimäki et al., 2009). And lastly, the screening questionnaires had to be greatly shortened to become more feasible and convenient for bus drivers and to increase participation rates. However, eliminating questions also eliminates information that can affect the sensitivity, reliability, and validity as compared to the full screening test (Goldberg, 1972).

Despite the limitations, there are several strengths in this study. This is the first known study to investigate the potential effects of psychological strain on LS7 components and cardiovascular risk in bus drivers. This is also one of the few studies that have analyzed psychological and cardiovascular health in women bus drivers, since the vast majority of bus driver research to date has examined only men. Further research is needed to corroborate the findings of this study and to evaluate the effectiveness of interventions that aim to reduce CVD by improving the occupational psychological health and working conditions of bus drivers.

CHAPTER 6: CONCLUSION

Despite evidence in the general literature that mental health disorders, such as PTSD, depression, and burnout, are linked to CVD, these relationships have not been investigated in bus drivers. Given that the job characteristics of bus driving can lead to high levels of occupational stress and that stress can result in both cardiovascular and psychological strain, there is a conceivable association between poor mental health indicators and cardiovascular health in this occupational group. This study supports that hypothesis. Even when controlling for age, gender, race, socioeconomic status, and education combined, this study found that certain measures of psychological strain were associated with CVD risk factors identified by the AHA LS7. Associations were also found when the analysis was stratified by sex. These findings suggest that some mental health indicators can predispose both male and female bus drivers to cardiovascular risk factors and to poor cardiovascular health.

This research has implications not only for bus drivers, but also for transit authorities, occupational medicine physicians, and the communities in which bus drivers serve. Policy and practice targeting the psychosocial work environment with therapy for mental health may reduce the burden of adverse cardiovascular outcomes among bus drivers across the world. Additionally, using mental health screening tools as part of a primary prevention plan may identify those most at risk of developing CVD and can prompt early intervention. The benefits of preventing cardiovascular illness in bus operators include but are not limited to decreases in healthcare costs, decreased rates of absenteeism and turnover, decreased rates of grievances against the employer, and decreases in interpersonal conflicts. Most importantly, disease prevention promotes a healthier workforce with improved well-being and performance. As a result, the safety of bus drivers and road travelers alike can be further secured.

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