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Associations between COVID-19-Related Job Stressors and Marijuana Use in Californian Adult
Workers

THESIS

submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE

In Environmental Health Sciences

by

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2022

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Dedication

To John Shahin, our families, and our friends.

Thank you for everything.

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I would like to thank my thesis advisor, Dr. Jian Li, and my thesis committee Dr. Ulrike Luderer and Dr. Kitazawa for their support, mentorship, and guidance on this research project and thesis. I would also like to thank Dr. Alya Khan, the residency program director, for her ongoing mentorship, dedication, and support in the residency program and master's program.

Abstract

The COVID-19 pandemic has caused disruptions in the daily lives of many workers. These changes led to increased stress for workers. The effects of the pandemic on the mental health and behavior of the general population and workers are an important public health issue. Job stress has been associated with substance use in workers, specifically alcohol and tobacco use. Substance use has been studied in various populations throughout the pandemic, but there have been fewer studies specifically on marijuana use in workers. However, use of marijuana and cannabis products, in general, has been rising and cannabis is the third most used drug in the United States after alcohol and tobacco.

We conducted a cross-sectional analysis of COVID-19-related job stressors and marijuana use in the prior month and the prior year. We utilized data from the California Health Interview Survey from 2020. Data from 10,365 Californian workers was assessed in this study. COVID-19-related reductions in work hours, lost jobs, and working from home were considered job stressors. Approximately 4.17% of the study population experienced job loss, 21.02% experienced a reduction in work hours, and 40.21% switched to working from home due to COVID-19. Logistic regression analyses were used to predict the odds of marijuana use within the past month and past year. COVID-19-related job stressors were statistically significantly related to marijuana use within the past month and the past year ($p < 0.05$). These associations remained significant upon adjustment for covariates. Stratified analyses were then conducted to assess whether the associations varied by demographic and socioeconomic strata. Male workers had significant associations between COVID-19-related job stressors and marijuana use within

one month and one year. COVID-19-related job loss and marijuana use were significantly associated for the Black and Hispanic groups and lower income groups. Working from home due to COVID-19 tended to be significantly associated with marijuana use in Whites, Asians, and Hispanics and in higher educational and income groups.

Overall, associations between job stressors and marijuana use during COVID-19 were significant across Californian workers. This suggests that job stressors due to the COVID-19 pandemic may be related to marijuana use in workers. Our results warrant further investigation of how and why job stressors differentially impact demographic groups. Additionally, research on the burden of marijuana use on these groups and how it affects their relationships, health, and work can help to reveal the scope of the problem and develop mitigation strategies.

Chapter 1 Introduction and Purpose

The coronavirus (COVID-19) pandemic began in 2019. The World Health Organization (WHO) announced an outbreak of COVID-19 in January 2020 in Wuhan, China. Within the next few months, cases of the virus were confirmed throughout the world and a pandemic was declared in March 2020. In the United States, 42 states and Puerto Rico issued stay-at-home orders in 2020 between March 1st and May 31st (Moreland et al., 2020). Eight states had stay-at-home orders which extended beyond May 31st (Moreland et al., 2020). On a global scale, high rates of stay-at-home orders and containment policies occurred in March and April of 2020, with increasing heterogeneity emerging in May 2020 (Phillips et al., 2021).

The mandated stay-at-home periods have been associated with increased sedentary behaviors and increased anxiety and mental health symptoms (Flanagan et al., 2021; Marroquín et al., 2020). In addition to the lifestyle and social changes due to stay-at-home orders, the COVID-19 pandemic also led to rapid changes in the workplace, including increased work from home and concerns regarding job insecurity (Chirumbolo et al., 2021; Lin et al., 2021). It has been reported that the unemployment rate in the United States reached 14.7% in April 2020 (*The Employment Situation - September 2022*, 2022). In addition, between April and December 2020, it is estimated that 50% of paid work hours were telework compared to 5% of paid work hours before the pandemic, indicating the magnitude of change experienced by the working population (Barrero et al., 2021).

The pandemic's impact on mental health has garnered significant interest by public health experts and the public. However, there are fewer studies that specifically focus on substance use

patterns during COVID-19. Overall, it has been shown that there was an increase in reported mental health problems during the pandemic (Mukhtar, 2020; Hossain et al., 2020). There are likely varying degrees of impact on mental health based on demographic strata (Hossain et al., 2020). Substance use patterns have been more mixed, depending on the population and the substance, making it difficult to identify one overarching trend in the positive or negative direction regarding substance use during the COVID-19 pandemic (Schmidt et al., 2021). For example, alcohol use trends have shown both increased use and decreased use, and alcohol use is also associated with previous alcohol use and demographic factors (Roberts et al., 2021; Schmidt et al., 2021).

Further, there is controversy in the literature regarding the relationships between work stressors, economic stress, and substance use (Catalano et al., 2011; Dávalos et al., 2012; Nagelhout et al., 2017). Therefore, more research on substance use during the COVID-19 pandemic is needed to elucidate trends and guide effective public health surveillance. This can also further help to design interventions and preventive programming for future periods of crises or disaster.

There have been a significant number of studies on adolescent and student mental health and substance use due to COVID-19-related changes in their academic and social environments (Chaffee et al., 2021; Oh et al., 2021). There are fewer studies that examine mental health and substance use in working adults in the United States during the pandemic. Within that category of mental health and substance use, a small number of studies focus on marijuana in working adults, as a greater number of studies have focused on alcohol and tobacco use. This study is the largest study, to our knowledge, that addresses potential relationships between marijuana use and COVID-19-related job stressors in workers in the United States.

The primary objective of this study is to identify associations between COVID-19-related job stressors with marijuana use in Californian adult workers. Further, we aimed to analyze the sociodemographic subgroups in Californian workers to assess variations in the strengths of associations between COVID-19-related job stressors and marijuana use. We hypothesized that COVID-19-related job stressors, including reduced work hours, lost jobs, and working from home, would be associated with higher odds of marijuana use in the previous month and previous year.

Chapter 2 Literature Review

Trends in Economic Hardship and Substance Use

Before the COVID-19 pandemic became a worldwide crisis in 2020, the global financial crisis that began in 2007-2008 was the most recent worldwide hardship (Colell et al., 2015). A body of research emerged from this time period that focused on the effects of economic stress on the well-being of people, including patterns of substance use (Colell et al., 2015).

There are two main hypotheses that predict the opposite effects of economic downturns and/or unemployment on substance use: counter-cyclical and pro-cyclical (Dávalos et al., 2012; Nagelhout et al., 2017). The pro-cyclical theory suggests that due to decreased income and resources, substance use decreases during times of increased unemployment or economic downturn. The counter-cyclical theory states that during periods of increased unemployment and/or economic downturns, substance use increases (Nagelhout et al., 2017). A large macroeconomic study in the United States showed that increased unemployment rates were associated with increased problematic alcohol use (Dávalos et al., 2012). Another international, large literature review showed that increased unemployment was associated with increased drug use (Nagelhout et al., 2017). The counter-cyclical hypothesis is substantiated by another study that tied increased unemployment rates with increased hospital admissions for treatment of alcohol use, marijuana use, and cocaine use (Azagba et al., 2021). Studies from this time period showed an increase in binge drinking patterns, but not necessarily the number of heavy drinking days in adults (Bor et al., 2013; Colell et al., 2015). Studies have also shown increased cannabis

use in adults who were unemployed during this period, which is of particular interest for our study (Compton et al., 2014; Colell et al., 2015).

The association between economic stress and substance use was further studied during the COVID-19 pandemic (Tran et al., 2022). Although the root causes of the economic downturn during the pandemic differ from the economic recession that began in 2007-2008, this data provides a foundation for how financial and employment stressors can influence substance use on a large scale (Wallheimer, 2020).

Occupational Factors and Substance use

This section aims to summarize the state of the literature regarding different occupational factors and substance use before the COVID-19 pandemic began. One theme that emerged was increased substance use due to emotional stressors. Negative experiences and emotional masking at work are associated with increased alcohol use (Frone, 2015; Grandey et al., 2019). Stressful work exposures in public-facing jobs have been associated with higher alcohol, tobacco, and cannabis use, further supporting that negative emotional states and stress at work are tied to substance use (Airagnes et al., 2018). In addition, effort-reward imbalance has emerged as a workplace stressor associated with worker substance use (Li et al., 2021; Skogen et al., 2019).

Work schedules have also been studied in relation to substance use. A large study substantiated that switching from regular daytime work to shift work, and continuous shift work were associated with increased odds of cigarette smoking and drinking alcohol (Jung et al., 2022). There was also increased high-volume drinking (binge drinking) in workers who switched from day work to shift work (Jung et al., 2022). A large population-based French study showed an association between night shift work and smoking, alcohol use, and marijuana use (Grandey

et al., 2019). This was further supported by a large French cohort study that showed night shift work was associated with increased smoking in women, increased marijuana use in men, and increased alcohol use in both genders (Hamieh et al., 2022). Changes in substance use are adverse effects associated with night shift work in the literature (J. P. Brown et al., 2020).

Although alcohol and smoking behaviors are more frequently studied, there have been studies that focused on marijuana use in workers. One study of marijuana use by workers before the legalization of recreational marijuana in Canada showed that a quarter of the surveyed workers were using marijuana before or at work. Interestingly, being in a "safety-sensitive" job, which is job with increased safety risk if impaired, was associated with using marijuana before or during work (Carnide et al., 2021). Another large study in Australia showed that males, smokers, ages 14-24 years old, and high psychological distress were all correlated with marijuana smoking in workers between 2010 and 2019 (Roche et al., 2022). These study results are in line with trends that were shown in larger cross-sectional studies on substance use.

In terms of specific occupational groups, many studies have focused on substance use trends in blue-collar workers. One study of transit operators showed an association between work burnout with alcohol use and alcohol dependence (C. Cunradi, 2003). It was further shown that job-related stress in urban transit operators was associated with initiating, maintaining, and increasing smoking (C. B. Cunradi et al., 2007). A review of alcohol use in farm workers concluded that farmworkers have been shown to have higher odds of risky alcohol drinking than the general population (Watanabe-Galloway et al., 2022). A study of construction workers from 2013-2016 showed a statistically significant higher in the prevalence of smoking, using smokeless tobacco and binge drinking in construction workers compared to all other workers (Boal et al., 2020). Workers who reported greater physical strain at work also reported greater

alcohol use, marijuana use, and tobacco use (Barnes & Zimmerman, 2013; Hamieh et al., 2022)

Overall, the data supports that alcohol use and tobacco product use may be higher in blue-collar

workers compared to other workers.

Due to the rapid increase in people working from home, several studies retrospectively

assessed data from before the beginning of the COVID-19 pandemic to assess the effects of

working from home on substance use behaviors. Data from a large United States Survey from

2018 indicated a lower likelihood of smoking and a lower frequency of smoking in teleworkers

(Nargis et al., 2021). A study in Norway supported that remote work >15 hours per week was

associated with higher odds of alcohol use compared to those who worked fewer hours remotely

or in person (M. B. Nielsen et al., 2021). Overall, there was no consensus on the effects of

working on substance use trends before the COVID-19 pandemic due to the small number of

published studies.

COVID-19 and Job Stressors

Work conditions rapidly changed for many workers during the COVID-19 pandemic. An

association between work-related stressors and substance use have previously been suggested

since before the pandemic (Frone, 2008). Overall, mental health generally declined in workers

during the pandemic (M. B. D. Nielsen et al., 2022). Disruption of employment, low household

income, and disrupted healthcare all predicted increased serious psychological distress in a large

longitudinal study of United States adults during COVID-19 (Breslau et al., 2021). Other studies

also found that factors such as job insecurity, long periods of isolation, and worry about the

future were associated with psychological distress in workers during the pandemic (Xie et al.,

2022; Giorgi et al., 2020). Workers during COVID-19 had differing experiences based on circumstances such as whether they were considered essential workers or non-essential workers.

Essential workers had their own challenges which warrant discussion. Healthcare workers were at particular risk for contracting COVID-19 and reported higher levels of perceived risk and stress due to potentially contracting COVID-19 (Martin et al., 2022). Fear of contracting COVID-19 in healthcare workers has been associated with psychological distress, decreased work satisfaction, and increased turnover (Labrague & Santos, 2021; Shah et al., 2021). Another study of healthcare workers over a six-month period during COVID-19 showed that the high number of workers reporting work stress and job burnout increased throughout the study period (Teo et al., 2021). Essential workers in healthcare were also less likely to have reduced hours, while essential workers in the service industry were more likely to report COVID-19-related job loss (Martin et al., 2022).

Many workers, estimated up to 50% in Europe and between 30-50% in the United States, switched to telework or remote work during the pandemic (Galanti et al., 2021,)Frize et al., 2021). Remote work has been shown to have both negative and positive outcomes in terms of worker perceptions, productivity, and health behaviors in different studies (Chow et al., 2022; Hackney et al., 2022). One review of European studies found that workers felt greater efficiency, work control, and work-life balance while working from home, although men reported significantly higher rates of work efficiency from home than women (Ipsen et al., 2021). However, studies have also shown that increased social isolation and family-work conflict in those who worked from home were associated with decreased self-reported productivity and increased self-reported job stress (Galanti et al., 2021).

Working from home has also been shown to relate to changes in health behaviors, such as going to bed later at night (Conroy et al., 2021). A study of telework during the COVID-19 pandemic in Japan showed a decrease in physical exercise and decreased satisfaction with work for those who switched from the office to telework (Mougharbel et al., 2021). Another study of workers in Japan similarly showed decreased physical activity and increased uninterrupted sedentary behavior in workers who worked from home (Fukushima et al., 2021). The effects on body weight and physical activity due to working from home are suggested to have continued past the initial lockdown periods of the COVID-19 pandemic, as studies continue to show increased sedentary behavior and body weight in 2021 (Coşkun et al., 2022). Other studies have shown a decrease in the overall well-being of workers that is most significant in workers who worked from home (M. B. D. Nielsen et al., 2022; Xiao et al., 2021).

A reduction in work hours due to COVID-19 was another measured job stressor by CHIS 2020. A reduction in work hours as a voluntary job change has been studied in terms of gender during the pandemic. Women with children in dual-income homes disproportionately reduced their work hours during COVID-19 compared to men (Collins et al., 2021). Another job stressor of interest is losing a job due to COVID-19. As discussed in previous sections, job loss or involuntary unemployment are specifically associated with increased marijuana smoking in previous studies (Compton et al., 2014). Further, losing a job has also been associated with higher symptoms of depression during the COVID-19 pandemic (Vogel et al., 2021). Both losing a job and a reduction in work hours are associated with food insecurity during the COVID-19 pandemic (Singleton et al., 2022).

General Trends in Mental Health and Substance Use During COVID-19

The impact of the COVID-19 pandemic on mental health and substance use patterns in the general population has been of interest throughout the pandemic. One behavioral economics theory hypothesized that due to the decreased perceived consequences of substance use during the COVID-19 lockdowns and the abrupt decrease in rewarding alternatives to substance use, substance use would potentially rise during the pandemic (Acuff et al., 2021). Throughout the COVID-19 pandemic, studies have shown an increase in negative mental health effects in children, adolescents, and adults (Czeisler et al., 2020; Meherali et al., 2021). There are a variety of approaches to measuring declining mental health and well-being in the literature, from studies focusing on self-reported symptoms to others reporting the incidence of diagnosed mental health conditions such as anxiety, depression, and post-traumatic stress disorder. Examples of measured indicators of mental health and overall well-being included disturbances in sleep and appetite, impairment in social interactions, stress, worry, and risky behaviors (Meherali et al., 2021). In older adults and the elderly, studies have generally shown increased rates of anxiety, depression symptoms, and rates of mental health diseases during the pandemic (Sepúlveda-Loyola et al., 2020). Further studies have shown that older adults are at risk in terms of their physical health due to lockdown conditions and the switch to telemedicine (Cocuzzo et al., 2022). Older adults are also vulnerable to economic recessions and may be more at risk for food insecurity (Cocuzzo et al., 2022). One small study of older adults over 75 years old in the United Kingdom showed that less than 10% met the criteria for generalized anxiety disorder and major depressive disorder (L. Brown et al., 2021). However, the lack of significant results may be due to the small sample

size and the expanded social services available in the United Kingdom, which differ from the United States.

Substance use is often tied to other mental health conditions and stressors (Bonnet et al., 2022; Sinha, 2008). During the pandemic, an association between negative mental health symptoms and substance use problems was demonstrated (Edwards et al., 2018). The World Drug Report from the United Nations in 2022 stated there was a worldwide increase in the volume of cannabis products used in 2020 compared to previous years and it remained the most used illicit drug in the world (*UNODC, World Drug Report 2022.*, 2022). In terms of substance use, alcohol, cigarette, and marijuana use have generally been shown to have increased during the pandemic, although there have been mixed results based on demographics (Clendennen et al., 2021; Vanderbruggen et al., 2020). Another emerging theme from the literature suggests that substance use may have increased more for people who already used a substance pre-pandemic (Cabral, 2022; Oksanen et al., 2021). For people who already used electronic cigarettes, marijuana, and cigarettes, those who reported distress due to the pandemic were more likely to consider increasing their use of cannabis and electronic cigarettes (Cabral, 2022). Further, adults who were more negatively impacted by the pandemic were also more likely to report increased drinking compared to those who were less impacted due to COVID-19 (Grossman et al., 2020) .

Specific patterns of marijuana use are more challenging to identify given a paucity of research on this topic. Adolescents were most frequently studied in terms of marijuana use in the pandemic (Bonnet et al., 2022). Further, in the studies that included adults and marijuana use, results were mixed in terms of changes in use during the COVID-19 pandemic (Bonnet et al., 2022). There is indirect evidence of increased use or increased problematic use such as increased sales and increased post-mortem detection, which casts some doubt on the trends that have been

self-reported in studies (Mariottini et al., 2021; Schauer et al., 2021). This may have to do with the heterogenous policy on marijuana in the different countries where these studies have been conducted. Recreational marijuana remains largely illegal, although decriminalized, in the majority of European countries in 2022. Studying marijuana use is also challenging within the United States due to the differences in state laws regarding legalization and decriminalization of recreational and medical marijuana. This has created heterogeneity in policies and populations affected by the legal status of marijuana (Pacula & Smart, 2017). California is one of eleven states (including District of Columbia), that had legalized recreational marijuana before 2020. California legalized medical marijuana in 1996 and recreational marijuana use in 2016, so both were legal throughout the course of the CHIS 2020 data collection period. In general, studies in states that have legalized recreational marijuana have shown an association with increased prevalence of cannabis use (Gali et al., 2021; Goodman et al., 2020; Subbaraman & Kerr, 2020).

Substance use in Workers during the COVID-19 Pandemic:

Studies in workers showed mixed results for substance use. One study showed that there was a positive association between job insecurity and use of alcohol, marijuana, and cigarettes during COVID-19 (Wan et al., 2022). A small study of young adult Californian workers also showed that those who lost a job during COVID-19 were more likely to report increased marijuana and alcohol use (Fedorova et al., 2022). A study of Veterans with employment disruptions and financial stress during COVID-19 showed that employment disruption increased odds of cannabis use significantly and that participants with financial stress had increased odds of increasing alcohol use (Tran et al., 2022). In studying reduced work hours as a job stressor, limited literature is available. There is a study that showed an association between reduced work

hours due to the pandemic and drinking a greater total volume of alcohol, whereas increased work hours were associated with more days of drinking alcohol (Martin et al., 2022). Further, as job instability and financial distress can be a consequence of reduced working hours and reduced income, the results previously discussed may also be applicable to those workers with lost jobs and with reductions in hours.

Identifying trends of substance use in workers who switched to working from home is challenging due to a lack of peer-reviewed publications that address this issue. Most studies also occurred during the initial COVID-19 pandemic lockdown and have not reported long-term or longitudinal results on those who worked from home. One large study, which captured a large number of teleworkers in Finland, reported that 25% of workers increased their drinking of alcohol and 25% of workers reported a decrease in their drinking of alcohol. Overall, the study showed that remote work itself was not predictive or associated with increased alcohol use (Oksanen et al., 2021). However, cyberbullying at work and psychological distress were associated with increased alcohol drinking, indicating that there may be specific factors of working from home that influence substance use (Oksanen et al., 2021). Another large cross-sectional study in Norway showed greater odds of consuming alcohol for a pooled group of students who studied from home and workers who worked from home during COVID-19 (Alpers et al., 2021). More studies on the substance use patterns of remote workers are important to understand this job condition, as many workers will likely continue working from home.

A body of literature exists on the mental health effects of COVID-19 on those considered essential workers during the pandemic. These studies primarily focused on the health and well-being of healthcare workers during the pandemic, although there are larger studies that focus on essential workers as a general group. In a study of nurses, fear of the COVID-19 pandemic was

associated with increased psychological distress and decreased job satisfaction (Labrague & Santos, 2021). One study showed increased days of tobacco use and fewer workers sleeping eight hours per day when essential workers were compared to non-essential workers (Martin et al., 2022). In a study that examined essential workers, workers between 25-44 years old and male essential workers tended to have increased substance use due to COVID-19 (Sugg et al., 2021). Healthcare workers were particularly at risk for increased alcohol use and tobacco use (Mounir et al., 2021; Moya-Salazar et al., 2022; Murthy & Narasimha, 2021). It was also suggested in a study that psychological distress mediated increases in tobacco use for healthcare workers (Mounir et al., 2021). Night-shift healthcare workers were also studied, and results showed an increase in smoking cigarettes and tobacco use during COVID-19 (Cousin et al., 2022).

Mitigating Factors and Interventions for Worker Health during the Pandemic

Social support theory has been utilized in studies to try to mitigate the effects of job insecurity due to COVID-19 (Wan et al., 2022). During COVID-19, employees with co-worker support and family support reported less emotional exhaustion (Usman et al., 2021). Further, it has been shown that workers' perceptions of family-specific support from their supervisors were tied to a reduction in work-family conflict, increased job satisfaction, and improved well-being during COVID-19 (Evanoff et al., 2020). The positive associations between supervisor support, employee stress, and work-family conflict had been suggested before the pandemic, suggesting that this is likely a strong factor in overall employee well-being (Almeida et al., 2016).

There are studies that further associate the positive effects of social support with reduced substance use for certain workers under stress (Gerich & Lehner, 2022). One such study examined the effects on pet support in mediating the effects of stress due to job insecurity during

the COVID-19 pandemic. There was less impact of the COVID-19 pandemic in terms of alcohol and marijuana use, emotional exhaustion, and depression in the workers who reported high levels of pet support (Wan et al., 2022). This study suggests that pet-friendly policies and encouraging pet support could be beneficial for certain workers. Although few interventions have been published, forms of social support for the worker have consistently been highlighted as a protective factor in past studies.

Mitigation strategies and health promotion programs for healthcare workers have emerged as an important organizational goal during COVID-19 given their increased workloads and risk of contracting the virus. A study of nurses showed that those who had COVID-19-related training had less fear related to COVID-19, suggesting that effective organizational programming could mitigate long-term psychological distress and turnover (Labrague & Santos, 2021). Cognitive behavioral therapy and mindfulness programs have also been suggested as potentially effective programs for healthcare workers, as they have been shown to be effective in post-traumatic stress disorder (Raudenská et al., 2020). When the literature is analyzed as a whole for healthcare workers during the COVID-19 pandemic, there is substantial heterogeneity in studies, which can make it difficult to draw strong conclusions on the effectiveness of any particular type of intervention (Buselli et al., 2021). These findings shed light on the necessity for more effective transmission of information regarding protocols and outcomes to improve the health of healthcare workers through employer and organizational policy.

Proposed Mechanisms Linking Job Stress to Substance Use

Whether psychological strain is an essential intermediary between job stress/financial stressors and drug use is a complex question. Currently, there is no single agreed-upon theory.

There are some researchers who approach job stress as causing two pathways of strain reactions: a psychological reaction and a behavioral strain reaction (Wan et al., 2022). In this model, stress can induce both reactions, but psychological strain is not essential to induce a behavioral reaction. However, there is also a strong argument that associates psychological strain and drug use, rather than considering drug use as behavior in response to initial stressors.

It has been shown that with increasing levels of emotional and psychological stress, there is a decrease in behavioral control and increased impulsive behaviors. In addition, with increased stress there is decreased prefrontal activity and weakening of prefrontal networks, which likely occurs in both acute and chronic stress experiences (Sinha, 2008; Arnsten, 2015). Increased limbic system and corticostriatal activity also occurs. These activated networks lead to more reflexive and primitive regulatory behaviors, translating into less behavioral control (Sinha, 2008). Further acute stress has been associated specifically with increased cue reactivity and drug self-administration (Sharp, 2017).

Biologically, stress is a neurophysiologic response that humans have to respond to perceived threats or challenges (Torres-Berrio et al., 2018). In response to a threat or stressor, the paraventricular nucleus in the hypothalamus stimulates the release of corticotrophin-releasing factor (CRF). This will then stimulate the anterior pituitary gland to release adrenocorticotropin hormone (ACTH). ACTH will then circulate in the bloodstream and bind to receptors of the adrenal cortex on the adrenal gland. This will stimulate corticosteroid secretion, which will bind to receptors throughout the body, causing organ-level effects of the acute stress response. Catecholamines, such as norepinephrine, are released by the adrenal medulla and sympathetic nerves. CRF also activates norepinephrine release in the locus coeruleus, which increases the level of CRF in the extended amygdala (Torres-Berrio et al., 2018). CRF's extrahypothalamic

effects are in the corticostriatal and limbic regions and influence psychological and behavioral stress responses. The cross-talk between norepinephrine and CRF in the brain is the proposed mechanism that ties the physiologic stress response with drug-seeking behavior (Torres-Berrio et al., 2018).

Focusing on limbic activity, it is hypothesized that the basolateral amygdala plays a role in stress-induced drug use behaviors, along with behavioral disturbances in other mental health disorders (Sharp, 2017). The amygdala is involved in fear and anxiety processing, emotional and behavioral responses, and reward. Under acute and chronic stress, subjects become insensitive to devaluations of rewards in more of a behavior of habit, rather than engaging in goal-directed behaviors (Sharp, 2017). Stress also affects motivation to obtain rewards and increases the desire for appetitive rewards (Sharp, 2017). This has been linked to the acute stress response through increased glucocorticoid levels. Activation of the glucocorticoid receptors in dopamine-1 receptor postsynaptic neurons, which include the neurons from the nucleus accumbens and prefrontal cortex, alters the activity of the downstream dopaminergic ventral tegmental area (VTA) neurons (Sharp, 2017; Sinha, 2008). The absence of glucocorticoid receptors has been shown to reduce the motivation to obtain cocaine and decrease neuronal firing rate and burst frequency (Sharp, 2017). Further, CRF activates circuits that are involved in stress-induced reinstatement of drug seeking. CRF-responsive neurons in the amygdala have been shown to mediate the effects of stress and drug-seeking behaviors. These stress-induced behaviors and drugs seeking have been shown to particularly involve the amygdala. In summary, it has been shown that glucocorticoids lead to increased dopamine release, which ties the biological stress response with pathways that are altered in substance use (Sinha, 2008). Stress-related hormones disrupt the limbic system, which is heavily involved in human reward pathways and in addiction.

Our proposed mechanism for the pathways starting from work stress leading to the target behavior of substance use is shown in Figure 1. This suggested mechanism attempts to integrate social, economic, behavioral, and biological hypotheses regarding work stress, psychological strain, and substance use.

Protective Factors
-Social support (peer, familial)
-Supervisor and organizational support
-Personal protective equipment/ education on COVID-19 transmission

Initial stressor
-Work-related stressors
-Financial stressors
-Fear of contracting COVID-19 at work
-Night shift work

Psychological Strain
-Negative emotional states/depressed mood
-Poor coping mechanisms
-Unmet aspirations
-Increased deprivation

Biological responses:
-HPA axis activation
-Autonomic nervous system activation
-Prefrontal cortex decreased activity
-Increased limbic system activity

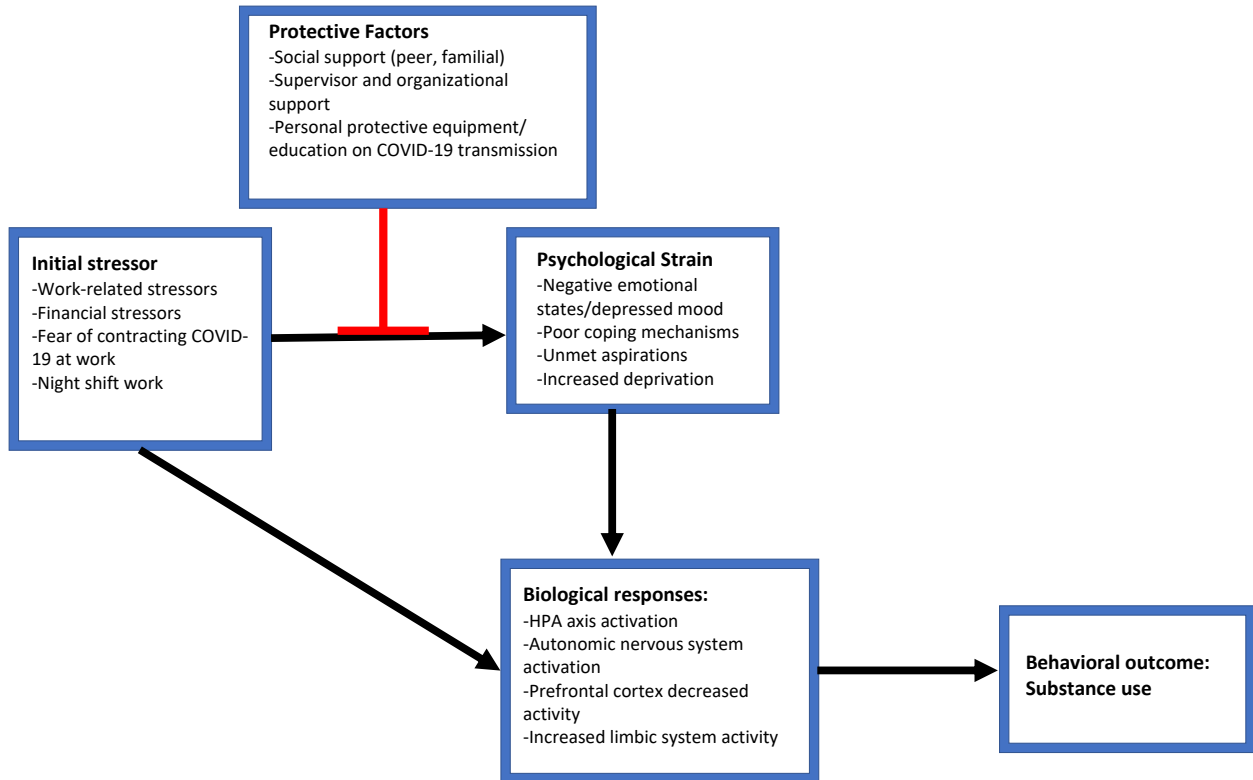**Behavioral outcome: Substance use**

Figure 1:   A proposed pathway between work stress and substance use. (Arnsten, 2015; Dávalos et al., 2012; Gerich & Lehner, 2022; Sinha, 2008; Wan et al., 2022; Zhang et al., 2014)

Chapter 3 Research Design and Methods

The California Health Interview Survey (CHIS) 2020 was used as the source of data for this cross-sectional study. The first state-wide CHIS was collected in 2001 and was primarily a biennial survey until 2011, when the survey became a continuous survey model, enabling an annual release of data (Sherr, Best, et al., 2021). It is administered by the University of California, Los Angeles (UCLA). CHIS 2020 surveyed 22,661 households and 21,949 adults in 2020 from March 1st, 2020-October 30 ,2020 (*What Is CHIS?*, n.d.). The publicly available dataset from 2020 was used as the source of data for this study.

CHIS 2020 Design and Data collection:

Further details and elaboration of the study designs and methods are publicly available by the CHIS study team (Sherr, Best, et al., 2021). The sampling is an address-based sample methodology with an option for web or telephone data collection. Participants were invited to complete the survey online or call to be interviewed. Participants received a letter and $2.00 pre-incentive when invited to participate in the study. Non-responders then received reminder postcards and a final letter and postcard (Sherr, Best, et al., 2021). To achieve a representative sample across different counties, CHIS used an address-based sample design. The 58 counties were grouped in to 44 geographic sampling strata. Los Angeles County was further sub-stratified into eight Service Planning Areas, and San Diego was further sub-stratified into six Health Service Districts. Six targeted groups of interest in the 2019-2020 CHIS cycle were selected and models created to predict households with the following attributes: Korean, Vietnamese, Other Asian, Hispanic or Spanish Speaker, Low Educational Attainment or Not a US Citizen, and Have Children under the age of 19. These models resulted in strata for which the models predicted

none of the six attributes and strata for which no data was found. They then developed relative sampling fractions to select households within these modeled strata. One adult respondent and one adolescent and/or child were randomly selected from the residential address.

The interviews were conducted in six languages: English, Spanish, Chinese, Vietnamese, Korean, and Tagalog. Tagalog was only administered by telephone, while all other languages were available in both the phone and web administrations of the survey. SSRS, a survey and market research firm, was contracted and worked with UCLA to develop methodology and data collection methods for CHIS 2019-2020. SSRS completed the phone interviews. There was a "child first" procedure in place, so that any adult in the home could respond to questions about the child interview before the adult interview with the selected adult. This was meant to increase the number of child interviews. The overall response rate was 12.2% for 2019-2020. Eight proxy interviews were completed, in which a spouse/partner or adult child completed the extended interview on behalf of an adult. This was done to reduce bias for health estimates or chronically ill or people with disabilities (Sherr, Best, et al., 2021).

Three imputation procedures were implemented to fill in missing responses in order to accurately weight the data. One method was random selection from the observed distribution of respondents, which was used when the percentage of missing items was small for variables. Second, was a "hot deck" approach, in which a value reported by a respondent is assigned to a "similar" person who did not answer the specific item on their questionnaire. The final technique used was external data assignment, which was used for inputting information for missing geocoding variables (Sherr, Goyle, Langdale, Engle-Bauer, et al., 2021).

CHIS Demographic Characteristics and Variables:

On the 2019-2020 extended adult questionnaire, two sections of the questionnaire collected demographic variables from participants. For the purposes of our study, we gathered data on the following covariates from the demographic sections: age, gender identity, race, marital status, and educational level. We also utilized household annual income as a demographic variable in our analysis, from the "Employment, Income, Poverty Status, Food Security" section of the survey (Sherr, Goyle, Langdale, Engle-Bauer, et al., 2021).

Gender was categorized into male and female, based on the identification of the participant in the questionnaire. Race and ethnicity were categorized into the following categories: Hispanic, white (Non-Hispanic), African American, Asian, and "Other" race. American Indian/Alaskan natives, and "Other/Two or more races" were pooled into the "Other" race category due to the very small sample sizes. Age was categorized into four groups: 18-34 years old, 35-49 years old, 50-64 years old, and 65 years and older. Education was also categorized into four groups: high school education or less, some college/vocational school/associates degrees, bachelor's degree/some graduate school, and master's degree/doctoral degrees. Marital status was categorized into three categories: married, never married, and other relationships status/separated/divorced/living with a partner. Salary was based on annual salary in the previous year before taxes and was divided into five categories: 49,000 dollars and less, 50,000-89,000 dollars, 90,000-129,000 dollars, 130,000-179,000 dollars, 180,000 dollars and over.

COVID-19 Related Job Changes:

 COVID-19-related questions were added to the CHIS 2020 questionnaire in mid-March 2020, due to the statewide stay-at-home order in California, which also resulted in the closure of schools and non-essential business (Ponce et al., 2021). To capture those who were working at the time of the survey administration, we further restricted the study population based on work status one week before survey administration. The most relevant question on the questionnaire stated: Which of the following were you doing last week?

 1. Working at a job or business

 2. With a job or business but not at work

 3. Looking for work

 4. Not working at a job or business

 5. Refused

 6. Don't know

 Those who answered "1. Working at a job or business" were included in this study analysis.

 For the questionnaires collected in 2020, a new series of questions was added to the adult questionnaire to better understand the impact of COVID-19 on Californians. Our analysis included the COVID-19 question that related to job changes that was added on May 5th, 2020. The question was stated as follows: "Have you experienced any of the following situations because of the Coronavirus or COVID-19 outbreak?" For those who selected any of the following were included in the analysis:

 1. I've lost my regular job

 2. I've had a reduction in hours or a reduction in income

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3. I've switched to working from home.

In the data analyses, these conditions are categorized as "lost job," "reduced work hours," and "working from home," respectively.

<u>Marijuana use reporting</u>:

The CHIS asked two relevant questions to our study regarding marijuana use. "Have you ever, even once, tried marijuana or hashish in any form?" which was answered "yes" or "no" by the participant. If the answer was yes, they were then asked "How long has it been since you last used marijuana or hashish in any form?" And given the option to answer in days, months, or years. Based on their answers, the answers were coded into the following categories:

1. Inapplicable

2. Within the past month

3. More than one month to one year ago

4. More than one year to 5 years ago

5. More than 5 years to 10 years ago

6. More than 10 years to 15 years ago

7. More than 15 years ago

For our data analysis, those we used marijuana in the past month were included in our one-month analysis of marijuana use and working conditions. Those who reported marijuana use within one month and between one month to one year were pooled to account for our analysis of marijuana use in the past year.

<u>Statistical Analysis</u>:

One-year weights were calculated by CHIS for both the household and the adult analysis. The weight associated with households selected were the product of the following: base weights defined by the design stratum, residential status adjustment for household eligibility, adjustment for nonresponse to the CHIS screener, and calibration to the Census Planning Database Low Response Score (Sherr, Goyle, Langdale, & Best, 2021). This calculated household weight was then multiplied by the adult analysis weight. Adult weighting accounted for the following adjustments: inverse selection probability of one adult within each household with a completed screener, adjustment for adult nonresponse, pre-calibration trimming, adjustment to align the weight sums to adult population counts by geographic area within California, demographics, and other characteristics (Sherr, Goyle, Langdale, & Best, 2021). The purpose of the replicate weights is to align the characteristics of the study population more closely to the general Californian population.

Replicate weights provided with the CHIS data 2019-2020 were used in the logistic regression analyses. Overall demographic characteristics were analyzed and weighted descriptive statistics were generated. Logistic regression analyses were then completed to examine associations between each COVID-19-related job condition and marijuana use in the past year and marijuana use in the past month (30 days). The logistic regression models accounted for gender, race, marital status, educational level, and household income. Stratified logistic regression modeling was then completed to examine associations with COVID-19-related work stressors and marijuana use. Statistical analyses were performed using the SAS 9.4 software package, Survey Analysis Procedures.

Chapter 4 Results

The CHIS 2020 adult sample size was 21,949 in terms of adults who were screened and completed the interview. Of those 21,949, our inclusion criteria for working in the week before the questionnaire narrowed the sample size for our study to 10,365 adults. This sample of 10,365 adult Californian workers was used for the analysis in this study. Of those workers, 1,812 workers (17.48%) reported using marijuana in any form in the week prior to the questionnaire. In the year before the questionnaire, 2,726 workers (26.30%) reported using marijuana. The demographic characteristic data is reported in Table 1, including the percentage of each demographic subgroup that reported marijuana use in the last month and last year. In terms of self-reported gender, 4,838 participants (46.67%) identified as male and 5,527 (53.32%) identified as female. In terms of race, white participants made up the greatest percentage of the overall sample (57.05%), then Hispanic participants (21.96%), followed by Asian participants (14.46%). The smallest groups were African Americans (3.22%) and "Other" (3.31%). The sample population also favored educated workers, 35.52% of the sample had a bachelor's degree and 30.49% of the sample had a masters or higher graduate degree. 24.07% had some college, vocational school, or an associate degree and 9.92% of survey participants had a high school education or less. In terms of COVID-19-related job changes, the most frequently reported job change was working from home (n=4168, 40.2%), while job loss was the least frequently reported job change (n=432, 4.17%).

Table 1: Demographics and the proportion who have smoked marijuana in the past year and the past month.

Variable	Number of workers	Proportion of study population (%)	Percentage of demographic used Marijuana last month (%)	Percentage used Marijuana last year (%)
Age				
18-34	1971	19.02	25.82	39.37
35-49	3546	34.21	17.34	27.27
50-65	3565	34.39	14.11	20.56
66 and older	1283	12.38	14.42	19.49
Gender				
Male	4838	46.68	18.48	26.64
Female	5527	53.32	16.61	26.00
Race				
Hispanic	2276	21.96	15.91	23.59
White	5913	57.05	20.02	30.00
African American	334	3.22	19.16	25.15
Asian	1499	14.46	7.74	14.08
Other	343	3.31	25.07	34.99
Income				
Less than 49,999	1774	17.12	18.66	25.25
50,000-89,999	2170	20.94	18.94	26.50
90,000-129,000	2100	20.26	18.81	27.90
130,000-179,000	1656	15.98	15.10	25.42

over 180,000	2665	25.71	15.95	26.12
Education				
High School or Less	1028	9.92	15.95	22.18
Some College, vocational school, or associates degree	2495	24.07	17.84	24.49
Bachelors	3682	35.52	19.26	29.66
Masters or Graduate	3160	30.49	15.63	25.16
Marriage				
Married	6024	58.12	13.68	21.17
Widowed/separated/divorced/other status	2443	23.57	22.31	31.97
Never Married	1898	18.31	23.34	35.30
Work Conditions				
Job Loss	432	4.17	24.30	33.80
Reduced work hours	2179	21.02	20.61	29.42
Work from home	4168	40.21	19.22	29.92

Logistic regression analysis was then applied on the weighted data for associations between COVID-19-related job conditions and marijuana use in the past month and marijuana use in the past year. There are significant associations between lost job and marijuana use in the past month and in the past year, reduced work hours and marijuana use in the past month and in the past year, and remote work and marijuana use in the past month and in the past year. This analysis was first run without controlling for covariates (Table 2). COVID-19-related job loss was statistically significantly associated with marijuana use within the past month (OR 1.653, 95% CI 1.221, 2.239) and one year (OR 1.479, 95% CI 1.101, 1.989). For the group that reported reduced work hours due to COVID-19, there was a statistically significant association with marijuana use within the past month (OR 1.393, 95% CI 1.171, 1.658) and the past year (OR 1.288, 95% CI 1.112, 1.492). For those who switched to working from home, there was a statistically significant association with marijuana use within the past month (OR 1.422, 95% CI 1.226, 1.651) and past year (OR 1.639, 95% CI 1.458, 1.842). This analysis was then run controlling for covariates: age, race, income, gender, education, and marital status (Table 3). COVID-19-related job loss was statistically significantly associated with marijuana use within the past month (OR 1.740, 95% CI 1.223, 2.475) and one year (OR 1.626, 95% CI 1.163, 2.273). For the group that reported reduced work hours due to COVID-19, there was a statistically significant association with marijuana use within the past month (OR 1.333, 95% CI 1.118, 1.589) and the past year (OR 1.288, 95% CI 1.108, 1.497). For those who switched to working from home, there was a statistically significant association with marijuana use within the past month (OR 1.298, 95% CI 1.106, 1.523) and past year (OR 1.358, 95% CI 1.205, 1.530).

Table 2: Association of reported COVID-19 related job conditions with marijuana use in the past 30 days and past year not controlling for covariates. Significant P-value <0.05.

	Marijuana 30-days odds ratios, (95% CI)	P-value	Marijuana past year odds ratios, (95% CI)	P-value
Job Loss	1.653 (1.221, 2.239)	**0.0015**	1.479 (1.101, 1.989)	**0.0101**
Reduced Work Hours	1.393 (1.171, 1.658)	**0.0003**	1.288 (1.112, 1.492)	**0.0010**
Work From Home	1.422 (1.226, 1.651)	**<0.0001**	1.639 (1.458, 1.842)	**<0.0001**

Table 3: Association of reported COVID-19 related job conditions with marijuana use in the past 30 days and past year controlling for covariates. Significant P-value <0.05.

	Marijuana 30-days odds ratios, (95% CI)	P-value	Marijuana past year odds ratios, (95% CI)	P-value
Job Loss	1.740 (1.223, 2.475)	**0.0025**	1.626 (1.163, 2.273)	**0.0050**
Reduced Work Hours	1.333 (1.118, 1.589)	**0.0017**	1.288 (1.108, 1.497)	**0.0012**
Work From Home	1.298 (1.106, 1.523)	**0.0018**	1.358 (1.205, 1.530)	**<0.0001**

The next step in the analysis was to complete stratified multivariable logistic regression analyses to evaluate how different demographic variables could influence the relationship

between COVID-19-related job changes and marijuana use. This was completed for both marijuana use within one month and marijuana use within one year. The demographic variable groups were used as strata. For example, to assess for possible confounding due to education, COVID-19-related job changes and marijuana use were assessed separately for the high school or less education group, some college/vocational school or associate degree group, bachelor's degree group, and the masters or higher graduate degree group. The other demographic variables: age, race, income, gender, and marriage were still controlled for in this analysis. Logistic regression analyses were run for each stratum to determine the association between each COVID-19-related job condition and marijuana use at one month and one year. This process was completed for every demographic stratum within each demographic variable (education, age, race, income, gender, and marriage). The resulting odds ratios (OR), confidence intervals (CI), and P-values are presented in table and graphic form (Tables 4, 5, and 6).

For the stratified analyses for COVID-19-related job loss, there was a statistically significant association between job loss and marijuana use at both one month and one year in the 18–34-year-old age group (Table 4). There is also a statistically significant association between job loss and marijuana use at both one month and one year for the male gender group. In terms of race/ethnicity, there is a statistically significant association between job loss and marijuana use at both one month and one year for the Hispanic group and the African American group. Within the "Other" racial category, which included Native American/Pacific Islanders, there is a statistically significant association between COVID-19-related job loss and marijuana use only at one year. In terms of income, there was a statistically significant association between COVID-19-related job loss and marijuana use at both one month and one year in the lowest income group (<$49,999). The highest educational group (masters and higher professional degrees) and the

lowest educational group (high school educational level or less) both had statistically significant associations between COVID-19-related job loss and marijuana use within the past month and past year.

The logistic regression results of the stratified weighted data for those who changed to working from home due to COVID-19 are shown in Table 5. The 18-34-year-old age group had a statistically significant association between working from home and marijuana use in the past year (OR 1.557, 95% CI 1.229, 1.973). The 35-49-year-old age group had a statistically significant association between working from home and marijuana use in the past month (OR 1.393, 95% CI 1.144, 1.696) and the past year (OR 1.349, 95% CI 1.109, 1.641). Both male and female gender groups had statistically significant associations between working from home due to COVID-19 and marijuana use in the past month and the past year. For the male group who worked from home due to COVID-19 the odds ratios were 1.304 (CI 0.998, 1.703) and 1.446 (CI 1.180, 1.772) at one month and one year, respectively. For the female group who worked from home due to COVID-19, the odds ratios were 1.281 (CI 1.034, 1.586) and 1.257 (CI 1.073, 1.473) at one month and one year, respectively. In terms of race, the white racial group had statistically significant associations between working from home at both one month (OR 1.246, 95% CI 1.013, 1.532) and one year (OR 1.265, 95% CI 1.085, 1.473). The "Other" racial group also had statistically significant associations between working from home at both one month (OR 3.949, 95% CI 1.739, 8.939) and one year (OR 2.994, 95% CI 1.342, 6.684). Participants that identified as Hispanic had a statistically significant association between working from home and marijuana use in the past month (OR 1.425, 95% CI 1.043, 1.948) but not in the past one year (OR 1.290, 95% CI 0.988, 1.686). The strata that identified as Asian on CHIS had a statistically

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significant association between working from home and marijuana use in the past year (OR
2.060, 95% CI 1.404, 3.024) but not in the past month (OR 1.072, 95% CI 0.708, 1.623).

*Table 4: Logistic regression predicting marijuana use in the past 30 days and the past year for
workers who reported job loss due to COVID-19, controlling for other demographic variables.
Significant P-value <0.05.*

Age	30 days odds ratios, (95% CI)	P-value	1 year odds ratios, (95% CI)	P-value
18-34	1.891 (1.080, 3.310)	**0.026**	1.908 (1.286, 2.832)	**0.002**
35-49	1.916 (0.863, 4.253)	0.108	1.662 (0.834, 3.314)	0.147
50-65	1.362 (0.696, 2.663)	0.363	1.158 (0.620, 2.162)	0.642
66 and older	0.766 (0.257, 2.286)	0.629	0.530 (0.186, 1.507)	0.230
Gender				
Male	2.129 (1.244, 3.646)	**0.006**	1.877 (1.240, 2.839)	**0.003**
Female	1.327 (0.696, 2.531)	0.385	1.378 (0.843, 2.252)	0.199
Race				
Hispanic	2.875 (1.695, 4.878)	**0.000**	2.443 (1.334, 4.474)	**0.004**

White	0.879 (0.579, 1.335)	0.542	0.777 (0.532, 1.136)	0.190
African American	4.343 (1.467, 12.861)	**0.009**	3.731 (1.354, 10.283)	**0.012**
Asian	0.527 (0.051, 5.482)	0.588	0.663 (0.260, 1.690)	0.385
Other	0.888 (0.026, 30.325)	0.947	3.824 (1.039, 14.069)	**0.044**
Income				
Less than 49,999	3.594 (1.844, 7.003)	**0.000**	3.302 (1.752, 6.223)	**0.000**
50,000-89,999	1.088 (0.480, 2.468)	0.839	1.396 (0.821, 2.373)	0.215
90,000-129,000	0.766 (0.316, 1.862)	0.553	0.603 (0.258, 1.412)	0.241
130,000-179,000	1.243 (0.557, 2.773)	0.591	1.039 (0.487, 2.218)	0.921
over 180,000	1.148 (0.586, 2.251)	0.684	1.042 (0.532, 2.043)	0.902
Education				
High School or Less	3.112 (1.463, 6.617)	**0.004**	2.141 (1.011, 4.537)	**0.047**
Some College, vocational school, or associates degree	0.953 (0.431, 2.106)	0.904	1.169 (0.761, 1.795)	0.472
Bachelors	1.264 (0.651, 2.453)	0.484	1.432 (0.834, 2.459)	0.191
Masters or Graduate	2.255 (1.276, 3.988)	**0.006**	1.950 (1.156, 3.289)	**0.013**

Marriage				
Married	1.594 (0.888, 2.862)	0.117	1.224 (0.712, 2.104)	0.460
Widowed/separate/divorced	2.216 (0.966, 5.083)	0.060	1.898 (0.888, 4.059)	0.097
Never Married	1.424 (0.771, 2.630)	0.255	1.921 (1.136, 3.251)	**0.016**

Analysis for the highest household income group (over $180,000) yielded associations with working from home and marijuana use at both one month (OR 1.571, 95% CI 1.168, 2.113) and one year (OR 1.649, 95% CI 1.281, 2.121). The $90,000 -129,000 household income group also had significant associations with working from home and marijuana use at both one month (OR 1.431, 95% CI 1.043, 1.963) and one year (OR 1.649, 95% CI 1.281, 2.121). The $50,000-89,9999 household income group had significant odds ratios with working from home and marijuana use in the past year (OR 1.421, 95% CI 1.031, 1.958), but not in the past month (OR 1.81, 95% CI 0.822, 1.696). In terms of education, the group with Some College, vocational school, or associates degree had statistically significant associations between working from home and marijuana use in the past month (OR 1.414, 95% CI 1.021, 1.958) but not at one year (OR 1.365, 95% CI 0.894, 2.082). The bachelor's degree group had statistically significant associations between working from home and marijuana use in the past year (OR 1.491, 95% CI 1.195, 1.859) but not in the past month (OR 1.185, 95% CI 0.907, 1.547). The highest educational group, master's degree or higher graduate degree, had statistically significant associations between working from home and marijuana use within the past month (OR 1.356, 95% CI 1.045, 1.759) but not within the past year (OR 1.164, 95% CI 0.939, 1.443). The married

group who reported working from home due to COVID had statistically significant odds ratios both in the past one month (OR 1.446, 95% CI 1.167, 1.792) and in the past one year (OR 1.451, 95% CI 1.214, 1.733). For those who were never married, there was statistical significance between working from home and marijuana use in the past year (OR 1.576, 95% CI 1.202, 2.066).

For the group of participants who reported reduced work hours due to COVID-19 in the year 2020, the results of logistic regression stratified analyses are presented in Table 6. There was a significant association between reduced work hours and marijuana use in the past month (OR 1.642, 95% CI 1.266, 2.129) and the past year (OR 1.141, 95% CI 0.927, 1.405) for the male group. Analyses for the 35-49-year-old age group showed significant associations between reduced work hours and marijuana use in the past year (OR 1.397, 95% CI 1.045, 1.868) but not in the past month. The 50–65-year-old age group had statistically significant associations between reduced work hours due to COVID-19 and marijuana use in the past month (OR 1.521, 95% CI 1.063, 2.177) but not in the past year. In terms of race, the Asian racial group has statistically significant associations between reduced work hours and marijuana use both in the past month (OR 2.379, 95% CI 1.365, 4.147) and in the past year (OR 1.858, 95% CI 1.122, 3.076). For the white racial group, there were significant associations for reduced work hours due to COVID-19 predicting marijuana use within the past year (OR 1.249, 95% CI 1.003, 1.555) but not in the past month. The "Other" racial group had a statistically significant association between reduced work hours due to COVID-19 and marijuana use in the past month (OR 3.100, 95% CI 1.050, 9.152) but not in the past year. For the stratified analysis based on household income, those with income less than $49,999 had statistically significant associations between reduced work hours due to COVID-19 and marijuana use both within the past month

(OR 1.513, 95% CI 1.064, 2.151) but not within the past year. The income group with 50,000-89,9999 household income per year had statistically significant associations between reduced work hours due to COVID-19 and marijuana use both within the past month (OR 1.541, 95% CI 1.056, 2.248) but not within the past year. The income group with household income $130,000-179,000 had statistically significant associations between reduced work hours due to COVID-19 and marijuana use in the past one year (OR 1.863, 95% CI 1.197, 2.900) but not in the past month. The high school or less educational group had statistically significant associations between reduced work hours due to COVID-19 within the past one year (OR 1.490, 95% CI 1.020, 2.177) but not in the past one month. Those with some college, vocational school, or an associate degree has statistically significant associations between reduced work hours due to COIVD-19 in the past one month (OR 1.751, 95% CI 1.305, 2.349) and in the past one year (OR 1.47, 95% CI 1.122, 1.929). For the marital status strata, the married group had statistically significant associations between reduced work hours and marijuana use in the past one month (OR 1.399, 95% CI 1.113, 1.759) and one year (OR 1.319, 95% CI 1.065, 1.633). The never married group also had a statistically significant association between recued work hours due to COVID-19 and marijuana use in the past one month (OR 1.611, 95% CI 1.116, 2.325) and one year (OR 1.636, 95% CI 1.203, 2.225).

Table 5: Logistic regression predicting marijuana use in the past 30 days and the past year for workers who reported working from home due to COVID-19, controlling for other demographic variables. Significant P-value <0.05.

Age	30 days odds-ratios, (95% CI)	P-value	1 year odds-ratios, (95% CI)	P-value
18-34	1.330 (0.981, 1.804)	0.066	1.557 (1.229, 1.973)	**0.000**
35-49	1.393 (1.144, 1.696)	**0.001**	1.349 (1.109, 1.641)	**0.003**
50-65	1.165 (0.838, 1.618)	0.358	1.149 (0.884, 1.493)	0.295
66 and older	0.875 (0.515, 1.486)	0.617	0.815 (0.537, 1.235)	0.330
Gender				
Male	1.304 (0.998, 1.703)	0.052	1.446 (1.180, 1.772)	**0.001**
Female	1.281 (1.034, 1.586)	**0.024**	1.257 (1.073, 1.473)	**0.005**
Race				
Hispanic	1.425 (1.043, 1.948)	**0.027**	1.290 (0.988, 1.686)	0.061
White	1.246 (1.013, 1.532)	**0.038**	1.265 (1.085, 1.473)	**0.003**
African American	0.893 (0.438, 1.820)	0.752	1.060 (0.445, 2.525)	**0.000**

Asian	1.072 (0.708, 1.623)	0.739	2.060 (1.404, 3.024)	**0.000**
Other	3.943 (1.739, 8.939)	**0.001**	2.994 (1.342, 6.684)	**0.008**
Income				
Less than 49,999	1.028 (0.700, 1.511)	0.886	1.047 (0.741, 1.481)	0.791
50,000-89,999	1.181 (0.822, 1.696)	0.364	1.421 (1.031, 1.958)	**0.032**
90,000-129,000	1.431 (1.043, 1.963)	**0.027**	1.497 (1.1125, 1.992)	**0.006**
130,000-179,000	1.236 (0.849, 1.799)	0.265	1.121 (0.784, 1.604)	0.526
over 180,000	1.571 (1.168, 2.113)	**0.003**	1.649 (1.281, 2.121)	**0.000**
Education				
High School or Less	1.301 (0.818, 2.068)	0.263	1.365 (0.894, 2.082)	0.147
Some College, vocational school, or associates degree	1.414 (1.021, 1.958)	**0.038**	1.312 (0.948, 1.814)	0.100
Bachelors	1.185 (0.907, 1.547)	0.210	1.491 (1.195, 1.859)	**0.001**
Masters or Graduate	1.356 (1.045, 1.759)	**0.023**	1.164 (0.939, 1.443)	0.164
Marriage				

Married	1.446 (1.167, 1.792)	**0.001**	1.451 (1.214, 1.733)	**<0.0001**
Widowed/separate/divorced	1.071 (0.767, 1.495)	0.683	0.991 (0.733, 1.341)	0.954
Never Married	1.318 (0.960, 1.808)	0.087	1.576 (1.202, 2.066)	**0.001**

Table 6: Logistic regression predicting marijuana use in the past 30 days and the past year for workers who reported reduced hours at work due to COVID-19, controlling for other demographic variables. Significant P-value <0.05.

Age (years old)	30 days odds ratios (95% CI)	P-value	1 year odds ratios (95% CI)	P-value
18-34	1.267 (0.936, 1.715)	0.124	1.229 (0.951, 1.589)	0.114
35-49	1.307 (0.962, 1.777)	0.086	1.397 (1.045, 1.868)	**0.025**
50-65	1.521 (1.063, 2.177)	**0.022**	1.231 (0.904, 1.678)	0.184
66 and older	1.148 (0.765, 1.723)	0.501	1.514 (0.925, 2.478)	0.098
Gender				
Male	1.642 (1.266, 2.129)	**0.000**	1.419 (1.118, 1.801)	**0.005**
Female	1.010 (0.784, 1.301)	0.938	1.141 (0.927, 1.405)	0.208
Race				
Hispanic	1.222 (0.908, 1.644)	0.184	1.143 (0.873, 1.498)	0.326
White	1.176 (0.910, 1.520)	0.213	1.249 (1.003, 1.555)	**0.047**
African American	2.627 (0.796, 8.670)	0.112	2.280 (0.741, 7.017)	0.149
Asian	2.379 (1.365, 4.147)	**0.003**	1.858 (1.122, 3.076)	**0.017**

Other	3.100 (1.050, 9.152)	**0.041**	2.071 (0.851, 5.041)	0.107
Income				
Less than 49,999	1.513 (1.064, 2.151)	**0.022**	1.328 (0.961, 1.833)	0.084
50,000-89,999	1.541 (1.056, 2.248)	**0.026**	1.290 (0.926, 1.797)	0.130
90,000-129,000	1.379 (0.881, 2.160)	0.158	1.376 (0.947, 2.0000	0.093
130,000-179,000	1.487 (0.819, 2.699)	0.190	1.863 (1.197, 2.900)	**0.006**
over 180,000	0.822 (0.554, 1.220)	0.327	0.902 (0.626, 1.300)	0.576
Education				
High School or Less	1.466 (0.951, 2.260)	0.082	1.490 (1.020, 2.177)	**0.040**
Some College, vocational school, or associates degree	1.751 (1.305, 2.349)	**0.000**	1.47 (1.122, 1.929)	**0.006**
Bachelors	1.213 (0.897, 1.640)	0.207	1.195 (0.927, 1.541)	0.166
Masters or Graduate	1.148 90.765, 1.723)	0.501	1.141 (0.813, 1.600)	0.442
Marriage				
Married	1.399 (1.113, 1.759)	**0.005**	1.319 (1.065, 1.633)	**0.012**
Widowed/separate/divorced	1.039 (.0723, 1.495)	0.833	0.945 (0.676, 1.321)	0.739

Never Married	1.611 (1.116, 2.325)	**0.012**	1.636 (1.203, 2.225)	**0.002**

Chapter 5 Discussion

Using data from a large cross-sectional study, we studied the associations between COVID-19-related job stressors and marijuana use in Californian adult workers. Epidemiologic studies of this population throughout the pandemic are relatively limited compared to other populations of interest. We found each of the COVID-19-related job stressors (lost job, working from home, and reduced work hours) were significantly associated with higher odds of marijuana use in the past month and the past year. These associations remained statistically significant when controlling for covariates, indicating a strong association between the job stressor and marijuana use. This finding aligns with our hypothesis that work stress due to COVID-19 would predict greater rates of marijuana use in Californian workers. This finding is also in line with previous literature that associates economic downturns and job insecurity with increased substance use (Dávalos et al., 2012; Nagelhout et al., 2017).

Working from home has been one of the most studied work conditions during the COVID-19 pandemic, given the necessity for rapid organizational change due to stay-at-home orders for non-essential employees. Yet this is the first study, to our knowledge, that associates the job stressor of working from home due to the COVID-19 pandemic with marijuana use. While reduced work hours or job loss could potentially lead to marijuana use due to increased stress and concern for financial hardship, working from home does not cause the same risks of food insecurity and/or financial insecurity. There are several possibilities that can explain the finding that working from home has been associated with increased marijuana use at one month and one year. One hypothesis may be that marijuana use is associated with coping with stressors

from working at home. It has recently been shown that there is an increased form of presenteeism in employees who work from home, in which they call out sick less often than employees who are in person (Brosi & Gerpott, 2022). This has been shown to be mediated by feelings of guilt regarding the worker's own illness and guilt regarding the impact on other co-workers (Brosi & Gerpott, 2022). This could also lead to effort-reward imbalance in the working-from-home condition, given that perceptions about productivity and workplace support changed for many workers. Perceived effort-reward imbalance for workers has been tied to increased drug use before COVID-19 in previous studies (Li et al., 2021). Further, one study showed that the preference of the employee, whether to telecommute or not telecommute, strongly mediated the association between working from home and alcohol use (Watanabe et al., 2022). It is possible that remote workers' work preferences or perceived effort-reward imbalance contributed to marijuana use, which could also play a role in the differences found between socioeconomic and demographic subgroups while working from home.

While other studies have shown no difference in marijuana use across sociodemographic groups, our data did show that COVID-19-related job conditions and marijuana use did differ by sociodemographic groups in our stratified logistic regression analyses (Brenneke et al., 2022). This may suggest that job stressors differentially impacted socioeconomic and sociodemographic groups and potentiated marijuana use in certain groups. An important demographic variable that emerged in our study was male gender. In the male subgroup, most of the work-related stressors were associated with marijuana use at one month and at one year. The exception was the association between males who worked from home and marijuana use in the past month, however this odds ratio was very close to significance ($P = 0.052$). This shows a strong association between periods of job stress and marijuana use for male workers. This is supported

by previous literature, which has also shown that males are more likely to increase alcohol use in response to economic stressors (R. L. Brown & Richman, 2012). Men in male-dominated occupations and who experienced high work intensity in high school also tended to use more cannabis and alcohol (Leadbeater et al., 2020). Further, it has been suggested in a study that males are more likely to utilize substances in an "escapist" path to handle work-related stress, whereas women were more likely to use stimulating substances and engage in presenteeism in handling work stress (Gerich & Lehner, 2022).

The female gender strata had significantly increased odds of marijuana use associated with working from home due to COVID-19 but did not have increased odds of marijuana use associated with losing a job or reduced work hours. Although no known previous studies have associated marijuana use and work-from-home in women, we can propose possibilities based on supporting literature. In a two-wave study during COVID-19, women reported a greater increase in non-work interruptions, work-based interruptions, multitasking, and surprises while working from home than males (Leroy et al., 2021). Many of these disruptions were tied to greater emotional exhaustion, lower performance, and greater family-to-work interference (Leroy et al., 2021). A thematic study of professional women in Turkey also suggested that working from home cemented traditional gender roles and resulted in greater domestic duties for women. It also found that women were assigned less work, potentially alienating women from professional development (Çoban, 2022). It can be hypothesized that women may have experienced greater levels of responsibility and distress due to work-family conflict, especially given traditional gender roles, which may have resulted in higher marijuana use. However, this is in contradiction with literature that males tend to use marijuana more often as a stress-coping mechanism (Gerich

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& Lehner, 2022). This finding warrants future study of how women have handled the stressors and opportunities in a working-from-home environment.

Younger age was also associated with marijuana use for the lost job and working from home job conditions. For workers who lost jobs due to COVID-19, the 18–34-year-old age range was significantly associated with marijuana use at one month and one year. For workers who worked from home due to COVID-19, there were statistically significant associations with marijuana use in workers from 18-49-years-old. This trend of younger workers using marijuana to cope with work-related stressors is in line with other studies that show an increased association of marijuana use in younger workers (Roche et al., 2022). This is further supported by a study of Californian adults that showed younger adults were more likely than older age groups to use marijuana both pre and post legalization of recreational marijuana(Gali et al., 2021). Workers with reduced work hours or incomes did not share this same pattern. Workers from 35-65-years-old with reduced work hours were more likely to use marijuana in this study. It is unclear why reduced work hours or reduced incomes were more highly associated with marijuana use in an older group of workers.

Another interesting association that was found in our study was in the marriage status of the participants. Our logistic regression analyses found that there were significant associations for married workers who reported working from home due to COVID-19 or reduced work hours due to COVID-19 and marijuana use within the past month and the past year. These findings were unexpected given the general trends reported in the literature. Married men and women have reported decreasing their use of marijuana, cigarettes, and alcohol after marriage (Merline et al., 2008). Further, divorce is associated with higher rates of substance use in adults (Edwards et al., 2018). It has been shown that specifically in men that marriage is associated with

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decreased substance use (Salvatore et al., 2020). One explanation for the findings in our study is that the COVID-19-related job conditions of reduced work and working from home may be associated with increased conflict or marital strife. It has been shown that there is an association between substance use, specifically alcohol, and marital strain for adults (Smith & Gibson, 2020; Rodriguez et al., 2020). This is supported by a study that associated COVID-19-related stress and financial stress, which showed stressors affected alcohol drinking behaviors of the partner (Rodriguez et al., 2021). Although job loss due to COVID-19 and marijuana use for married workers was not statistically significant, the odds ratio (1.594), 95% confidence interval (0.888, 2.862), and p-value (0.12) were approaching significance and further studies may elucidate whether there is a strong relationship. The current literature primarily involves alcohol use between married couples and our study suggests that more research on marijuana use and marriage dynamics during the COVID-19 pandemic is warranted.

The association between lost jobs due to COVID-19 and reduced work hours due to COVID-19 and marijuana use was also most pronounced in the groups with lower annual household incomes. However, for working from home, an opposing trend was observed – the higher income level groups had significant associations between the work condition and marijuana use. This pattern is also reflected by educational levels: those with master's degrees or other graduate degrees were more likely to have an association between working from home and marijuana use than those with a high school education or lower. It has been shown that those with the lowest income levels and lower educational attainment have had lower self-reported mental and physical health during the pandemic (Yun et al., 2022). As these groups were more vulnerable to job loss and reduced hours, it is possible that this led to increased mental stress and marijuana use as a coping behavior.

Working from home was the only COVID-19-related job stressor that was associated with greater marijuana smoking in both the highest educational and highest income group. The demographics of those who switched to working from home during the COVID-19 pandemic are not indicative of the overall workforce. Those who worked from home during COVID-19 pandemic tended to have higher incomes, higher education, and better overall self-reported health (Marshall et al., 2021). Essential workers who worked in person tended to have lower socioeconomic status and be racial minorities (Lyttelton & Zang, 2022). There is a body of data that educated workers and those with high incomes that work from home reported increased stress during the COVID-19 pandemic. Teleworking in a group of psychology professionals during the pandemic was associated with higher stress scores, depression, and work-related burnout compared to those in the workplace (Serrão et al., 2022). In a large cross-sectional study, working from home during COVID-19 was associated with increased stress, reduced work-life balance, and decreased work satisfaction in workers (Sandoval-Reyes et al., 2021). This study population, a convenience sample, was over 90% educated with a college degree or higher (Sandoval-Reyes et al., 2021). This provides supporting evidence that working from home may have been a job change that negatively affected highly educated people during the COVID-19 pandemic, potentially leading to increased marijuana use.

COVID-19-related job loss and marijuana use at one month and one year were significant for the African American and Hispanic groups. This may be related to findings that under-resourced communities are more likely to experience job loss in general (Wright & Chan, 2022). In April 2020, during the first COVID-19 lockdown period, Black and Latino adults had higher unemployment rates than white adults (Singleton et al., 2022). This unemployment gap expanded as the pandemic continued (Couch et al., 2020). Further, the trauma of COVID-19-related job

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losses for these minority communities is compounded by the systemic divestment and fewer resources allocated to them over generations (Wright & Chan, 2022). COVID-19-related job loss and employment disruption was also shown to be associated with greater psychological distress in Blacks and Hispanics (Fisher et al., 2021; Matthews et al., 2021). This is further substantiated by other self-reported surveys in which Blacks and Hispanics reported higher psychological distress during the pandemic (Purtle, 2020). Additionally, Black and Hispanic workers may have had increased stress due to job loss, as they had less alternative work options during the pandemic (Couch et al., 2020). The odds of telework were significantly lower for Hispanic and Black workers in studies, and their occupations and educational levels were strong mediators of this effect (Asfaw, 2022). It is possible that due to less accumulated wealth, less alternative employment opportunities, and less community resources, job loss caused increased stress for Hispanic and African American workers leading to marijuana use to cope with the trauma and stress.

While the association between reduced work hours in the lower income and lower education workers and marijuana use were in line with the other job stressors due to COVID-19, there was other significant data that is less easily explained in the stratified analysis for reduced work hours. For instance, reduced work hours were associated with marijuana use within one month and one year for Asians and within one year for White people. It is possible that the effect observed in our study is associated with lower-income Asian populations, who were more negatively affected by the COVID-19 pandemic than higher-income Asians (Yi et al., 2021). Lower-income Asians were less likely to be able to switch to working from home and were more likely to experience food insecurity (Yi et al., 2021). Recognizing and studying the diverse subgroups within Asian race may help better understand these findings. Overall, our hypothesis

was correct that reduced hours due to COVID-19 were associated with marijuana use. The stratified analysis did reveal unexpected demographic associations that differed from COVID-19-related job loss and working from home, specifically in the age and race sub-analyses. Interestingly, data on reduced work hours and substance use was also limited in previously published literature, making it difficult to corroborate or explain these findings.

Limitations and Strengths of this Study

This study was with a cross-sectional design. The most important limitation of this cross-sectional study is that causal inference cannot be made based on this study. In general terms, this study cannot confirm that there was a causal or temporal relationship between COVID-19-related job stressors and marijuana use in the past month and in the past year. Causal relationships also cannot be assumed within the sub-stratified analysis. In addition, the data was self-reported by participants as part of the CHIS 2020 study, which can lead to response bias and recall bias. This would be more likely to affect the marijuana use data, as participants were asked to recall their last use of marijuana, which could involve recall for up to years.

Another limitation of our study is that we were not able to distinguish which questionnaires occurred during the period of COVID-19 lockdowns in California and which questionnaires were administered after the lockdowns were lifted. Preliminary data reported suggest that as the pandemic progresses substance use patterns may change. A study in Israel showed that cannabis use decreased and alcohol use stayed consistent after the initial COVID-19 lockdown, however, marijuana is still an illegal recreational substance in Israel which may have also affected behaviors (Bonny-Noach et al., 2021).

The legal status of marijuana differs across the United States, and this limits the generalizability of these results to all states. California legalized recreational marijuana in 2016 and legalized medicinal marijuana in 1996. As of 2022, recreational marijuana has been legalized in 21 states and Washington, D.C. These differing policies further limit the current generalizability of these study results, especially in states that have not legalized medical and recreational marijuana. Further given this is a secondary analysis of a cross-sectional study, we were not able to delineate whether the self-reported marijuana use was medicinal or recreational. This is an important consideration, as medicinal marijuana requires a prescription from a healthcare provider. The ability to identify trends in medical and recreational use separately can help suggest what causes changes in adult marijuana use.

Another limitation due to the study design is that participants were asked whether they had reduced hours *or* reduced income due to COVID-19 under the same category. This combines both a work stressor – reduced hours and an economic stressor – reduced income into one pooled response. This makes it even more difficult to interpret the results from this job/economic stressor. Given that reduced work hours is a relatively understudied work stressor in the literature, researchers should be encouraged in the future to study reduced work hours as in independent work stressor.

Our study is also limited in that it cannot be used to estimate the burden of clinical cannabis use disorders in the working population. Examining the quantity of marijuana and frequency of marijuana use, in addition to the time since the last use, would provide valuable information to better characterize the burden of marijuana use on workers. Evaluating for disordered use of marijuana workers would also be helpful, although biological and clinical understanding of the disorder is still developing. The National Academies of Sciences released

recommendations for the development of standardized and validated questionnaires to be used for research and public health surveillance of cannabis use (Division et al., 2017; Keyhani et al., 2020). The Cannabis Use Identification Test-Revised (CUDIT-R) and Cannabis Assessment Tool (CAT-1) have been developed as cannabis misuse screening tools, with the CAT-1 being developed specifically for adults (Adamson et al., 2010; Keyhani et al., 2020).The integration of standardized tools into large studies will help increase our knowledge of the epidemiology of substance use in general and how it relates to occupational stress.

Further, the collected data tended to skew more toward highly educated and high-income workers. Although the data was weighted and adjusted data to represent the population, a more widely distributed worker population may have better reflected the effects of each job condition and within each stratum. For example, the median household income between 2016-2020, adjusted for inflation, was $78,672. However, over 60% of our study sample reported household incomes over $90,000 in 2020. In addition, 34.7% of Californian adults over the age of 25 years old had a bachelor's degree or higher from 2016-2020. In our study, over 65% of workers had at least a bachelor's degree. This may have led to the overrepresentation of certain strata and can make it difficult to compare the results between strata for the education and income groups.

However, societal stigma also remains surrounding marijuana use. This may promote hesitancy to report marijuana use by participants. Although stigma has been declining, recent studies have shown marijuana use has not reached societal normalization (Reid, 2020). Social desirability bias may further play a role in influencing the results, which is the tendency for individuals to underreport fewer undesirable behaviors and viewpoints, and overreport more socially desirable behaviors and attitudes. This bias has been tied to the underreporting of drug

behaviors in cocaine and alcohol, and this could be limiting capturing the full scope of marijuana use in this study population (Latkin et al., 2017).

Despite the potential limitations of our study, there are also several strengths. For one, the size of our study sample is very large. In addition, this is the first study to address marijuana use in a large population of workers during COVID-19. Further, this is the first study to address marijuana use in workers who switched to working from home due to COVID-19, which is a work condition that is likely to remain at higher levels in the workforce.

Future Directions:

We have addressed a relatively understudied relationship with this study on marijuana use and work conditions during the pandemic. There are many directions and future studies that could result from this work. CHIS 2020 did not publicly release the specific illicit substance use and prescription medication misuse data from the questionnaires. Examining associations between COVID-19-related job stressors and illicit substances in the state of California would be a useful future direction. Although cannabis use disorders are increasing and leading to more hospitalizations over time, the effects of other illicit substances also cause a significant individual and public health burden (*UNODC, World Drug Report 2022.*, 2022). Further utilizing the alcohol and nicotine use data in CHIS 2020 can also be utilized to broaden our knowledge of worker health and development of mitigation strategies. However, in future studies on any substance, legal or illicit, it is important to ethically design and implement such studies, in order to protect those with substance use disorders who are a particularly vulnerable population (Fisher, 2011). This is particularly important in studying how substance use relates to work

stressors and the work environment, as there could be economic consequences for the study participants.

Studying mental health outcomes in people working from home, especially as it has emerged as a more common working condition due to the COVID-19 pandemic, can help to elucidate how organizations and employers can support employees in the future. Further, continued study on the interaction between stressors caused by work and job conditions and substance use are warranted. Another future direction would be to categorize the occupations in another large dataset and assess for whether certain occupations are more prone to marijuana use due to the stressors of COVID-19. This could be useful in further identifying working populations at risk for potential cannabis use disorders or impairment due to marijuana. In studying marijuana specifically, especially as marijuana use continues to increase in the United States and around the world, there is a strong need for standardized tools to be used both clinically and for research to drive policy, treatment, and public health surveillance of the burden of cannabis use at the individual and societal level (Adamson et al., 2010; Division et al., 2017; Keyhani et al., 2020).

In the future, continuing to explore how work-related stress differs by socioeconomic status and race is of vital importance to promoting a healthier workforce and population. Our study was not designed to fully explore the root causes of differences in work-related stressors and marijuana use in minority workers, workers with lower educational attainment, and/or workers with lower household incomes. Additionally, considering sub-groups within larger racial categories, particularly in Asians, can highlight associations and suggest inequities that are otherwise masked.

Given the proposed mechanisms of how acute and chronic stress affects human neurobiology, organizational support and programming for employees may help mitigate negative health behaviors due to stress (Arnsten & Shanafelt, 2021). Investing in developing effective programming and research now may help mitigate the negative effects on mental and behavioral health in workers due to the current pandemic and any future disasters that may occur. Further, our study ultimately aims to promote prevention – with the goal of prevention shifting into an essential role for employers, workplaces, and workers in the future.

Conclusions

A growing body of literature focuses on the COVID-19 pandemic and its impact on the general population's mental health and substance use. We have conducted data analyses of the largest epidemiologic study of job stress due to the COVID-19 pandemic and marijuana use in the United States thus far. The study results supported our hypothesis that COVID-19-related job stressors are significantly associated with marijuana use within the past month and year. These relationships were maintained for every job stressor even when controlling for gender, race, age, income, education level, and marital status.

Male gender was the demographic variable that most consistently was associated with job stressors and marijauna use, which is supported in previous literature on marijuana use. We then identified trends that those with lower income, less education, and racial and ethnic minorities were disproportionately impacted by COVID-19-related job loss. For these groups, COVID-19-related job loss and marijuana use were significantly associated. Different trends were observed in those who worked from home. Those in higher income and educational groups who transitioned to work from home due to COVID-19 were more likely to smoke marijuana in the past month and year. The sociodemographic differences observed between the job stressor of reduced work hours due to the COVID-19 pandemic and marijuana use require further exploration in future studies, as the patterns found were not well supported by the current literature.

Although our study is limited in proving causality, we expect that this study inspires further interest in the topic of work-related stressors, mental health, and substance use. Further

studies could be essential in identifying the burden of marijuana/cannabis use on individual workers and public health systems. Moreover, examining modifiable risk factors and vulnerable populations is essential to the mitigation and prevention of substance use disorders. Ultimately, this study and future work may contribute to a more equitable and healthy workforce.

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