Oil Drilling in Los Angeles and Perceived Stress Effects on Nearby Communities

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Abstract

Los Angeles is a city with a long history in the oil industry. While extraction began in the 1890s, the city remains the largest urban oil field in the nation to this day. Many of the city's neighborhoods where oil wells still remain are home to low income communities of color. These communities are often forced to deal with disproportionate amounts of pollutants and stressors, both of which can affect their ability to live healthy lives. While research is emerging on the physiological effects of living in close proximity to urban oil wells, this study seeks to examine the perceived mental stress effects of proximity to such wells. To do so, this study uses basic t-tests to find statistically significant differences in mean perceived stress levels of different groups of residents (grouped by proximity to wells, demographic information, and health information). While analysis did not show statistically significant differences in mean perceived stress levels between groups living in close and medium proximity t

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Introduction

Urban oil drilling in Los Angeles began in the late 19th Century, when the growing city discovered vast untapped oil reserves under its streets (Quam-Wickham 201

(Weinberger et al. 2017, Helmig et al. 2014). Studying the stress impacts of living near oil allows a more comprehensive mental and physical health picture of the impacts associated with living near oil developments in Los Angeles.

Los Angeles Oil Code has not been meaningfully updated since the 1950s (before the passage of the Clean Air Act and Clean Water Act), leaving communities with only outdated regulations to protect them from possible health impacts created by proximity to the oil wells (Liberty Hill 2015). While these oil wells have not yet been shown to cause direct negative physical or mental health outcomes for the communities living nearby, the city has yet to take any preventative policy measures to protect vulnerable communities from the possible dangers of living in close proximity to the wells despite the existence of drilling in vulnerable neighborhoods since the city's first comprehensive zoning plan, approved in 1921 (Cumming 2018).

The main research question of this paper is: **What is the relationship between proximity to urban oil wells and perceived stress levels in Los Angeles?** To answer this question, the paper uses Excel t-tests in oto analyze the results of a 900-respondent survey on perceived stress, collected as part of a larger study on urban oil development that examines lung function and resident proximity to active oil development. The t-tests compare perceived stress scale scores between different groups to explore any associations between a variety of factors and perceived stress levels in the survey population. These factors include race, exposure to odors, distance from well sites, and existing medical issues. To expand this analysis, this paper also examines the stress effects of proximity to oil considering the effects of cumulative stress, which occurs when people are exposed to multiple stressors.

Background

Despite its status today as an entertainment hub, Los Angeles is a city rooted in the oil industry. According to one oil industry executive, LA's oil output at its peak made it "[t]he equivalent of Saudi Arabia today" (S T A N D - L.A. 2020). Los Angeles' oil industry and population expanded together during the early 20th Century, with the city producing roughly 20 percent of the world's oil supply by the 1920s while its population exploded from roughly 50,000 in the 1890s to 1.2 million in 1930 (Quam-Wickham 2015, S T A N D - L.A. 2020). As the oil industry expanded, property owners, labor unions, and local governments became increasingly worried about the oil industry's aesthetic, environmental, and health impacts (Quam-Wickham 1998, Elkind 2012). Observers described "forests of oil derricks," one-hundred foot well fires like "livid towers of flames," and a report which found that oil and gas wells in the South Coast Air Basin (which includes much of Los Angeles County) were, by a significant margin, the biggest polluters of benzenes, BTEX emissions, and alkanes (all of which negatively impact health with chronic exposure) when compared to other oil and gas industry infrastructure including gas stations, and refineries (Ntuk et al. 2019).

Literature Review

sometimes cause even worse health impacts than exposure to single pollutants (Cushing et al. 2015, Mauderly and Samet 2009). The environmental justice movement as a whole is aimed at "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies," according to the EPA, but it encompasses even more than this definition (US EPA 2016). Other interpretations of environmental justice include access to transit and infrastructure, while still other groups call for an end to the production of toxic materials (Holifield 2001, First National People of Color Environmental Leadership Summit 1991).

Environmental justice communities such as Jefferson Park and University Park are not just home to oil wells and disproportionate amounts of pollution, but also face disproportionate cumulative health burdens. For example, low income and minority communities face disproportionately high rates of morbidity and mortality due to asthma in part because they lack access to quality healthcare, are exposed to disproportionate amounts of environmental irritants, and lack the social support systems needed to deal with the disease long-term (Butler, Bowers, and Cohen 2000). Children living in low-income minority communities are also disproportionately affected by lead poisoning, which can cause permanent intellectual disability and birth defects, through exposure to chipped paint due to lack of access to safe, modern housing (Benfer 2017). These are just two examples of specific health problems faced by environmental justice communities; such communities also face health disparities in perinatal outcomes, cardiovascular disease, and general self-rated health (Morello-Frosch et al. 2011).

This issue of cumulative health burdens on environmental justice communities is also a reality in Los Angeles, specifically: one study of LAUSD students revealed that minority students were disproportionately burdened by estimated cancer and respiratory risks and were also disproportionately exposed to environmental hazards (Pastor, Sadd, and Morello-Frosch 2002). Outside of student populations, whole neighborhoods with higher proportions of non-White residents in Los Angeles are also disproportionately exposed to air pollutants, specifically diesel particulate matter, nitrogen dioxide, and particulate matter, all of which contribute to respiratory problems, especially asthma (Su et al. 2012). Building on top of this, infants in environmental justice communities in Los Angeles (where mothers are exposed to a mixture of different air pollutants) are more likely to be born with low birth weights, which can lead to subnormal growth rates and increase the likelihood of illnesses in the child in the long term (Coker et al. 2016; Hack, Klein, and Taylor 1995).

B. Stress in Low Income Communities of Color

Stress does not affect all communities equally. Groups who are more likely to be exposed to stressful events include African Americans, people of color, and people of lower socioeconomic status (Hatch and Dohrenwend 2007). People of color in particular face stress in multiple areas: exposure to racial discrimination is directly associated with psychological distress and depressive symptoms, and racial discrimination can also feed into systemic/institutional racism which creates stressors and exacerbates stressors in many areas of life (Williams 2018).

Outside of race, lower socioeconomic status is strongly linked with increased stress; according to one study, lower socioeconomic status is associated with higher levels of stress hormones as well independent of race, gender, and age (Cohen, Doyle, and Baum 2006). Living in neighborhoods facing problems such as high levels of traffic pollution, decaying public spaces, and insufficient transit (all generally associated with lower socioeconomic status) has also been shown to be associated with higher stress levels in residents (Steptoe and Feldman 2001). Prolonged, environmental exposure to noise has also been found to be a potential cause of physiological stress in humans, especially impacting people who live in urban areas or near industry (Rylander 2004). As noted later in this literature review, stress has been shown to cause and exacerbate a variety of health issues including asthma (Shaw et al. 2018, Oh et al. 2004). This means that low-income communities of color are exposed to disproportionate health risks and can face an increased number of stressors, which in turn can cause and exacerbate wells (compared to Los Angeles County's approximately 5,000 active wells), ozone levels occasionally spiked to double the EPA's ground-level ozone ceiling of 70ppb, reaching almost 150 at some points (EPA 2015).

While previously mentioned studies focus on pollutants measured near unconventional oil and gas developments, there is also research on human health in proximity to oil developments. One study of residents of southwest Pennsylvania showed that people living in areas with higher densities of oil and gas developments reported increased cases of eyes/ears/nose/throat and neurological/muscular symptoms, and that living in close proximity to oil and gas developments could have health impacts (Blinn et al. 2020). Another study in a similar vein found an association between new health symptoms and exposure to new unconventional gas developments. The study, which retrospectively examined participants' health records verified by medical professionals, showed that, after a new unconventional gas development was drilled within one kilometer, participants saw new health symptoms which they did not experience until the drilling (Weinberger et al. 2017). These health impacts included increased number of stressors on individuals has also been associated with poorer self-rated health levels, a measurement which is predictive of increased mortality and negative health outcomes (Sternthal, Slopen, and Williams 2011).

Stress has been associated with increased respiratory problems, especially asthma (Oh et al. 2004). One study found that increased levels of perceived stress in caretakers led to higher rates of wheezing in the child they are taking care of, even independent of stress-induced behavioral changes in caregivers (Wright et al. 2002). Childhood wheezing has been linked to a variety of respiratory problems, including respiratory infections and possibly asthma. Another study looking for links between stress and respiratory problems found that, in children with asthma, acute stressors significantly increased the likelihood of asthma attacks in the following weeks. Additionally, risk of asthma attacks after acute stress events was increased and more likely to occur soon after the stress event if the child was exposed to multiple chronic stressors (Sandberg et al. 2000). Even more relevant to this paper, another study showed that higher perceived stress levels were strongly associated with increased asthma morbidity over the course of a year in a population of adult inner-city asthmatics (Wisnivesky et al. 2010). These studies show that stress can add to the disproportionately long list of health issues that urban, low-income communities of color often face.

B. Mental Health Impacts of Proximity to Industry

van Willigen 2005). These studies taken together show that industrial developments can have negative mental health and stress impacts on the surrounding communities, mainly through creating a feeling of powerlessness in the community.

C. Mental Health Impacts of Proximity to Unconventional Oil and Gas

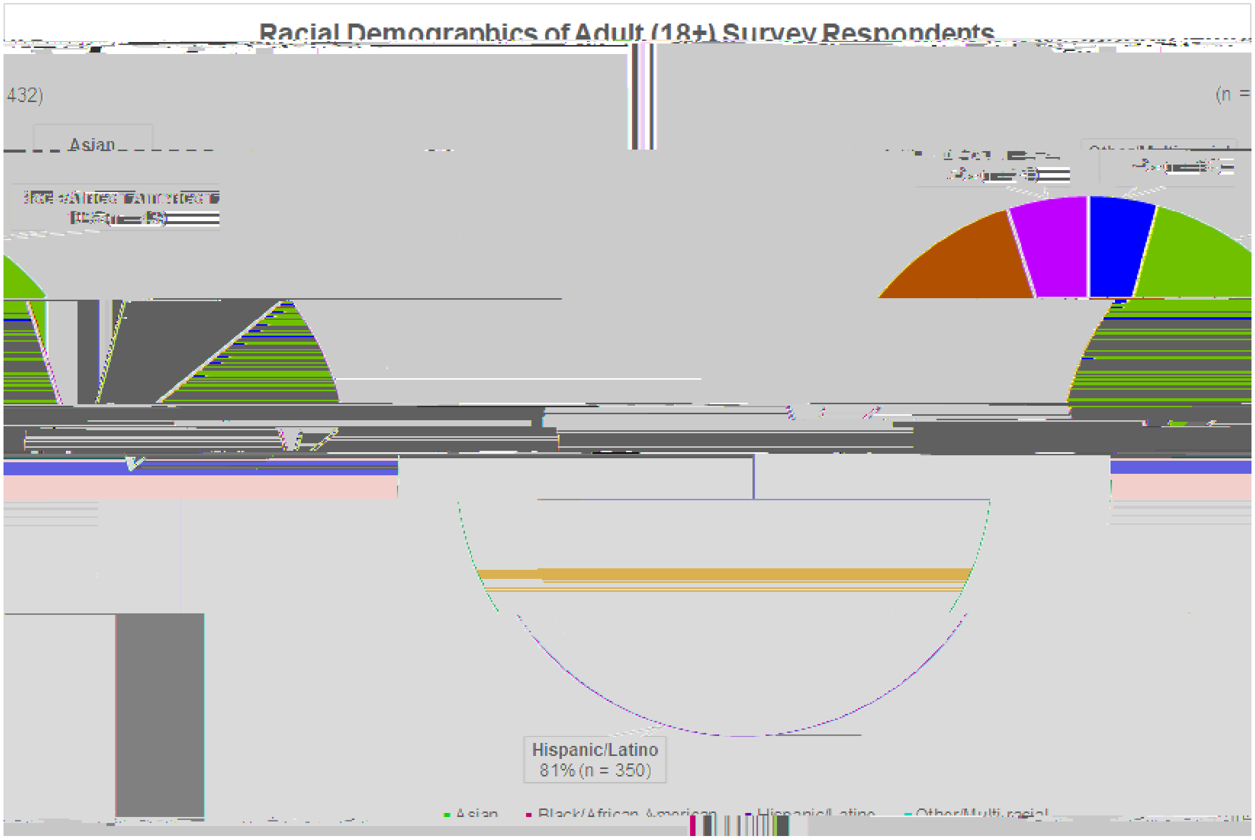
Bringing this discussion closer to the topic of oil drilling in Los Angeles, one study has also shown that proximity to unconventional oil and gas developments has negative mental health impacts on nearby communities. While it focused on fracking developments in Colorado, the study showed that uncertainty in knowledge of the health impacts of living near fracking developments and the perceived powerlessness of the community in controlling the creation and spread of such developments made living near fracking developments a chronic stressor for members of the community (Malin 2020). Another study on the mental health implications of living near unconventional oil and gas drilling took place in Texas, where unconventional techniques, specifically fracking, make up a growing proportion of oil and gas production. This study, which spanned roughly half of all counties in Texas, showed that respondents who lived

Methods

This project assesses whether proximity to oil wells in Los Angeles is associated with

Data

Chart I. Demographic Data



(Johnston et al. 2021)

Comparing Perceived Stress Score (PSS) by demographic variables:

Table I. PSS Statistics in Whole Adult Sample

	Mean	Standard Deviation (StDev)
Whole Survey Population (n = 538)	5.498	2.958
Adult Survey Population (n = 432)	5.641	2.951

Table II. PSS in Adults by Sex

- Research hypothesis: there is a statistically significant difference in mean PSS between adult women and men living near oil wells.
- Null hypothesis: there is no statistically significant difference in mean PSS between adult women and men living near oil wells.
    - We **fail to reject** the null hypothesis with 95 percent confidence as p (0.158) is greater than p=0.05.

	Mean	StDev
Men (n = 125)	5.336	3.208
Women (n = 306)	5.778	2.832

Table III. PSS in Adults by Race/Ethnicity

a. *Hispanic/Latino*

- Research hypothesis: there is a statistically significant difference in mean PSS between those adults who identify as Hispanic/Latino and those who do not identify as Hispanic/Latino.
- Null hypothesis: there is no statistically significant difference in mean PSS between those adults who identify as Hispanic/Latino and those who do not identify as Hispanic/Latino.
    - We **reject** the null hypothesis with 95 percent confidence as p (0.000089) is less than p=0.05.

	Mean	StDev
Hispanic/Latino (n = 350)	5.908	2.803
Non-Hispanic/Latino (n = 82)	4.5	3.297

b. Black/African American

- Research hypothesis: there is a statistically significant difference in mean PSS between those adults who identify as Black/African American and those who do not identify as Black/African American.
- Null hypothesis: there is no statistically significant difference in mean PSS between those adults who identify as Black/African American and those who do not identify as Black/African American.
    - We **fail to reject** the null hypothesis with 95 percent confidence as p (0.119) is greater than p=0.05.

	Mean	StDev
Black/African American (n = 43)	4.977	3.542
Non-Black/African American (n = 389)	5.715	2.874

c. Asian

- Research hypothesis: there is a statistically significant difference in mean PSS between those adults who identify as Asian and those who do not identify as Asian.
- Null hypothesis: there is no statistically significant difference in mean PSS between those adults who identify as Asian and those who do not identify as Asian.
    - We **reject**

d. Other/Multiracial

- Research hypothesis: there is a statistically significant difference in mean PSS between those adults who identify as Other/Multi-racial and those who do not identify as Other/Multi-racial.
- Null hypothesis: there is no statistically significant difference in mean PSS between those adults who identify as Other/Multi-racial and those who do not identify as Other/Multi-racial.
    - We **fail to reject** the null hypothesis with 95 percent confidence as p (0.0768) is greater than p=0.05.

	Mean	StDev
Other/Multiracial (n = 21)	4.524	2.822
Non-Other/Multiracial (n = 411)	5.698	2.949

Table IV. PSS in Adults by Site (AllenCo vs Murphy)

- Research hypothesis: there is a statistically significant difference in mean PSS between adults living near the AllenCo site and those living near the Murphy site.
- Null hypothesis: there is no statistically significant difference in mean PSS between adults living near the AllenCo site and those living near the Murphy site.
    - We <u>**reject**</u> the null hypothesis with 95 percent confidence as p (0.0309) is less than p=0.05

	Mean	StDev
AllenCo (n = 288)	5.858	2.774
Murphy (n = 144)	5.208	3.242

Table V. PSS in Adults by Age (under 65, 65+)

- Research hypothesis: there is a statistically significant difference in mean PSS between those 65+ years of age and those under 65 years of age.
- Null hypothesis: there is no statistically significant difference in mean PSS between those 65+ years of age and those under 65 years of age.
    - We **fail to reject** the null hypothesis with 95 percent confidence as p (0.0956) is greater than p=0.05

	Mean	StDev
Under 65 (n = 344)	5.770	2.866
65+ (n = 88)	5.136	3.231

Table VI. PSS in Adults by Proximity to Oil Well (within 200m vs within 200-1000m)

- Research hypothesis: there is a statistically significant difference in mean PSS between adults living under 200m from an oil well site and those living 200-1000m from an oil well site.
- Null hypothesis: there is no statistically significant difference in mean PSS between
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[redacted]

Living 200m and over from freeway (n = 143)	5.616	2.977

[redacted]

Table IX. PSS in Adults by Asthma Status

- Research hypothesis: there is a statistically significant difference in mean PSS between adults who have been diagnosed with asthma and those who have not.
- Null hypothesis: there is no statistically significant difference in mean PSS between adults who have been diagnosed with diabetes and those who have not.
  - We **fail to reject** the null hypothesis with 95 percent confidence as p (0.4719) is greater than p=0.05.

	Mean	StDev
Has been diagnosed with asthma (n = 60)	5.367	3.209
Has not been diagnosed with asthma (n = 372)	5.685	2.909

Table X. PSS in Adults by Wheezing Status

- Research hypothesis: there is a statistically significant difference in mean PSS between adults who have experienced wheezing in the past and those who have not.
- Null hypothesis: there is no statistically significant difference in mean PSS between adults who have experienced wheezing in the past and those who have not.
  - We **reject** the null hypothesis with 95 percent confidence as p (0.0129) is less than p=0.05.

	Mean	StDev
Has experienced wheezing in the past (n = 155)	6.116	2.980
Has not experienced wheezing in the past (n = 277)	5.375	2.906

Table XI. PSS in Adults by Odor Experiences

- Research hypothesis: there is a statistically significant difference in mean PSS between adults who reported noticing odors outside in the past 2 weeks and those who have not.
- Null hypothesis: there is no statistically significant difference in mean PSS between adults who reported noticing odors outside in the past 2 weeks and those who have not.
    - We **reject** the null hypothesis with 95 percent confidence as p (0.00185) is less than p=0.05.

	Mean	StDev
Has noticed odors outdoors in the past 2 weeks (n = 202)	6.109	2.814
Has not noticed odors outdoors in the past 2 weeks (n = 230)	5.230	3.013

Table XII. PSS in Adults Diagnosed with Asthma by Proximity to Oil Well

- Research hypothesis: there is a statistically significant difference in mean PSS between adults who have been diagnosed with asthma living under 200m from an oil well site and those living 200-1000m from an oil well site.
- Null hypothesis: there is no statistically significant difference in mean PSS between adults who have been diagnosed with asthma living under 200m from an oil well site and those living 200-1000m from an oil well site.
    - We **fail to reject** the null hypothesis with 95 percent confidence as p (0.40585) is greater than p=0.05.

	Mean	StDev
Living under 200m from well (n = 25)	4.960	3.075
Living 200-1000m from well (n = 35)	5.657	3.316

Table XIII. PSS in Adults Diagnosed with Diabetes by Proximity to Oil Well

- Research hypothesis: there is a statistically significant difference in mean PSS between adults who have been diagnosed with diabetes living under 200m from an oil well site and those living 200-1000m from an oil well site.
- Null hypothesis: there is no statistically significant difference in mean PSS between adults who have been diagnosed with diabetes living under 200m from an oil well site and those living 200-1000m from an oil well site.
    - We **fail to reject** the null hypothesis with 95 percent confidence as p (0.0641) is greater than p=0.05.

	Mean	StDev
Living under 200m from well (n = 31)	4.960	2.707
Living 200-1000m from well (n = 47)	6.234	3.364

Table XIV. PSS in Adults Who Have Experienced Wheezing by Proximity to Oil Well

- Research hypothesis: there is a statistically significant difference in mean PSS between adults who have experienced wheezing living under 200m from an oil well site and those living 200-1000m from an oil well site.
- Null hypothesis: there is no statistically significant difference in mean PSS between adults who have experienced wheezing living under 200m from an oil well site and those living 200-1000m from an oil well site.
    - We **fail to reject** the null hypothesis with 95 percent confidence as p (0.4663) is greater than p=0.05.

	Mean	StDev
Living under 200m from well (n = 52)	5.865	3.081
Living 200-1000m from well (n = 103)		

Table XV. PSS in Adults with Odor Experiences by Proximity to Oil Well

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Table XVII. PSS in Hispanic/Latino Adults by Proximity to Oil Well in Hispanic Adults Who Have Noticed Odors

- Research hypothesis: there is a statistically significant difference in mean PSS between Hispanic/Latino adults who have experienced odors in the past 2 weeks living under 200m from an oil well site and those living 200-1000m from an oil well site.
- Null hypothesis: there is no statistically significant difference in mean PSS between Hispanic/Latino adults who have experienced odors in the past 2 weeks living under 200m from an oil well site and those living 200-1000m from an oil well site.
    - We **reject** the null hypothesis with 95 percent confidence as p (0.0028) is less than p=0.05

	Mean	StDev
Living under 200m from well (n = 57)	6.456	2.619
Living 200-1000m from well (n = 67)		

Analysis

The mean PSS of the survey population as a whole was 5.498, and the standard deviation was 2.958. However, these results included children under the age of 18 whose answers to survey questions and perceptions of stress may not be reliable due to a lack of understanding of stress or the questions asked of them, further analysis was conducted on the adult population of survey subjects to reduce this unreliability. The mean PSS of adult subjects surveyed, of which there were 436, was 5.641 with standard deviation of 2.951.

Table XVIII. Tests With Statistically Significant Mean Differences Between Test Groups

Comparison Groups	**Higher Mean PSS Group**	**Lower Mean PSS Group**
PSS in Adults by Race/Ethnicity (Hispanic/Latino vs Non-Hispanic/Latino)	Hispanic/Latino (μ = 5.908)	Non-Hispanic/Latino (μ = 4.5)
PSS in Adults by Race/Ethnicity (Asian vs Non-Asian)	Non-Asian (μ = 5.742)	Asian (μ = 3.333)
PSS in Adults by Site (AllenCo vs Murphy)	AllenCo (μ = 5.858)	Murphy (μ = 5.208)
PSS in Adults by Wheezing Status	Experienced wheezing in the past (μ = 6.116)	Not experienced wheezing in the past (μ = 5.375)
PSS in Adults by Odor Experiences	Noticed odors outdoors in the past 2 weeks (μ = 6.109)	Not noticed odors outdoors in the past 2 weeks (μ = 5.230)
PSS in Hispanic/Latino Adults by Odor Experiences	**Hispanic/Latino**, noticed odors outdoors in the past 2 weeks (μ = 6.357)	**Hispanic/Latino**, not noticed odors outdoors in the past 2 weeks (μ = 5.480)
PSS in Hispanic/Latino Adults by Proximity to Oil Well in Hispanic Adults Who Have Noticed Odors	Hispanic/Latino, noticed odors outdoors in the past 2 weeks, **living under 200m from well** (μ = 6.456)	Hispanic/Latino, noticed odors outdoors in the past 2 weeks, **living 200-1000m from well** (μ = 5.045)

While most of the t-tests run failed to re[-)]deilm04 Tf1 0 0 1 202.82 427.27 Tm701 0 0 1 72.024 583.18

PSS scores The first showed that there was a statistically significant difference in the mean

had higher PSS scores than respondents living 200-1000m from a well site (mean PSS = 5.045).

The main goal of this study was to examine whether proximity to oil wells had a relationship with increased PSS scores. The t-test aimed at this question did not reject its null hypothesis and showed that the opposite was true: subjects who lived under 200 meters from a well did not have a statistically significant difference in perceived stress levels (mean PSS = 5.373) than those living 200-1000m from a well (mean PSS = 5.801), and those living further groups can experience increased stress levels due to increased exposure to stressors including lack of control over circumstances as well as discrimination (Hatch and Dohrenwend 2007; Gonzales and Kim 1997). The disproportionate percentages of Hispanic/Latino, as well as Black, residents in the University Park and Jefferson Park neighborhoods, which house the Murphy and AllenCo sites, further support the idea that minority populations are overexposed to health burdens as well as stressors.

The relationship between exposure to odor events and increased stress levels was another interesting outcome of this study. While some literature exists on the topic of odors and stress, most of these are focused on odors as stress relievers, using herb smells such as lavender or mint to reduce stress, to limited effect (Noritaka 2012; Motomura, Sakurai, and Yotsuya 2001). Other studies in the area are more focused on the health impacts which accompany odor exposure, including irritation, headaches, and nausea (Schiffman 1998; Schiffman and Williams 2005; Shusterman 1992). This study shows that a relationship between odor experiences and increased stress exists and should be studied more rigorously to determine causality and the reasons for the relationship.

Finally, another of the tests performed in this study showed that past experiences with wheezing were associated with increased perceived stress levels. There is existing research on the impacts of physical health on mental health, but these are less focused on respiratory problems like wheezing and more on how physical fitness and chronic illness can affect mental health (Ohrnberger, Fichera, and Sutton 2017; Hysing et al. 2007). The relationship touched upon in this study is in agreement with the results of these studies, which both point to decreased physical wellness being associated with decreased mental wellness, just as worse respiratory health signified by wheezing was associated with increased stress in this study.

While this study contained valid analysis, it also had its limitations. Issues included the usage of Excel for statistical analysis, the nature of t-tests as binary measures which simply indicate whether significant mean differences exist between groups, and a limited survey population which did not represent Los Angeles or even South Los Angeles as a whole.

First, the usage of Excel and t-tests: Excel is a rather limited software mainly used for data entry, storage, and visualization. While statistical analysis can be conducted in Excel, other tools such as SPSS are more suitable for pure data analysis purposes. This issue ties in with the usage of t-tests: more powerful statistical analysis software could be used to conduct different tests on this data set. For example, this could enable the usage of regression analysis to further examine the relationship between distance from well site and perceived stress levels. This paper's analysis used binary categories (within 200m of a well vs 200-1000m from a well) to compare distance from wells and perceived stress levels, but usage of regressions could allow a deeper understanding of this relationship by allowing the usage of interval values for distance compared to perceived stress scores.

Second, the survey data used in the study was relatively limited in scope. The survey was collected from populations already living in close proximity to oil wells, so there was no data from the larger population of Los Angeles as a whole to compare perceived stress levels with. This means that the perceived stress effects of living near oil *could* be felt in the population living within 1500 meters of a well, with a drop off in perceived stress outside that distance, and this study would not be able to detect that due to its relatively small, close proximity survey population.

Other state and local governments which have imposed setbacks on oil developments include Colorado and Dallas. In Colorado, legislation increasing setbacks for fracking developments from 500 to 2,000 feet was recently passed after a different bill mandated increased emphasis on public health in oil and gas legislation (Kohler 2020). In 2013, the Dallas City Council passed a city ordinance establishing a setback of 1,500 feet between oil and gas developments and residential buildings, showing that the power to implement oil and gas setbacks was possible on a local level as well (Austin and Zeeble 2013). Los Angeles County itself has flirted with the idea of public health setbacks for developments besides oil and gas, with the LACDPH calling for 500-foot buffers for developments near freeways to protect communities from air pollution (County of Los Angeles Department of Public Health 2019).

II. Increased Response to Odor Events and Increased Monitoring

Currently, the main government body that regulates air pollution in Los Angeles is the South Coast Air Quality Management District (SCAQMD). According to SCAQMD guidelines regarding oil wells, wells are only put under review in the case of three confirmed “odor events” in the past six months (South Coast Air Quality Management District 2015). Odor events are defined as occurrences of three separate people from three separate addresses issuing complaints to the SCAQMD about odors coming from a well, which results in a SCAQMD employee coming to the well to confirm the presence of the odor (odor events are not officially confirmed if the employee does not find an odor themselves). If a site experiences three confirmed odor events, the site owners must put forth an “Odor Mitigation Plan”. The plan must include odor monitoring, and if odors are detected through monitoring equipment, will lead to closure of the well only until the source of the odor is fixed.

The use of odor events to monitor problems with oil developments is flawed in and of itself. People who experience odors have already been exposed to whatever pollutants are causing the odor and closing the well until the odor is eliminated does not change this fact. To solve this issue of odors events doing too little too late, one legislative change could be lowering the requirements for official odor events. Lowering the number of complaints required to trigger a site visit by a SCAQMD employee would allow residents to feel more protected by SCAQMD guidelines while also regulating polluting facilities more closely to prevent future odor events from occurring. Control over events has been shown to mitigate the distress caused by those events, so giving residents increased control over when well sites are inspected could reduce the stress effects of odor events, which, as this study shows, are associated with increased perceived stress levels (Frazier and Caston 2015).

Another policy which should be implemented in tandem with setbacks and change in odor event policy is increased monitoring around oil wells. Many of the studies in this paper's literature review called for increased monitoring of air pollution from wells, and a better understanding of the physical effects of living near oil wells, combined with education programs for nearby

Conclusion

Research on the health impacts of exposure to oil and gas developments is a growing field. While most of this research largely focuses on physical health, this study was aimed at determining the stress impacts felt by communities living near wells in Los Angeles. While results of the study did not show that increased proximity to wells was correlated with increased stress, analysis of more specific populations, namely those exposed to odors coming from wells, showed that the consequences of living near wells could have some stressing effects on nearby communities. This study was mainly limited by its physical scope: respondents all lived roughly within 1000 feet of oil developments, so we were not able to determine stress differences between the population living within 1000 feet of wells and the population living outside that area.

The literature surrounding stress and proximity to industry, as well as the literature on the physical health impacts of proximity to oil developments, combine with this study to show that Los Angeles should implement setbacks from oil and gas developments as a preventative measure to protect public health while increasing funding to monitoring programs in order to deepen our understanding of the effects of proximity to oil developments.

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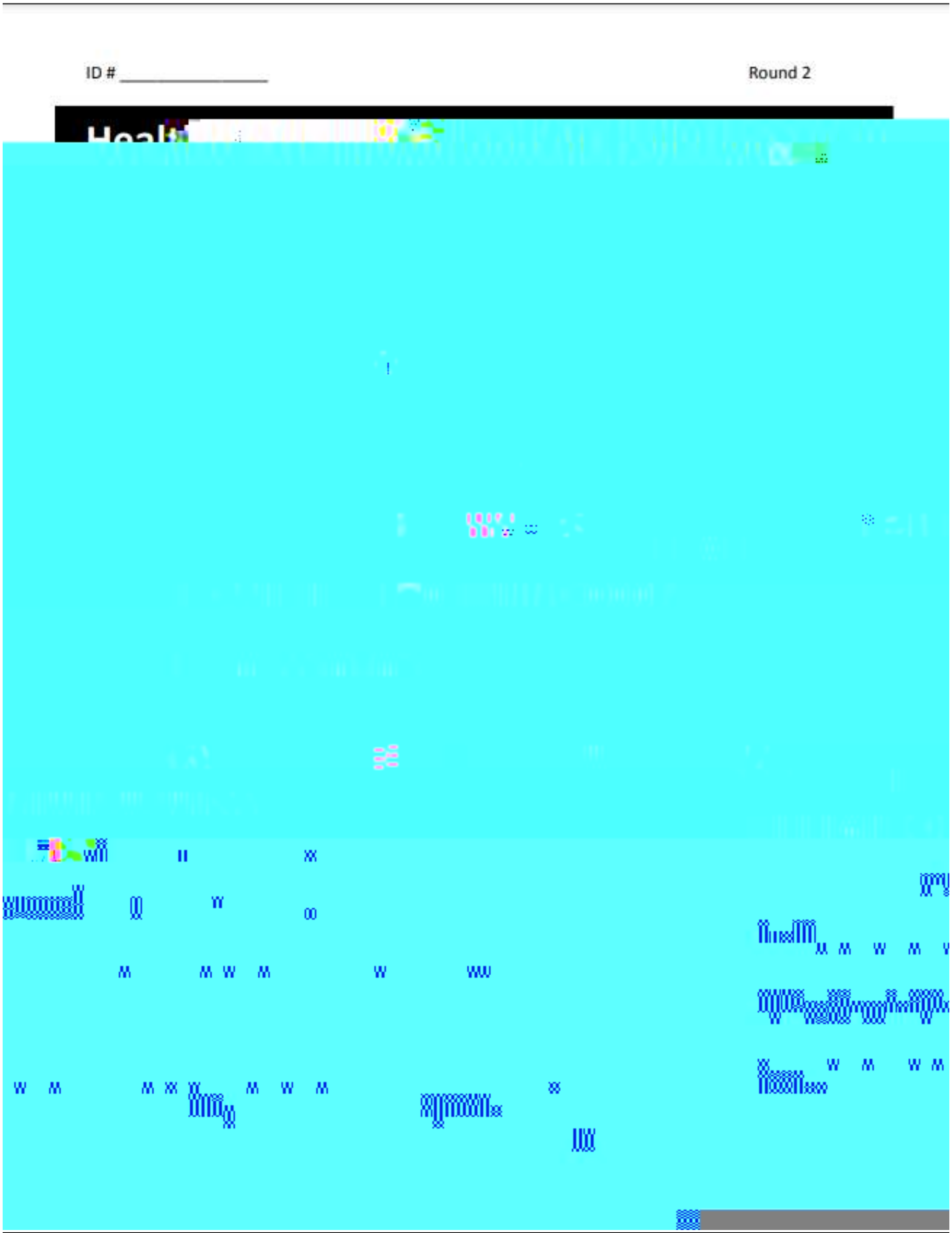
Appendix



ID # _______________ Round 2

ID # _______________ Round 2

Race/Ethnicity:

- O White/Caucasian
- O Latino/Hispanic
- O Black/African-American
- O Asian
- O American Indian
- O Other / More than one race

To help us find you if you move, please write down the name of a relative (such as grandparent, aunt, close friend, etc.) NOT LIVING WITH YOU who would know where you moved.

First and Last name: ____

Relation to you: ____________________________ Phone: ________________________

Who i[illegible]

ID # ______________ Round 2

B. School an[illegible] [illegible]kplace

Do you attend school? [illegible] O No

If yes, which school? ________________________________

Location (City/Nei[illegible]

[illegible] you currentl[illegible] [illegible]yed outside the home? O Yes O No

If yes, please provided informatio[illegible] your present job.

Employe[illegible]

ID # _______________ Round 2

4. **Do you have any of the following allergies…?**

Hay fever, grass or pollen O Yes O No

Food allergies O Yes O No If yes, what? _____________

Drug allergies O Yes O No If yes, what? _____________

Dog or cat allergies O Yes O No

Dust allergies O Yes O No

Other allergies O Yes O No If yes, what? _____________

5. Have you EVER had a heart attack?

O Yes O No

6. Have you EVER smoked cigarettes?

O Yes O No

If yes, have you smoked cigarettes in the past TWO WEEKS?

O Yes O No

ID # _______________ Round 2

9. **Please list any medications you currently use:**

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

ID #   Round 2

Irritation of the eyes/watery eyes	O Not at all	O Once or Twice	O A few times per week	O Daily
Irritation of the nose	O Not at all	O Once or Twice	O A few times per week	O Daily
Nosebleeds	O Not at all	O Once or Twice	O A few times per wee[illegible]	O Da[illegible]

ID # ____ Round 2

If yes

ID # ____________ Round 2

ID # ________________ Round 2

F. S [illegible] ss

In the last T[illegible] weeks, how often [illegible]