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Neighborhood disorder in Mexico: Is it associated with BMI and obesity?

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Bachelor of Science

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An abstract of
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Abstract

Neighborhood disorder in Mexico: Is it associated with BMI and obesity?
By Natalia Ramirez

Objective

Obesity and violence levels are leading public health concerns in Mexico, and both have continued rising without evidence of stopping in the last 30 years. Evidence of violence can be seen in neighborhoods through social and physical conditions. These conditions might be an indicator of potential threat and danger that may affects obesity and BMI through behavioral pathways such as lack of exercise. Therefore, the first objective of this study was to evaluate whether neighborhood disorder is associated with BMI and obesity status. The second objective was to test whether this association is mediated by perceived lack of safety, psychological distress, and exercise.

Methods

Data were analyzed for 7,276 adults from the third wave (2009-2012) of the Mexican Family Life Survey (MxFLS), a longitudinal, multi-thematic survey representative of the national, urban, rural, and regional population in Mexico. Measured weight and height were used to calculate BMI. Descriptive statistics were used to show the distribution of the demographic, health, and neighborhood characteristics of the participants. Multivariable linear and logistic regression models were used to evaluate the association of neighborhood disorder with BMI and obesity. In addition, potential mediation was assessed by comparing coefficient estimates between a model not including the mediators and a model adjusting for the potential mediators.

Results

The results indicate that neighborhood disorder is significantly positively associated with BMI but has a statistically non-significant association with obesity. Results further indicate that after adjustment, the association between neighborhood disorder and BMI is potentially mediated through exercising routinely. Meanwhile, in the final model for obesity, neighborhood disorder was not significant, and exercise was the only statistically significant mediating variable.

Conclusion

Neighborhood disorder was associated with BMI; exercise might be a mediator. Therefore, neighborhood disorder may discourage exercise and this decrease is associated with an increase in BMI. This study adds evidence on a topic that has been mostly studied in high-income countries where the threshold for disorder might be lower. These results suggest that public policy efforts should focus on the improvement of Mexican's perceptions of their neighborhood environment as it might be an important element in reducing the current obesity epidemic.

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Chapter 1: Introduction

1. Background

Obesity has been found to be a significant risk factor for chronic diseases including cardiovascular disease, diabetes, cancer, liver and kidney disease, and depression (1). In 2016, Mexico declared an epidemiological alert as a result of the concerning statistics that more than 73% of the adult population was overweight or obese and there were nearly 100,000 diabetes-related deaths each year (2). However, this declaration was not enough to curtail the upsurge of obesity and the most recent numbers from the Mexican National Health and Nutrition Survey (ENSANUT) 2018-2019, a nationally representative survey, indicates that as of 2019, about 36.1% of the Mexican population was obese, and 39.1% was overweight (3). These numbers indicate the importance of implementing effective interventions that will include a wide range of factors including individual, neighborhood and national level factors.

Population-based strategies to reduce obesity include making changes to the physical and social environment. This paper focuses on neighborhood conditions as they are important in obesity prevention since the neighborhood build environment (i.e lack of green spaces, higher number of fast food restaurants, and low walkability) and neighborhood social environment (i.e social capital, collective efficacy and crime) have been found to increase the development and prevalence of obesity (4). Specifically, this paper looks at neighborhood conditions from the perspective of neighborhood disorder which refers to the physical and social features of neighborhoods that may signal the breakdown of order and social control (5). Neighborhood disorder is important because it is an indicator of potential threat and danger since neighborhood conditions may create a

sense that social order has broken down. Studies consistently indicate that residents of neighborhoods that are characterized as having high neighborhood disorder or having low levels of perceived neighborhood safety tend to have higher BMI and higher risk of obesity than residents of neighborhoods that don't exhibit these characteristics (6–12). However, there is not a complete consensus about the pathways through which this association operates.

There are several hypothesized pathways through which neighborhood disorder is associated BMI/obesity, including behavioral and biological pathways. One of the most tested pathways in the literature is exercise as the mediator between the association of neighborhood disorder and BMI. This pathway might occur as neighborhood disorder can discourage exercise because of fear of a crime occurring and this decrease in exercise is associated with an increase in BMI/ obesity (6,8,12). A second pathway is neighborhood disorder increasing psychological distress which decreases exercise that is associated with BMI. This pathway lacks more conclusive evidence, but it postulates that residents residing in neighborhoods with high neighborhood disorder or low levels of neighborhood safety might suffer from higher psychological distress because of heightened perceptions of potential risks to physical safety. This psychological distress may lead to negative coping mechanisms such as less participation in exercise which is associated with higher risk of obesity (7,12). Finally, a biological pathway hypothesizes that neighborhood disorder might result in the chronic activation of the physiological stress system as a result of crime exposure and feeling unsafe which increases cortisol production which in turn increases BMI and risk of obesity (12,13).

2. Objective and Research Question

This study uses data from the third and last round of the Mexican Family Life Survey (2009-2012), a longitudinal, multi-thematic survey representative of the national, urban, rural, and regional population in Mexico. During the time period of 2007-2011, homicides as a result of trafficking illicit drugs by organized crime grew dramatically from a rate of 8.1 per 100,000 in 2007 to 23.7 per 100,000 in 2011 (14). The National Survey on Victimization and Perception of Public Safety (ENVIPE) from 2011, the earliest year this survey took place, indicated that 38.7 percent of the adult population throughout Mexico, which amounts to 31.6 million adults, reported feeling unsafe in their town or neighborhood (15). In 2019, ENVIPE reported this number went up to 50.6 % of the adult population feeling unsafe in their city and 78.9 % feeling unsafe at the state level (16). ENVIPE also reported that at the national level during the period of March-April 2019 the population of 18 years old or older witnessed in their neighborhood the consumption of alcohol (65.6 %), the consumption of drugs (51.1%) and the selling of drugs in their neighborhood (35.2%) (16).

This study is important as both the prevalence of obesity and the prevalence of crime and insecurity are high in Mexico. Most studies that have looked at neighborhood disorder and BMI/obesity have taken place in high income countries where crime and insecurity might not be as frequent (17). This study's objectives include providing further evidence of the association between neighborhood disorders and BMI/obesity, specifically in Mexico. Dr. Ortiz-Hernandez and Janssen have used the Mexican Family Life survey to look at this question with the previous rounds of the data but this study will use the last round of data and use perception of neighborhood disorder as opposed to

objective neighborhood disorder (17). Additionally, another aim of this study is to test a newly formulated hypothesized pathway involving neighborhood disorder decreasing perceived safety, which increases psychological distress that in turn lowers exercise which is associated with BMI. As describe in the literature, the incivility theory posits that those living in areas with signs of neighborhood disorder will report a greater perception of insecurity because of the perception of lack of control and low levels of social cohesion (15). This sense of perceived lack of safety can therefore result in psychological distress which can diminish exercise and indirectly increase BMI.

Chapter 2: Literature review

1. Obesity in Mexico

1-1. Prevalence of Obesity in Mexico

From 1999 to 2006, the increase in obesity prevalence in Mexico was among the highest documented in the world (18). Despite this concerning trend, Mexico did not declare an epidemiological alert until 2016, when more than 73% of the adult population was overweight or obese and diabetes-related deaths per year neared 100,000 (2). However, the declaration was not enough to curtail the upsurge of obesity. Thus, from 2000 to 2018, adult obesity and morbid obesity increased 42.2% and 98.1% respectively after adjusting for population according to four nationally representative health and nutrition surveys (19). As a result of this growth, the most recent data from the Mexican National Health and Nutrition Survey (ENSANUT) 2018-2019 survey indicates that in 2019 , about 36.1% of the Mexican population was obese, and 39.1% was overweight. This survey also found that obesity in Mexico is present in all regions, age groups and socioeconomic statuses; however, it has a substantially higher prevalence among women (40.2%) than in men (30.5%) (3). Unfortunately, national health data shows that the rate of growth continues to increase (6.2% increase from 2006 to 2016 vs 9.8% increase from 2012 to 2018) indicating that Mexico has not yet reached a point of saturation of obesity cases (3). Therefore, the proportion of overweight or obese Mexicans has the potential to continue growing over the next years without an effective intervention (3).

1-2. Nutrition transition in Mexico

Prior to the rise in obesity, Mexico went from having a high prevalence of undernutrition to having a high prevalence of diet related non-communicable diseases- a shift known as a nutritional transition (20). Mexico's nutritional transition has been

associated with the rapid process of urbanization, economic growth, and technological change and innovation resulting in decreased exercise both in and outside of the workplace, along with altered food patterns and dietary intake that popularized the consumption of energy dense processed foods (20).

2. Health impacts of obesity

Obesity has a detrimental effect on health as it is a risk factor for cardiovascular disease, diabetes, cancer and other chronic diseases, including osteoarthritis, liver and kidney disease, hypertension, sleep apnea, and depression (1). Due to its adverse impact on health, obesity related mortality accounted for 12.2% of the total national mortality in Mexico in 2004 (21). Moreover, research by the OECD projects that life expectancy in Mexico will be reduced by more than 4 years over the next 30 years due to overweight-related diseases (22). Worldwide, the Global Burden of Disease Study indicated that 10.8% of all deaths in the world were due to being overweight in 2015 and this number saw an increased to 12.3% in 2016 (3).

3. Food security in Mexico

Food security is defined as having physical and economic access to sufficient, safe, and nutritious food for all household members at all times to lead active and healthy lives (23) . An important factor in food security is affordability of health foods which has been affected by the flood of cheap unhealthy foods in the market and the increase in prices of staple foods in Mexico such as beans and corn that has shifted the diet of low income families from buying beans to wheat pasta (24). These observations are further validated by analysis done using the Mexican National Income and Expenditures Survey from 1994 to 2016 that found that more energy dense foods and foods and beverages with lower

nutritional quality were more affordable compared to healthier food. Further, food categories with low energy density and a higher nutrient rich food index became less affordable over time but the burden was higher for lower-income households (25). Morales-Ruan et al. calculated food insecurity levels in 2012 using a nationally representative survey of Mexico and found that 70.6% of the population has some level of food insecurity, 42.5% had mild insecurity, 17.7% had moderate insecurity and 10.3% had severe insecurity (26). This same paper also found that adults with mild food insecurity had a higher probability of obesity compared to those who were food secure, and this association was higher for women.

4. Individual level risk factors of obesity

4-1. Family history/genetics

In 2012, a systematic review by Elks et al. looking at BMI heritability estimates from twin and family studies found that BMI heritability estimates from twin studies ranged from 0.47 to 0.90 and 0.24 to 0.81 for family studies, suggesting that while there is a wide variation in the magnitude of BMI heritability, genetics accounts for a significant portion of obesity risk (27). Furthermore, studies looking at family predisposition to obesity, indicated that family history has the greatest impact on BMI in children under 10 years old (28). However, analysis of differences in variance of heritability for BMI found that interactions with environmental factors are involved in mediating the effect of obesity susceptible genes on BMI (29). More specifically, epigenetics studies identified DNA methylation and histone modification as potential mechanisms through which environmental factors dictate BMI (29).

4-2. Demographic factors

Research looking at the association of socioeconomic status and obesity indicates a distinction between developed and developing countries. This distinction was first explored in a landmark review by Sobal and Sunkard that found obesity in women is inversely associated to socioeconomic status (SES) in developed Western countries but there is a positive association between obesity and SES in developing countries (30). However, updated reviews by McLaren and Monteiro et al. indicate that as low- or middle-income countries develop, the burden of adult obesity shifts to the groups with lower SES (31,32). A study that looked at seven major Latin American cities during the period of April 2004 and August 2005, found that Mexico City had an inverse association between socioeconomic status and BMI (33). These results contrast with a cross-sectional analysis using the national health surveys done between 1998 and 2017 in 13 countries in Latin America and the Caribbean that looked at obesity prevalence by socioeconomic status. In this analysis the prevalence of obesity in Mexico was the highest in the middle wealth groups for women and in the wealthier, more educated groups among men (34). This study also estimated that the prevalence of obesity in Mexico in 2016 was higher among urban compared to rural men and women (34). Finally, in a nationally representative study that used data from the 2001 Mexican Health and Aging Study and included participants ages 60 and older, found that lower education was associated with lower risk of being overweight (35). Overall, the evidence seems to indicate that education and obesity might have a positive relationship in Mexico.

4-3. Behavioral factors

Smoking

Various studies indicate that current smokers have a lower BMI compared to never smokers, while former smokers have a higher BMI than never smokers (36–38). In a study that used the 2002 Swiss Health survey, a national survey, and studied participants older than 25 years old, results indicated that after adjusting for covariates, male ex-smokers were 1.9 times more likely to be obese than male non-smokers and females ex-smokers were 1.3 times more likely to be obese than female non-smokers (36). In contrast, male light smokers were 0.5 times less likely to be obese than male non-smokers and female light smokers were 0.7 times less likely to be obese than female non-smokers (36). For male heavy smokers, they were 1.3 times more likely to be obese than never-smokers (36). An additional study looking at adults ages 31 to 69 in the United Kingdom, representative of the general population, found that former smokers were more likely to be obese than current smokers and never smokers (38). Specifically, among smokers this study found that the risk of obesity increases with the amount smoked and the risk of obesity fell with time since quitting (38). Research indicates that there is an increase in weight after quitting that might be due to the fact that nicotine is a metabolic stimulant and appetite suppressant (37). In addition, the higher risk of obesity in heavy smokers compared to light smokers might be due to clustering of risky behaviors by heavy smokers that might contribute to weight gains such as poor diet (39). In a cross-section study using the United States National Health and Nutrition Examination Survey 1999-2006, results indicated that current smoker had higher body mass index (BMI) and waist circumference (WC) at higher levels of sedentary behavior compared to lower levels of sedentary behavior (40).

Alcohol

In a systematic review by Sayon-Orea et al. that analyzed the effects of alcohol consumption on body weight, the authors concluded that they could not conclusively confirm that there was a positive association between alcohol consumption and body weight (41). They reported that positive associations between alcohol intake and weight gain have been found but these results were found in studies with data on higher levels of alcohol consumption which could indicate that heavy drinkers might be the ones experiencing the increase in weight gain compared to light drinkers (41). For light to moderate alcohol intake, especially with wine intake, drinking seemed to be a protective factor against weight gain but this was not the case with the consumption of spirits (41). In a more recent systematic review , Traversy and Chaput found that in prospective studies, light to moderate alcohol consumption is not associated with adiposity gain but for heavy drinkers there was a more consistent association of weight gain (42). The authors also expressed that experimental studies suggested that moderate alcohol intake did not lead to weight gain over short follow up periods (42). In addition, the authors stated that many confounders could be conflicting these findings including that individuals who frequently drink moderate amounts of alcohol may in general have healthier lifestyle that is protecting them from weight gain (42).

Sleep Quality

In a review of literature on the relationship between decreased sleep duration/poor sleep quality and obesity that focused on adults, Beccuti and Pannain indicated that recent studies confirm the previous findings of an association between sleep loss and risk of obesity (43). This review also indicated that in the approximately 50 epidemiological

studies that were done in different geographical regions on this topic, the majority found a significant association between short sleep (<6 hours per night) and increase risk of obesity (43). These results have been found in both cross sectional and longitudinal data and may be related to effects of sleep on dietary intake or physical activity (44). Pathways that sleep may affect weight include the possibility that lack of sleep may stimulate appetite and increase calorie intake due to a dysregulated production of hormones related to appetite (45).

Dietary Patterns

As part of the nutritional transition in Mexico, in the period of 1984 and 1998 a study indicated that there was significant decrease in expenditures on some food groups such as fruits and vegetables meanwhile there was an increase in expenditure on refined carbohydrates and sugars (18). This trend continues and is of particular concern as a systematic review reported that dietary patterns that were characterized by high energy, high fat and low fiber foods predisposes young people to later be overweight and obese (46). A study that assessed dietary patterns and obesity in Mexican adults using Mexican national data also found that of the three major dietary patterns, they found the patterns that contained the highest intakes of refined food, sweets and animal products were associated with being overweight or obese (47).

Physical activity and sedentary lifestyle

Central to this study is the individual risk factor of physical activity. The WHO definition of physical activity for adults is at least 150 minutes per week of moderate-to-vigorous physical activity or at least 75 minutes per week of vigorous physical activity (48). This WHO definition is used as a marker for what inactivity is considered and in

2012, the estimated prevalence of physical inactivity worldwide was 31% (49). Medina et al. estimated the 2012 prevalence of inactivity using the Mexican National Health and Nutrition Survey (ENSANUT) and found a 19.4% prevalence which was an increase from the 2006 estimates of 13.4% (49). Gomez et al. using the 2006 ENSANUT found that physical activity was negatively associated with the prevalence of overweight/obesity for adults ages 20 to 69 years old but this association was found only among adult males and not among women (50). An additional study that looked at survey participants 50 years and older during the period of 2009-2010 in Mexico using data from the Study on global ageing and adult health (SAGE), found that practicing vigorous physical activity was significantly associated with a lower mean BMI and these were nationally representative results (51). A study in the United States using national data also found a negative association between physical activity and BMI (52).

Along with physical activity, the amounts of hours an individual is in a sedentary position is also a risk factor for obesity (53). In 2015, it was estimated that 14.8% of adults in Mexico City were classified in the highest sitting category of greater than 420 minute per day using a cross sectional representative survey (54). This study also found participants who were overweight/obese were more likely to report sitting time in the highest category than those with normal weight (54). In a study that used data from a large prospective cohort study, Health Professional's Study, in the United States to look at the relationship between the sedentary behavior of watching TV and obesity, it was found that increased TV watching is strongly associated with obesity and weight gain, even after controlling for diet and exercise (55).

4-4. Psychosocial stress factors

Psychosocial stress is defined by situations that may cause a feeling of being socially threatened such as being judged by one's peers, being rejected by others and having one's performance judged by others (56). Examples of psychosocial stress include being fired, losing a loved one, childhood trauma, financial strain, and relationship difficulties. In a 2011 meta-analysis of 14 prospective studies, it was revealed that psychosocial stressors (e,g. work stress, losing a loved one, and caregiver stress) are risk factors for adiposity (57). In a more recent paper, Cuevas et al. found that multiple types of individual psychosocial stressors may be risk factors of obesity and cumulative exposure to these stressors may increase the odds of obesity (58). A study that looked at adult Latinos in the United States, found that reporting 3 or more chronic stressors was associated with higher odds of being obese compared to those that did not report any stressors (59).

5. Neighborhood level risk factors of obesity

5-1. Walkability

In this paper, walkability refers to the environmental features that makes the walkable environment such as areas being crossable, compact, structurally well and safe (60). A systematic review consisting of cross-sectional studies that took place in high income countries indicated that there was an inverse association between walkability and obesity in adults (61). Among women 20 years old and older residing in Utah, a study confirmed the previous finding of the association between living in more walkable neighborhoods and lower obesity (62). In a study that focused on Latinos residing in the United States, the authors found neighborhood walkability was negatively related to obesity when physical activity was included as a mediator and this was statistically

significant (63). These study results go along with the findings from a study that took place in Cuernavaca, Mexico where participants recorded the barriers to physical activity and one of the common barriers were poor sidewalk quality (64).

5-2. Neighborhood deprivation

Neighborhood deprivation can be measured by a variety of indicators including unemployment, area income and education, percent of poverty, community disadvantage and material deprivation. In a literature review by Black and Macinko of 16 articles from high-income countries in the period between 1997 to 2006, found that even after controlling for individual level SES, the literature consistently demonstrated that living in deprived neighborhoods increases the odds of being obese or having higher BMI (65). In a study using data from the Geographic Research on Wellbeing survey, a population-based sample of California mothers, the authors found that living in or moving to census tracts that experienced long term low poverty levels was associated with lower odds of being obese compared to those living in census tracts with long term high poverty (66). Additional evidence using the 2000 Decennial Census data indicates that those living in areas with high concentrations of poverty in the United States are at greater risk of increases in central adiposity over time that are over and above the effects of household poverty, individual behaviors and demographics associated with obesity (Kwarteng et al., 2017). This study also explored mediation pathways and found that the association between neighborhood poverty and central adiposity were mediated by perceptions of the neighborhood physical environment and by the cumulative stress index (67).

In Mexico specifically, a study using the 2006 ENSANUT found that areas of the country where area deprivation was highest had lower risks of individual obesity

outcomes (68). In contrast, a study that used cluster randomized cross-sectional data from four neighborhoods in 2010 with differing socioeconomic status in Tijuana, a Mexican border city, found that those living in the lowest income neighborhood were 2.4 times more likely to be obese compared to those living in a middle-class neighborhood in Tijuana (69). More research with updated data needs to be done on neighborhood deprivation and obesity in Mexico to have more of a clear understanding of this relationship since at the nation level the trend of poverty and obesity has changed which might mean that there could be changes at the neighborhood level too.

6. Crime and perceived safety in Mexico

6-1. Crime in Mexico

In the 1980s, Mexico's crime groups and drug traffickers assigned distinct regional areas of control for each group that included established networks and trafficking routes (70). However, the groups began fighting for territorial control and access to markets as production and distribution increased, leading to an increase in violence across Mexico (70). The Mexican government officially declared war on criminal organizations in 2006 and launched an initiative to combat cartels using military force. Homicides as a result of trafficking illicit drugs by organized crime still grew dramatically from a rate of 8.1 per 100,000 in 2007 to 23.7 per 100,000 in 2011 (14). In 2012, the government's strategy shifted efforts away from violent exchanges and toward improving law enforcement capacity and supporting public safety (70). Unfortunately, Mexican law enforcement and the military have continued to struggle to curb violence and in 2019, Mexico's national public security system reported more than 34,500 homicides (71). This was an increase from the 2018 numbers of drug-related homicides

which was 33,341 and was until then the highest recorded number of homicides in Mexico (70).

6-2. Perceived safety in Mexico

The National Survey on Victimization and Perception of Public Safety (ENVIPE) from 2011, the earliest year this survey took place, indicated that 38.7% of the adult population in Mexico reported feeling unsafe in their city (15). In 2019, ENVIPE reported this number went up to 50.6 % of the adult population feeling unsafe in their city and 78.9 % feeling unsafe at the state level (16). Overall, from the period of 2013-2019 there was an increasing trend of feeling unsafe within last 2 years seeming to reach a mostly stable point as the state level numbers stayed in the upper 70 percent and the city numbers stayed in the lower 50 percent. The ENVIPE also reported that at the national level during the period of March-April 2019, the population of 18 years old or older witnessed in their neighborhood the consumption of alcohol (65.6 %), the consumption of drugs (51.1%) and the selling of drugs in their neighborhood (35.2%) (16). These stark numbers beg the question about what the perception of those in charge of public safety in Mexico is. In 2019, 76.6% of the 18 years old or older population believed that the transit police was corrupt, followed by 68.4% of the population believing that judges were corrupt and lastly 67.9% of population believing the municipal preventive police was corrupt (16).

7. Neighborhood Disorder

7-1. Neighborhood disorder definition

Neighborhood disorder refers to the physical and social features of neighborhoods that may signal the breakdown of order and social control (5). Accordingly,

neighborhood disorder can be broken down into physical and social disorder. Physical disorder refers to the neighborhood landscapes including signs of high levels of decay and deterioration such as abandoned houses, graffiti, trash on the streets, abandoned cars, and vacant lots (72). Social disorder refers to events in public places seen as potentially threatening, such as the presence of people taking drugs or alcohol in the street, drug dealing, fights and arguments, presence of homeless people, public drunkenness, street prostitution, and other activities that create a sense of danger (72). Neighborhood disorder is an indicator of potential threat and danger because it creates a sense that social order has broken down.

7-2. Perceived versus objective perception of safety and neighborhood environment

Studies assessing objective and perceived measures of neighborhood conditions found moderate to low agreement in these two measures indicating that these measures might be assessing different dimensions of one's physical environment (73). There is also evidence that indicates that people's perception of their physical environment mainly relates to factors such as demographics, perceptions of the social neighborhood environment, their self-reported health, and depressed mood (74). In addition, research assessing objective and perceived measures of safety did not substantially agree, indicating that these measures might be assessing different dimensions of one's physical environment (75). Of particular relevance to this particular paper, studies indicate that perception of neighborhood conditions are more strongly associated with health outcomes than objective measures (12).

7-3. Neighborhood disorder and psychological distress

Psychological distress is defined as a state of emotional suffering that is typically characterized by symptoms of depression and anxiety (76). Research conducted in Illinois indicates that the daily stress of living in a neighborhood where social order is broken down is associated with depression (77). A study using a community sample of 818 individuals from Baltimore that were screened for an HIV prevention intervention found that perception of neighborhood characteristics predicted depressive symptoms at a 9 month follow up interview (78). Overall, studies seem to consistently indicate that chronic exposure to disorder and decay in resident's own neighborhood is associated with higher levels of depression and anxiety (7). An additional study also found that perceived neighborhood disorder is associated with high levels of anxiety, anger and depression (79). An explanation as to why neighborhood disorder might be associated with psychological distress includes that it may increase the perception of potential risk to one's physical safety (8).

7-4. Neighborhood disorder/perceived safety and physical activity

A meta-analysis estimating the odds of accumulating high levels of physical activity when the perception of safety from crime is high found that those reporting feeling safe from crime were 1.27 more likely of achieving higher levels of physical activity (80). It has been suggested that neighborhood disorder might discourage exercise within neighborhoods because of the fear of crime (8). There have been a limited number of quantitative evidence that neighborhood disorder is a barrier to exercise but a study looking at an ethnically and socioeconomically diverse population of urban older adults in New York found that residents of neighborhoods with higher neighborhood disorder

were on average less active at baseline. This study also found that higher neighborhood disorder was not associated with changes in overall exercise over time (81).

7-5. Neighborhood disorder and perceived safety

The incivility theory posits that those living in areas with signs of neighborhood disorder will report a greater perception of insecurity. The theory suggest that neighborhood disorder projects a perception of lack of control and low levels of social cohesion which in turn induces a greater sense of vulnerability with respect to crime, resulting in an increase feeling of lack of safety (15). In a report by the Inter-American Development Bank using data from 2011, they found the respondents who reported feeling unsafe also reported some of the following characteristics : the presence of social unrest behaviors or incivility in their neighborhood, being the direct victim of a crime in 2010, being the indirect victim of a crime, not having confidence in the police, and taking part in organizing some joint activities with their neighbors to protect themselves from crime (15).

7-6. Link between neighborhood disorder and obesity

Studies consistently indicate that residents of neighborhoods that are characterized as having high neighborhood disorder or having low levels of perceived neighborhood safety tend to have higher BMI and higher risk of obesity than residents of neighborhoods that don’t exhibit these characteristics (6–12,82,83). Literature exploring exercise as a pathways through which neighborhood disorder/neighborhood safety may influence obesity, mostly points to findings that high neighborhood disorder/low levels of perceived neighborhood safety limits exercise which in turn is associated with a higher risk of obesity (6,8,12). An additional pathway through which neighborhood

disorder/perceived safety may influence obesity is psychological distress. This pathway lacks more conclusive evidence, but it postulates that residents residing in neighborhoods with high neighborhood disorder or low levels of neighborhood safety might suffer from higher psychological distress because of heightened perceptions of potential risks to physical safety. This psychological distress may lead to negative coping mechanisms such as less participation in exercise which is associated with higher risk of obesity (7,12). Finally, another possible pathway includes the chronic activation of the physiological stress system because of crime exposure and feeling unsafe increases cortisol production which increases BMI (7,12).

Chapter 3: Conceptual Framework

In 2016, Mexico declared obesity an epidemic when more than 73% of the adult population was overweight or obese and diabetes-related deaths per year neared 100,000 (2). The prevalence of obesity has continued to increase since then and the most recent numbers from the Mexican National Health and Nutrition Survey (ENSANUT) 2018-2019 indicates that in 2019, about 36.1% of the Mexican population was obese, and 39.1% was overweight (3). These numbers indicate the importance of implementing effective interventions that will include a wide range of factors including individual, neighborhood and national level factors.

Neighborhood disorder refers to the physical and social features of neighborhoods that may signal the breakdown of order and social control (5). Neighborhood disorder is important because it is an indicator of potential threat and danger since neighborhood conditions may create a sense that social order has broken down. Studies consistently indicate that residents of neighborhoods that are characterized as having high neighborhood disorder or having low levels of perceived neighborhood safety tend to have higher BMI and higher risk of obesity than residents of neighborhoods that don't exhibit these characteristics (6–12,82,83). However, there is not a complete consensus about the pathways through which this association operates.

Figure 1 shows the conceptual framework delineating the three potential pathways of interest for this paper through which neighborhood disorder might be associated with BMI. This framework incorporates components of pathways that have been previously studied, along with additional elements that this study hypothesizes should be included as part of the mediating pathway between the association of neighborhood disorder and

BMI. The first and most tested pathway in the literature is exercise as the mediator between the association of neighborhood disorder and BMI. This first path might occur as neighborhood disorder can discourage exercise because of fear of a crime occurring and this decrease in exercise is associated with an increase in BMI and obesity. Findings for the most part point to evidence that high neighborhood disorder/low levels of perceived neighborhood safety limits exercise which in turn is associated with a higher risk of obesity (6,8,12). The second pathway is neighborhood disorder increasing psychological distress which decreases exercise that is associated with BMI. This pathway lacks more conclusive evidence, but it postulates that residents residing in neighborhoods with high neighborhood disorder or low levels of neighborhood safety might suffer from higher psychological distress because of heightened perceptions of potential risks to physical safety. This psychological distress may lead to negative coping mechanisms such as less participation in exercise which is associated with higher risk of obesity (7,12).

The third and main pathway of focus for this paper is delineated in figure 1 and has not been previously formulated in the literature as seen in this paper. It incorporates the two previous pathways described and postulates that neighborhood disorder decreases perceived safety, which increases psychological distress that in turn lowers exercise which is associated with BMI. The big connector in this third pathway is perceived safety combining the previous two pathways to create a new pathway to analyze. As described in the literature, the incivility theory posits that those living in areas with signs of neighborhood disorder will report a greater perception of insecurity because of the perception of lack of control and low levels of social cohesion (15). This sense of

perceived lack of safety can therefore result in psychological distress which can diminish exercise and indirectly increase BMI.

Chapter 4: Methods

1. Data Source

The data for this paper comes from the Mexican Family Life Survey (MxFLS). The MxFLS is a longitudinal, multi-thematic survey representative of the national, urban, rural, and regional population in Mexico, covering over 8 thousand households in 150 communities (92). The MxFLS contains information from a 10-year period, collected in three rounds: 2002, 2005-2006 and 2009-2012 (84). The baseline population was selected using a probabilistic, stratified, multistage sampling design created by the Mexican National Institute of Statistics and Geography (84). The study population is comprised of the Mexican households selected in 2002 along with the new households that broke off from the original households, that round two and three of the survey captured as time went on. The primary sampling units were selected under criterions of national, urban-rural and regional representation on pre-established demographic and economic variables (84).

The survey interviewed each household member ages 15 and above and collected information on a broad range of issues, including demographics, income, consumption, livelihood strategies, human capital (including a cognitive Raven's test), migration, social interactions, health, and victimization. All household-level information was reported by an individual of 18 years of age or over, who was generally the household head or household head's partner. The MxFLS also collected extensive data on locality-level economic, social, and physical infrastructure, through a community questionnaire administered to key informants. Community-level information was directly provided by the municipal president (mayor) or by any other relevant local authority officer. Included

in the community leader independent assessments were assessments of neighborhood safety (84). The survey was developed and managed by researchers from the Iberoamerican University and the Center for Economic Research and Teaching and supported by institutions including the National Institute of Statistics and Geography, the National Institute of Public Health, the University of California, Los Angeles (UCLA) and Duke University.

The longitudinal nature of the survey meant that second and third rounds of the survey required relocating and reinterviewing the base round sample. This follow-up presented a large challenge given the nature of the migration phenomena experienced in Mexico. As part of the follow-up, the investigating team had to relocate and interview those individuals or household who migrated within Mexico or emigrated to the United States of America as well as the individuals or households that broke off on their own from previous samples. The second and third rounds relocated and reinterviewed almost 90 percent of the original sampled households. At the same time, the MxFLS and UCLA team were able to reach a recontact rate of immigrants residing in the United States of over 91% (84).

This analysis will use the third round of data (2009-2012) because at this time, homicides as a result of trafficking illicit drugs by organized crime grew dramatically from a rate of 8.1 per 100,000 in 2007 to 23.7 per 100,000 in 2011 (14). The National Survey on Victimization and Perception of Public Safety (ENVIPE) from 2011, the earliest year this survey took place, indicated that 38.7 percent of the adult population throughout Mexico, which amounts to 31.6 million adults, reported feeling unsafe in their town or neighborhood (15). Therefore, the security concerns at that period were

becoming graver and this specific round of data should measure the increased safety concerns.

2. Variables Creation

2-1. Outcome variables

The first outcome of interest is BMI, which was created by dividing weight in kilograms by height in meters squared. Weight and height were measured by a trained anthropometrist or nurse in all three rounds. Weight was measured with a digital scale (Tanita) to the nearest 0.1 kg and height was measured to the nearest 0.1 cm with a SECA stadiometer. Height was converted from centimeters to meters to follow standard BMI calculation procedures. BMI is included as continuous variable in this analysis. The second outcome of interest is a binary variable indicating if the participant is obese. Obesity was defined as having a BMI greater than or equal to 30 kg/m^2 in accordance with clinical guidelines for obesity in adults by the National Heart Lung and Blood Institute (85).

2-2. Main exposure

Neighborhood disorder is the main exposure variable and is included in the analysis as a continuous variable constructed based on the sum of the number of potentially threatening neighborhood conditions and behaviors present in the neighborhood. The neighborhood conditions and behaviors that were included for the neighborhood disorder scale were whether in the community/locality there are 1) abandoned building, houses, or businesses (“In your community are there abandoned buildings, houses, or businesses?”) 2) gangs that gather frequently (“In your community are there gangs that gather frequently?”) 3) people are frequently drinking alcohol or

taking drugs in the streets ("In your community are there people who are frequently drinking alcohol or taking drugs on the street?") and 4) sex workers in the streets ("In your community are there prostitutes on the street?") . The answers to the questions were either yes, no or I do not know. For this analysis, the responses of "I do not know" were coded as missing. The values for the constructed variable ranged from 0 to 4 neighborhood disorder events. The answers to these questions came from the household level section of the survey, which only one member of the household answered. This analysis therefore assumes that the household member's answers about their perception of neighborhood conditions are representative of the whole household.

2-3. Mediating variables

Psychological distress

Psychological distress was measured based on the responses to the first 20 items from the mental health module in MxFLS. These first 20 questions come from the Clinical Questionnaire for the Diagnosis of Depressive Syndrome (Cuestionario Clinico para el Diagnostico del Sindrome Depresivo (CCDSD)) also referred to as the Calderón depression scale that was designed and tested by the Mexican Institute of Psychiatry for the Mexican population (86). The questions assess mental health and include questions about how often the respondent experiences sadness, lack of energy, difficulty concentrating, less appetite, feeling obsessive, nervous/anxious, tired, insecure, useless, and wishes to die, among others (see Table 1 for a full list of the 20 questions). Respondents can answer each question by "No", "Yes, sometimes", "Yes, lots of times," and "Yes, all the time" and each question is given a score between 1 (for no symptoms) and 4 (for symptoms present all the time). The final scale was created by summing these

values and potential values range from 20 to 80. A higher score indicates a greater number and intensity of depressive symptoms and according to clinical experience, scores above 45 are qualified as clinical depression (87). For the analysis, psychological distress was included as a continuous variable.

Exercise

Exercise is measured based on the answer to the question of whether the individual does any physical exercise routinely ("Do you do any type of physical exercise as a routine?"). The response to this question were either yes or no and a dichotomous variable was created based on the response.

Perceived lack of safety

Perceived lack of safety is constructed based on the questions that asked participants about feeling scared of being assaulted or attacked during the day ("Do you feel [...] of being attacked or assaulted during the day?") and during the night ("Do you feel [...] of being attacked or assaulted during the night?"). The response values for these questions include the values of "Really scared" (1), "Scared" (2), "A little scared" and "Do not feel scared" (4). To help with interpretation, the original values for these two questions were flipped directions so that the scale went from 1-4 to now 0-3, thus a higher value now indicates a higher level of perceived lack of safety. The two variables were summed for each individual and divided by two to obtain the mean of these responses and generate the individual-level perceived lack of safety measure. The constructed variable's values range from 0 to 3 and a higher value indicates higher perceived lack of safety.

2-4. Control variables

Age and sex

Age was asked in three different sections of the survey. There were a few inconsistencies between the variables, but the most complete version of the variable found in the individual level section of the survey was ultimately used, and the two other variables were used to fill in for the few instances that the age variable that was used had missing values. Sex was coded as female equal to one and males equal to zero.

Education

The education variable was based on the survey question "last level of education you attended?". For analysis purposes a new categorial variable was created and the values from this question were then categorized into the categories of no education, elementary or less, less than high school, high school, and some college or more. The category elementary or less contains the values "preschool or kindergarten", and "elementary". Less than high school contains the values of "secondary school", and "open secondary school". High school consists of the values "open high school" and "high school". Finally, the category college or more consists of the values "basic normal", "college" and "graduate". The response "DK" was coded as missing for this variable.

Perceived socioeconomic status

Perceived socioeconomic status is defined as an individual's perception of their own position in the social ladder (88). The MxFLS includes the MacArthur SES Ladder question which is a simple way to capture the relative socioeconomic status of respondents in a multidimensional sense. Evidence from epidemiological studies seem to indicate that the MacArthur SES Ladder question is correlated with health outcomes and has predictive power even after controlling for objective SES measures such as income and education (89). The MacArthur SES Ladder question is "Please imagine a ladder

with six steps. In the lowest or first step are the poorest people in Mexico and in the highest or sixth step are the richest. In which step are you now?" and the response values range from 1 to 6. In this study perceived socioeconomic status was included as a continuous variable in the analysis.

Other covariates

The population size variable consists of the values: metropolitan areas >100,000 inhabitants, urban areas 15,001–100,000, small urban areas 2500–15,000, and rural areas <2500.The geographic region for this analysis was created based on the state the participant lives in, which was then categorized as one of the following regions: southeast, central, west-central, northeast, and northwest. Smoking status was based on the question "Smoke/Used to smoke". For the analysis, smoking is a binary variable equal to 1 if the participants stated that that they smoked or used to smoke.

3. Data preparation

3-1. Data used

The MxFLS is available as a public use STATA dataset. This analysis uses the MxFLS-3 which consists of information from the period 2009-2012. The survey itself is divided into individual, household, and community parts but this analysis only uses the individual and household parts of the survey. From the individual survey, only book 3a-b (characteristics of adult household members) and book S (anthropometrics and biomarkers) were used. In addition, from the household part of the survey, book C (control level) and book 2 (household economy) were used.

3-2. Sample creation and data cleaning

In order to be eligible for this analysis, participants had to meet the condition of being 18 years old or older, present for the interview and existing in more than one of the files used. For this analysis, only one member per household that meets the previously stated criteria is randomly selected to be part of the analysis sample using the proc surveyselect procedure in SAS. The raw wave 3 file contains 10,990 unique household but only 9,147 of those households met our criteria. Therefore, the starting sample size was 9,147 individuals before missing observations were deleted. Observations had missing data on BMI (1,614, 17.6%), education (140, 1.5%), region (129, 1.4%), population size (129, 1.4%), smoking status (318, 3.5%), and perceived socioeconomic status (333, 3.6%). Listwise deletion was performed in SAS to omit observations with the missing data, resulting in a preliminary analytic sample size of 7,278. This analytic sample size was further reduced by two record after restricting the sample to exclude values containing extreme BMI values that were considered invalid. Extreme BMI values for adults were defined as values less than or equal to 10 kg/m^2 and values greater than or equal to 58 kg/m^2 base on a paper by Ortiz-Hernández at al. who used the MxFLS data (17). The records dropped contained values of 3 kg/m^2 and 9 kg/m^2 for BMI. The final analysis file consists of 7,276 records. This analysis will not include survey weights as issues around the values of the weights occurred and the decision was ultimately made to not include them in for the analysis. The results of this analysis are therefore only representative of the respondents that were included in this analysis and not representative of all Mexicans residing in Mexico.

4. Statistical analysis

All analyses were conducted using SAS 9.4. This analysis does not include survey weights and results are only representative of the respondents that were included in this analysis.

4-1. Descriptive analysis

Unweighted descriptive statistics of the demographics and health characteristics of the analysis population (Table 2) as well as the descriptive statistics of the neighborhoods they live in (Table 3) were obtained to see the distribution of the characteristics of the analysis population and their neighborhoods.

4-2. Modeling

Multivariate linear regressions were used to assess the association between neighborhood disorder and BMI (Table 4). Meanwhile, multivariate logistic regressions were used to assess the association between neighborhood disorder and obesity (Table 5). All logistic and linear analysis include adjustment of the following covariates: age, gender, education, region, population size, perceived socioeconomic status, and smoking status. In order to assess the effect that the hypothesized mediation variables of perceived lack of safety (model 2), psychological distress (model 3) and exercise (model 4) had on the two study outcomes, they were included on their own before they were included in the final model. The final model includes all the mediation variables plus the exposure of interest (model 5), and this model is compared to the original model (model 1) containing the exposure without any mediation variables to see if the estimates changed. This method provides a simple way to test whether the hypothesized mediation variables are indeed potential mediation variables. Values of the estimates for the variables in each

model along with their 95% confidence interval can be seen in Table 4 and 5. Multicollinearity of the variables in the regression models was examined using tolerance, and independent variables were not found to be collinear (Tolerance < 0.10).

In the models below, Y refers to the continuous outcome of BMI. β_0 represents the intercept, betas (β) are the regression coefficients for the main exposure and mediators, and gammas (γ) are regression coefficients for other variables that are adjusted for in the models:

Unadjusted Linar model (Model 0):

$$\mathrm{E}[Y|\beta_1] = \beta_0 + \beta_1 * Neighborhood\ disorder$$

This model looks at the association between neighborhood disorder and BMI, unadjusted for covariates.

Adjusted Linear model (Model 1):

$$\mathrm{E}[Y|\beta_1, \gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5, \gamma_6] = \beta_0 + \beta_1 * Neighborhood\ disorder + \gamma_1 * Age + \gamma_2 * Sex + \gamma_3 * Education + \gamma_4 * Region + \gamma_5 * Smoking + \gamma_6 * Perceived\ SES$$

This model looks at the association between neighborhood disorder and BMI, adjusted for the covariates of age, sex, education, region, smoking and perceived SES.

Adjusted Linear model (Model 2):

$$\mathrm{E}[Y|\beta_1, \gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5, \gamma_6] = \beta_0 + \beta_1 * Perceived\ lack\ of\ safety + \gamma_1 * Age + \gamma_2 * Sex + \gamma_3 * Education + \gamma_4 * Region + \gamma_5 * Smoking + \gamma_6 * Perceived\ SES$$

This model looks at the association between perceived lack of safety and BMI, adjusted for the covariates of age, sex, education, region, smoking and perceived SES.

Adjusted Linear model (Model 3):

$$\mathrm{E}[Y|\beta_1,\gamma_1,\gamma_2,\gamma_3,\gamma_4,\gamma_5] = \beta_0 + \beta_1 * Psychological\ stress + \gamma_1 * Age + \gamma_2 * Sex + \gamma_3 * Education + \gamma_4 * Region + \gamma_5 * Smoking + \gamma_6 * Perceived\ SES$$

This model looks at the association between psychological stress and BMI, adjusted for the covariates of age, sex, education, region, smoking and perceived SES.

Adjusted Linear model (Model 4):

$$\mathrm{E}[Y|\beta_1,\gamma_1,\gamma_2,\gamma_3,\gamma_4,\gamma_5,\gamma_6] = \beta_0 + \beta_1 * Exercise + \gamma_1 * Age + \gamma_2 * Sex + \gamma_3 * Education + \gamma_4 * Region + \gamma_5 * Smoking + \gamma_6 * Perceived\ SES$$

This model looks at the association between exercise and BMI, adjusted for the covariates of age, sex, education, region, smoking and perceived SES.

Adjusted Linear model (Model 5):

$$\mathrm{E}[Y|\beta_1,\beta_2,\beta_3,\beta_4,\gamma_1,\gamma_2,\gamma_3,\gamma_4,\gamma_5,\gamma_6] = \beta_0 + \beta_1 * Neighborhood\ disorder + \beta_2 * Perceived\ lack\ of\ safety + \beta_3 * Psychological\ stress + \beta_4 * Exercise + \gamma_1 * Age + \gamma_2 * Sex + \gamma_3 * Education + \gamma_4 * Region + \gamma_5 * Smoking + \gamma_6 * Perceived\ SES$$

This model looks at the association between neighborhood disorder and BMI, adjusted for the covariates of age, sex, education, region, smoking and perceived SES. and hypothesized mediators of perceived lack of safety, psychological stress, and exercise.

In the models below, Y refers to the binary outcome of obesity. β_0 represents the intercept, betas (β) are the regression coefficients for the main exposure and mediators, and gammas (γ) are regression coefficients for other variables that are adjusted for in the models.:

Unadjusted Logistic model (Model 0):

$$\ln\left[\frac{\Pr(Y=1)}{1-\Pr(Y=1)}\right] = \beta_0 + \beta_1 * Neighborhood\ disorder$$

This model looks at the association between neighborhood disorder and obesity, unadjusted for covariates.

Adjusted Logistic model (Model 1):

$$\ln\left[\frac{\Pr(Y=1)}{1-\Pr(Y=1)}\right] = \beta_0 + \beta_1 * Neighborhood\ disorder + \gamma_1 * Age + \gamma_2 * Sex + \gamma_3 * Education + \gamma_4 * Region + \gamma_5 * Smoking + \gamma_6 * Perceived\ SES$$

This model looks at the association between neighborhood disorder and obesity, adjusted for the covariates of age, sex, education, region, smoking and perceived SES.

Adjusted Logistic model (Model 2):

$$\ln\left[\frac{\Pr(Y=1)}{1-\Pr(Y=1)}\right] = \beta_0 + \beta_1 * Perceived\ lack\ of\ safety + \gamma_1 * Age + \gamma_2 * Sex + \gamma_3 * Education + \gamma_4 * Region + \gamma_5 * Smoking + \gamma_6 * Perceived\ SES$$

This model looks at the association between perceived lack of safety and obesity, adjusted for the covariates of age, sex, education, region, smoking and perceived SES.

Adjusted Logistic model (Model 3):

$$\ln\left[\frac{\Pr(Y=1)}{1-\Pr(Y=1)}\right] = \beta_0 + \beta_1 * Psychological\ stress + \gamma_1 * Age + \gamma_2 * Sex$$
$$+ \gamma_3 * Education + \gamma_4 * Region + \gamma_5 * Smoking + \gamma_6 * Perceived\ SES$$

This model looks at the association between psychological distress and obesity, adjusted for the covariates of age, sex, education, region, smoking and perceived SES.

Adjusted Logistic model (Model 4):

$$\ln\left[\frac{\Pr(Y=1)}{1-\Pr(Y=1)}\right] = \beta_0 + \beta_1 * Exercise + \gamma_1 * Age + \gamma_2 * Sex$$
$$+ \gamma_3 * Education + \gamma_4 * Region + \gamma_5 * Smoking + \gamma_6 * Perceived\ SES$$

This model looks at the association between exercise and obesity, adjusted for the covariates of age, sex, education, region, smoking and perceived SES.

Adjusted Logistic model (Model 5):

$$\ln\left[\frac{\Pr(Y=1)}{1-\Pr(Y=1)}\right] = \beta_0 + \beta_1 * Neighborhood\ disorder$$
$$+\beta_2 * Perceived\ lack\ of\ safety + \beta_3 * Psychological\ stress$$
$$+ \beta_4 * Exercise + \gamma_1 * Age + \gamma_2 * Sex + \gamma_3 * Education$$
$$+ \gamma_4 * Region + \gamma_5 * Smoking + \gamma_6 * Perceived\ SES$$

This model looks at the association between neighborhood disorder and obesity, adjusted for the covariates of age, sex, education, region, smoking and perceived SES. and hypothesized mediators of perceived lack of safety, psychological stress, and exercise.

Chapter 4: Results

1. Descriptive results of study population

This study was based on adult (aged ≥ 18 years) participants from the 2008 cycles of the longitudinal MxFLS. The study population consisted of 7,276 participants, who had low educational attainment and 51.9% of them considered themselves as having low SES (Table 2). Approximately 59% of the study population was female and the mean age was 41 years old. Slightly over 2% of population had depression (Calderon depression scale >45), and the mean score for the Calderon depression scale was 26 with a possible range of values between 20 and 80 points (Table 2). In terms of exercise, 15.4% of the study population reported exercising routinely and the mean number of hours per week they reported exercising was 0.24 hours per week. A little over 87% of the population reported watching television during the week (mean: 11 hours/week, SD: 10.55). The study population lived across all the Mexican regions and 54.6% lived in rural areas (Table 2).

In terms of health, the mean BMI was 28.0 kg/m^2 and 30.7% of the study population was obese (Table 2). Only about 16.2% of the population reported smoking and 86.8% reported having good or regular health. The mean number of neighborhood disorder events was 0.98 (SD:1.09), with a possible range of events between 0 and 4 (Table 3). Perceived lack of safety was also reported, and the mean perceived lack of safety score was 0.66 (SD:0.98) with a possible range of values between 0 and 3 (Table 3). In assessing the frequency of neighborhood events by BMI category, results indicate there were more events (1 and greater) among overweight and obese individuals compared to the normal weight group of study participants (Figure 2).

2. Association between neighborhood disorder and BMI/obesity

One of the goals of this paper is to assess whether there is an association between neighborhood disorder and BMI/obesity. Unadjusted models that included only the exposure of interest (Model 0) were run to see the effect size of neighborhood disorder on our outcomes of interest BMI and obesity before adjustments by the control variables and potential mediators. In addition, adjusted models (Model 1 and Model 5) were run that included the control variables of age, gender, education, region, population size, perceived socioeconomic status, and smoking status. The unadjusted linear regression indicates that higher neighborhood disorder events (by one event or more up to 4) is associated with an average increase in BMI of 0.19 kg/m^2 (95% CI: 0.08, 0.31) (Table 4). This association was attenuated after adjusting for covariates, to an average increase in BMI of 0.15 kg/m^2 (95% CI: 0.04, 0.27) (Table 4). However, when the hypothesized mediators and covariates were included, higher neighborhood disorder events (by one event or more up to 4) is associated with an average increase in BMI of 0.16 kg/m^2 (95% CI: 0.04, 0.27) (Table 4). Meanwhile, the unadjusted logistic regressions indicate that the association between neighborhood disorder and obesity is marginally statistically significant (OR = 1.04; 95% CI: 1.00, 1.09) (Table 5). However, after adjusting for covariates and potential mediators, the association between neighborhood disorder and obesity is not statistically significant (OR = 1.03; 95% CI: 0.99, 1.09) (Table 5).

3. Mediation pathways results

The second goal of this paper is to assess whether the association of neighborhood disorder with BMI and obesity is mediated by perceived safety, psychological distress, and exercise. As part of the analysis, each of the hypothesized mediation variables were

included in their own separate models, adjusted for covariates, to analyze their individual association with BMI/obesity before including neighborhood disorder. The results indicate that from the hypothesized mediation variables, only exercise was significantly associated with BMI after adjusting for covariates. Therefore, in this study population, exercising routinely was associated with an average decrease in BMI of 0.36 kg/m^2 (95% CI: -0.71, -0.01), after adjusting for covariates (Table 4). In the final model (Model 5) that included neighborhood disorder and all the hypothesized mediators, exercising routinely continued to be the only mediation variable significantly associated with BMI (β = -0.36 kg/m^2; 95% CI: -0.72, -0.01) (Table 4). When all the mediation variables were included along with neighborhood disorder, the beta coefficient for neighborhood disorder increased only slightly (0.01 kg/m^2) compared with the beta coefficient from the model with neighborhood disorder plus covariates only (Model 1). This slight change in the neighborhood disorder beta after including the covariates and mediators might mean that exercising routinely is potentially mediating this association.

At the same time, the obesity analysis results indicate that from the hypothesized mediation variables, only exercise was significantly associated with obesity (OR=0.84; 95% CI: 0.72, 0.97), after adjusting for covariates (Table 5). This indicates that those in the study population that exercise routinely were 16% less likely to be obese than those who do not exercise routinely (Table 5). When including all mediation variables and neighborhood disorder, the odds ratio for neighborhood disorder increased only slightly (0.002) when compared with the odds ratio from the neighborhood disorder and covariates only model (Model 1). However, this association was not significant (OR = 1.03; 95% CI: 0.99, 1.09). In contrast, the indicator for exercising routinely continued to

be significantly associated with obesity (OR=0.84; 95% CI: 0.72, 0.97) and was the only mediation variable that was significant. These results indicate that from the main variables of interest in this study, exercise is the only variable that explains the variation in participant's obesity status.

4. Additional results

Estimates from the covariates of the final model for both the BMI and obesity indicate that being female, age (continuous), having an education of elementary or less versus no education, living in an urban versus rural area and perceived socioeconomic status were positively associated with obesity and BMI. In addition, for the BMI model having an education less than high school was positively associated with BMI. Meanwhile, living in the southwest, southwest, west central versus the northwest were negatively associated with BMI and obesity.

Chapter 5: Discussion and Conclusion

This paper aimed to test whether neighborhood disorder is associated with BMI and obesity among adults in Mexico. Further, this study built on prior research and tested whether the association of neighborhood disorder with BMI and obesity is mediated by perceived lack of safety, psychological distress, and exercise. The newly conceptualized theoretical model (Figure 1) shows a path where higher neighborhood disorder increases perceived lack of safety which would increase psychological distress. This would lead to lack of exercise that would be associated with higher BMI and obesity among Mexican adults. Data from the last round of the MxFLS (2009-2012), a longitudinal, multi-thematic survey representative of the national, urban, rural, and regional populations in Mexico was used to answer these questions.

1. Main findings

All analysis controlled for age, gender, education, region, population size, perceived socioeconomic status, and smoking status. The results from the linear regression analysis indicate that neighborhood disorder has a statistically significant and positive association with BMI. But the logistic regression revealed that neighborhood disorder has a non-significant association with obesity. Prior literature confirms this association between neighborhood disorder and BMI (1–6). However, the findings differ from literature that consistently reports a significant and positive association between neighborhood disorder and obesity (3,7–9). Coming to the effect size of the association, the study found that higher neighborhood disorder events (by one event or more up to 4) is associated with an average increase in BMI of 0.16 kg/m^2 (95% CI: 0.04, 0.27) (Table 4). This is a small effect size at the individual level.

A potential explanation for the small effect size for BMI could be that Mexico may have a higher threshold for neighborhood disorder (10) owing to existing levels of interpersonal violence (11). Similarly, the null association with obesity could be due to these reasons. Overall, in Mexico, low levels of neighborhood disorder could be seen as a regular characteristic that may not affect individuals' health. This finding is contrary to literature because previous studies have focused on high income countries (HICs), whereas this study looks at a middle-income country (MIC) (10). Therefore, a negative effect on BMI and obesity would only be seen in higher levels of disorder contrary to what HICs would see (10).

Another explanation for the small effect size of BMI could be the operationalization of the exposure variable in this study. Within the neighborhood environment literature, measurement of neighborhood disorder can variously include social disorder, physical disorder, or both depending on the interest of what the author wants to measure (1,3,6). In this study, both social and physical disorder were included in the number of neighborhood disorder events variable as it was hypothesized that both contribute to capturing the holistic view of the neighborhood environment including the sense of social breakdown and fear of safety. In addition, the inclusion of both the social and physical components can lead to a higher threshold of neighborhood disorder. This is important especially in Mexico where the threshold for neighborhood disorder could potentially be higher compared to HICs.

This analysis also tested whether the association of neighborhood disorder with BMI and obesity is mediated by perceived lack of safety, psychological distress, and exercise. In the final BMI model, the estimate for neighborhood disorder increased once the

mediators were included and only exercise was statistically significant (95% CI: -0.71, -0.01) (Table 4). This indicates that the association between neighborhood disorder and BMI may be mediated through exercise. Whereas neighborhood disorder was non-significant in the univariate as well as mediation obesity models. However, in the final obesity model, exercise was the only statistically significant mediating variable. This indicates that exercise is the main explanatory variable for obesity. Possible interpretations for this result include that for individuals with higher threshold for neighborhood disorder in this study, other factors such as lack of green spaces or walkability might be the prime sources affecting their lack of exercise, leading to higher levels of obesity. Meanwhile, those with a lower threshold for neighborhood disorder would, even at lower number of neighborhood disorders events, limit exercise and this would lead to higher BMI.

The results from this study did have not confirmed the newly conceptualize theorical pathway that this study created of neighborhood disorder increasing perceived lack of safety which would increase psychological distress leading to lack of exercise which is associated with higher BMI and obesity. However, the results from the mediation analysis did confirm the previous theory that neighborhood disorder can discourage exercise because of fear of a crime occurring, and this decrease in exercise is associated with higher BMI. One important point to emphasize is that in this study, exercise which is a subset of physical activity was the variable of interest. In particular, this study wanted focus on movement that is planned, and intentional as this is a modifiable factor that obesity interventions focus on.

In the literature, the concept of intentional movement was assessed in a variety of ways including as total intentional activity, irregular exercise, and moderate-to-vigorous physical activity. These measures were either self-reported or objective measures. In the case of this study, exercise was self-reported. Findings mostly point to evidence that high neighborhood disorder/low levels of perceived neighborhood safety limits exercise which in turn is associated with obesity and higher BMI, with some studies finding no mediation (5,7–9,12–14). From studies that found exercise was a mediation variable, the association of high neighborhood disorder/low levels of perceived neighborhood safety with BMI and obesity was consistently found to be partially mediated by exercise (5,7–9,12,13). This study provides further evidence pointing to exercise being a mediator for the association of neighborhood disorder with BMI and obesity. Future research should conduct formal mediation to test whether exercise partially mediates this association.

2. Other relevant findings

Table 4 and 5 shows the estimated for all the covariates included in the final model for both BMI and obesity. The analysis results indicate that being a woman is positively association with BMI (Table 4). The study also found that controlling for other covariates, women have a 67% higher probability of being obese than men (Table 5). These results align with recent estimates from the Mexican National Health and Nutrition Survey (ENSANUT) 2018-2019 indicating that women had a higher prevalence of obesity than men (15). A potential explanation for this gender difference is seen in results from a study that used ENSANUT 2006 and 2012, and found that the mean weekly minutes of moderate-to-vigorous physical activity were significantly higher in men than women in Mexico (16). Given that physical activity is negatively associated with BMI

and obesity this might explain part of the gender differences (17,18). In addition, a potential factor why physical activity might be lower for women is that woman might have higher levels of perceived lack of safety compared to men, which might result in less exercise.

This study also found that higher education levels and perceived socioeconomic status were associated with obesity status and BMI. These results also align with the estimates from ENSANUT 2015-2016 which found that for men, the wealthier and more educated groups had a higher prevalence of obesity in Mexico (19). However, for women only socioeconomic status was found to be significant such that the prevalence of obesity was higher in the wealthier groups (19). These estimates of higher prevalence of obesity among those with higher socioeconomic status could be the result of Mexico's nutritional transition (20).This transition was associated with technological change and innovation resulting in decreased physical activity both inside and outside of the workplace (20). Additionally, the transition led to altered food patterns and dietary intake that popularized the consumption of energy dense processed foods (20). I would hypothesize that those with higher SES would be the first to experience these changes due to higher purchasing power and therefore, also be the first to face the consequences of this change on their health as seen with their higher prevalence of obesity.

Additionally, results from the present study indicate that people living in urban locations (population>2,500) were more likely to be obese than those living in rural areas in Mexico. Cross-sectional analysis using ENSANUT 2015-2016 confirm these estimates such that the prevalence of obesity in Mexico in 2016 was higher among urban people compared to rural people (19). This urban-rural difference might be due to differences in

diet and lifestyle such as rural people are better able to maintain a more traditional diet compared to those in urban areas (21). Another explanation could be that those living in rural areas might have lowers levels of perceived lack of safety and can therefore exercise more which is associated with lower levels of obesity.

3. Limitations and strengths

This study has certain limitations. Due to the cross-sectional design of this study, causality, and temporality in the association of neighborhood disorder with obesity and BMI cannot be inferred. In addition, there is a possibility of measurement error and bias that could affect the precision and accuracy of the mediators in this study. This may contribute to attenuated results towards the null. The small effect size in the exercise medication variable for both the obesity and BMI models is of concern because the variable was self-reported. This variable has the potential for non-differential overestimation which may result in an association biased towards the null. Furthermore, this means that the null findings for the mediation variables of perceived lack of safety and psychological distress might not mean that these pathway does not exist, but that there may be issues with their measurement. Finally, this might also mean that the effect of exercise on BMI and obesity might be larger than the results in this analysis have revealed.

Another limitation is that since the effect size of neighborhood disorder in the final BMI model was significant but small (0.16; 95% CI: 0.04-0.27), it would be hard to disentangle the mediating paths. The mediator variables, perceived lack of safety and psychological distress, already had weak associations with BMI in their individual models; therefore, it was expected that they did not turn out to be potential mediators in

the final BMI model. Furthermore, the main exposure of interest, perceived neighborhood disorder events, was reported by a representative of the household during the survey. Therefore, this analysis assumes that the household member's perception of their neighborhood conditions is representative of the whole household. However, it is possible that the household representative has different views from the rest of the household, and this could bias the results toward the null. Another limitation is that around 20% of the sample was dropped because of missing variables, which might bias the results toward the null if the missing information might be the individuals who are more likely to be obese. Future work should use multiple imputation to address this limitation. Finally, even though the MxFLS data is supposed to be representative of the national Mexican population, the lack of availability of the weights in the analysis makes the results from this study only generalizable to the respondents that this analysis included.

Despite the limitations, this study has several strengths. The dataset in this study used objective measurements of height and weight as opposed to self-reported measures to estimate BMI. The sample size of this study is large at 7,276 individuals with a diverse background in terms of geography, rural/urban location, age, income, and education. This study also adds to the sparce literature focusing on neighborhood disorder in Mexico and other non-high-income countries. Finally, this study adds additional evidence toward exercise being a potential mediator between the association of neighborhood disorder and BMI.

4. Conclusion

Neighborhood disorder is associated with BMI and exercise might be a potential mediator in this association. Even though at the individual level the effect size of neighborhood disorder and BMI might be small, at neighborhood and national level it might have a big impact. Moreover, a newly formulated theoretical pathway was proposed and tested (Figure 1) that shows a path where higher neighborhood disorder increases perceived lack of safety which would increase psychological distress. This would lead to lack of exercise that would be associated with higher BMI and obesity among Mexican adults. Although results did not indicate that this pathway explained the association of neighborhood disorder with BMI and obesity, more research must be done to test this hypothesized theoretical pathway with other populations. Furthermore, future research should include formal mediation analysis to test the possible mediation of exercise that was found in this paper.

Ultimately, the results suggest that programs and public policy efforts should focus on the improvement of Mexican's perceptions of their neighborhood environment as it might be an important element in reducing the current obesity epidemic. Policies should promote collaborative efforts with urban planners, law enforcement, government officials and community advocates to create less stressful and more secure neighborhood environments. Examples of programs that should be considered include investing in maintaining and creating public spaces such as park and community center where individuals feel safe to participate in. These spaces will help participants to build ties within their communities, which will encourage continued participation in activities and

lower perceived lack of safety. Finally, programs could be created with input of community members to address drug use and crime prevention in the neighborhood.

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Tables and Figures

Fig.1. The conceptual framework between neighborhood disorder and BMI

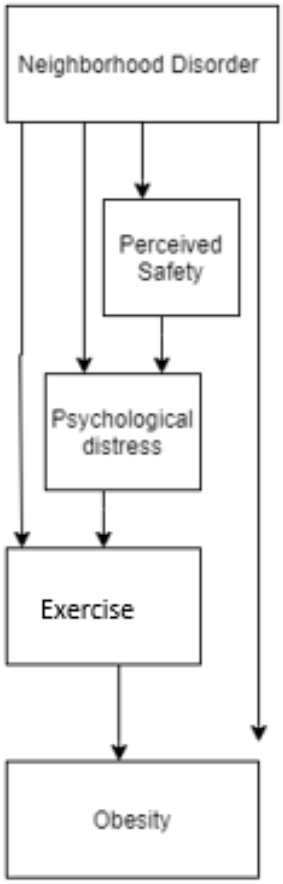

Figure 2. Distribution of number of neighborhood disorder events by BMI categories (n=7,275)

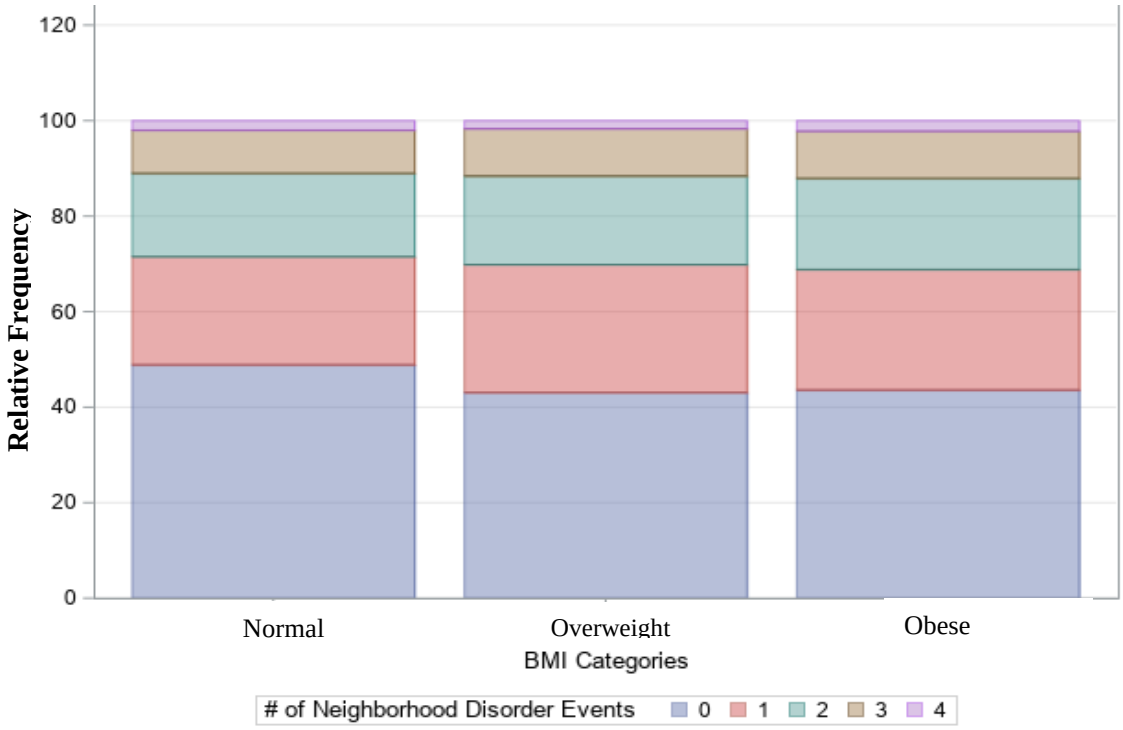

Table 1. Questions from MxFLS Mental Health Module, 2009 used to create the psychological distress scale variable
Clinical Questionnaire for the Diagnosis of Depressive Syndrome (CCDSD): Items 1-20
1. In the last 4 weeks, have you felt sad or anguished?
2. In the last 4 weeks, have you cried or felt like crying?
3. In the last 4 weeks, have you slept badly at night?
4. In the last 4 weeks, have you woken up spiritless (due to lack of energy or fear)?
5. In the last 4 weeks, have you had difficulties focusing on your daily activities?
6. In the last 4 weeks, has your appetite diminished?
7. In the last 4 weeks, have you felt obsessive or constantly repetitive?
8. In the last 4 weeks, has your sexual interest decreased?
9. In the last 4 weeks, do you think you've been underperforming in your job or daily activities?
10. In the last 4 weeks, have you felt pressure in the chest?
11. In the last 4 weeks, have you felt nervous, sorrowful, anxious, or eager more than normal?
12. In the last 4 weeks, have you felt tired or discouraged more than normal?
13. In the last 4 weeks, have you felt pessimistic or have thought things will go wrong?
14. In the last 4 weeks, have you frequently had a headache?
15. In the last 4 weeks, have you felt more irritated or angry than normal?
16. In the last 4 weeks, have you felt insecure or lacking confidence in yourself?
17. In the last 4 weeks, have you felt useless to your family?
18. In the last 4 weeks, have you felt fear of something, as if you were waiting for something serious to happen?

19. In the last 4 weeks, have you wished to die?
20. In the last 4 weeks, have you lost interest in things?

Table 2: Demographic and Health Characteristics, MxFLS 2009-2012 (n=7,276)

Variable	Percent
Age (mean, SD)	41 (17.37)
Age categories	
18-30	33.9%
31-40	21.2%
41-50	16.2%
51-60	12.3%
61-70	8.5%
>70	7.9%
Sex	
Male	40.6%
Female	59.4%
Educational attainment	
No education	9.9%
Elementary or less	37.0%
Less than high school	27.9%
High school	14.2%
Some college or more	11.0%
Region	
Central	20.0%
West-central	21.2%
Central	18.2%
Northeast	14.3%
Northwest	26.2%
Urban	
Yes	45.6%
No	54.4%

Population size	
Rural (<2500)	45.6%
Small urban areas (2500-14,999)	9.9%
Urban areas (15,000-9,999)	10.8%
Metropolitan areas (>=10,000)	33.7%
Perceived Socioeconomic Status	
Low	51.9%
Middle	40.2%
High	7.9%
BMI, kg/m^2(mean, SD)	28 (5.48)
BMI, kg/m^2	
<25	31.8%
25-30	37.5%
>=30	30.7%
Female abdominal obesity	
Yes	54.7%
No	39.8%
Missing	5.5%
Male abdominal obesity	
Yes	24.8%
No	74.0%
Missing	1.2%
Smoking status	
Smoker	16.2%
Non-smoker	83.8%
How is your health?	
Very good	8.2%
Good	42.6%
Regular	44.2%
Bad	5.0%

Calderon depression scale (mean, SD)	26 (7.40)
Psychological distress	
Yes	2.2%
No	97.8%
Hours per week participated in sports, cultural, or entertainment activities?(mean, SD)	0.56 (2.61)
During the past week did participate in sports, cultural, or entertainment activities outside your household?	
Yes	9.9%
No	90.1%
Hours per week watching TV? (mean, SD)	11 (10.55)
During the past week, did you watch TV?	
Yes	87.5%
No	12.5%
Hours per week exercising? (mean, SD)	0.24 (0.88)
Do you do any type of physical exercise as a routine?	
Yes	15.4%
No	84.6%

Abbreviations: SD, standard deviation; MxFLS, Mexican Family Life Survey

Table 3: Neighborhood and safety descriptive characteristics, MxFLS 2009-2012 (n=7,276)

Variable	Percent
In the community/locality people frequently drink alcohol or take drugs in the streets?	
Yes	40.3%
No	59.1%
Missing	0.6%
In the community/locality there are abandoned building, houses, or businesses?	
Yes	27.1%
No	72.2%
Missing	0.7%
In the community/locality there are gangs that gather frequently?	
Yes	25.4%
No	73.8%
Missing	0.7%
In the community/locality there are sex workers in the streets?	
Yes	5.4%
No	93.3%
Missing	1.3%
Neighborhood disorder score (mean, SD)	0.98 (1.09)
Number of neighborhood disorder events	
0	45.1%
1	25.0%
2	18.4%
3	9.6%
4	1.9%
Scared of being attacked/assaulted during the day?	
Very scared	5.1%
Scared	13.9%
A little scared	18.3%

Don't feel scared	62.7%
Scared of being attacked/assaulted during the night?	
Very scared	7.6%
Scared	15.0%
A little scared	18.0%
Don't feel scared	59.4%
Perceived lack of safety score (mean, SD)	0.66 (0.89)

Abbreviations: SD, standard deviation;
MxFLS, Mexican Family Life Survey

Table 4: Association between neighborhood disorder and BMI (n=7,276)

	Model 0: Neighborhood disorder only	Model 1: Neighborhood disorder	Model 2: Perceived lack of safety	Model 3: Psychological distress	Model 4: Exercise	Model 5: Neighborhood disorder + mediation variables
Variable	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**
Number of neighborhood disorders events	0.19 (0.08, 0.31)**	0.15 (0.04, 0.27)**	--	--	--	0.16 (0.04, 0.27)**
Perceived lack of safety						
Yes		--	0.01 (-0.13, 0.15)	--	--	-0.004 (-0.15, 0.14)
Psychological distress scale		--	--	-0.0005 (-0.02, 0.02)	--	-0.003 (-0.02, 0.01)
Exercise						
Yes		--	--	--	-0.36 (-0.71, -0.01)*	-0.36 (-0.71, -0.01)*
Age (years)		0.04 (0.03, 0.05)***	0.04 (0.03, 0.05)***	0.04 (0.03, 0.05)***	0.04 (0.03, 0.05)***	0.04 (0.03, 0.05)***
Gender						
Female		1.24 (0.98, 1.51)***	1.25 (0.98, 1.51)***	1.25 (0.98, 1.52)***	1.23 (0.97, 1.50)***	1.24 (0.97, 1.50)***
Education						
Elementary or less		1.06 (0.60, 1.52)***	1.06 (0.60, 1.52)***	1.06 (0.60, 1.52)***	1.07 (0.61, 1.53)***	1.06 (0.60, 1.52)***
Less than high school		0.78 (0.25, 1.31)**	0.79 (0.26, 1.32)**	0.79 (0.26, 1.32)**	0.81 (0.28, 1.34)**	0.79 (0.26, 1.32)**
High school		0.07 (-0.53, 0.66)	0.06 (-0.53, 0.66)	0.06 (-0.53, 0.66)	0.11 (-0.49, 0.70)	0.10 (-0.50, 0.70)
College or more		-0.07 (-0.69, 0.55)	-0.09 (-0.71, 0.53)	-0.09 (-0.71, 0.53)	-0.03 (-0.66, 0.59)	-0.02 (-0.65, 0.61)
No education		ref	Ref	ref	ref	Ref
Region						
Southeast		-1.02 (-1.40, -0.65)***	-1.06 (-1.43, -0.69)***	-1.06 (-1.43, -0.69)***	-1.07 (-1.44, -0.70)***	-1.03 (-1.40, -0.66)***
Southwest		-1.10 (-1.46, -0.73)***	-1.08 (-1.44, -0.71)***	-1.08 (-1.44, -0.71)***	-1.07 (-1.43, -0.70)***	-1.08 (-1.45, -0.71)***
West-Central		-1.17 (-1.56, -0.79)***	-1.18 (-1.56, -0.80)***	-1.18 (-1.56, -0.80)***	-1.18 (-1.56, -0.80)***	-1.17 (-1.55, -0.79)***
Northeast		0.08 (-0.33, 0.49)	0.06 (-0.35, 0.47)	0.06 (-0.35, 0.47)	0.04 (-0.37, 0.45)	0.06 (-0.35, 0.47)
Northwest		ref	Ref	ref	ref	Ref

Population size					
Metropolitan areas (>=10,000)	0.81 (0.51, 1.11)***	0.87 (0.57, 1.17)***	0.87 (0.58, 1.17)***	0.88 (0.58, 1.17)***	0.82 (0.51, 1.12)***
Urban areas (15,000-9,999)	0.73 (0.30, 1.15)***	0.77 (0.34, 1.19)***	0.77 (0.34, 1.19)***	0.77 (0.34, 1.19)***	0.73 (0.30, 1.16)***
Small urban areas (2500-14,999)	0.76 (0.33, 1.20)***	0.80 (0.36, 1.23)***	0.80 (0.36, 1.24)***	0.80 (0.37, 1.24)***	0.77 (0.33, 1.21)***
Rural (<2500)	ref	Ref	ref	ref	Ref
Smoker					
Yes	-0.03 (-0.39, 0.32)	-0.02 (-0.37, 0.33)	-0.02 (-0.37, 0.33)	-0.01 (-0.37, 0.34)	-0.03 (-0.38, 0.33)
Perceived socioeconomic status	0.33 (0.18, 0.48)***	0.33 (0.18, 0.48)***	0.33 (0.18, 0.48)***	0.34 (0.19, 0.49)***	0.34 (0.19, 0.49)***

*** significant at the .001 level, ** significant at the .01 level, * significant at the .05 level

Table 5: Association between neighborhood disorder and obesity (n=7,276)

	Model 0: Neighborhood disorder only	Model 1: Neighborhood disorder	Model 2: Perceived lack of safety	Model 3: Psychological distress	Model 4: Exercise	Model 5: Neighborhood disorder + mediation variables
Variable	**β (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Number of neighborhood disorders events	1.04 (1.0, 1.09)	1.03 (0.98, 1.08)	--	--	--	1.03 (0.99, 1.09)
Perceived lack of safety						
Yes		--	0.99 (0.94, 1.05)	--	--	0.99 (0.94, 1.06)
Psychological distress scale		--	--	1.0 (0.99, 1.01)	--	1.0 (0.99, 1.01)
Exercise						
Yes		--	--	--	0.84 (0.72, 0.97)*	0.84 (0.72, 0.97)*
Age (years)		1.01 (1.01, 1.02)***	1.01 (1.01, 1.02)***	1.01 (1.01, 1.02)***	1.01 (1.01, 1.02)***	1.01 (1.01, 1.02)***
Gender						
Female		1.67 (1.49, 1.86)***	1.67 (1.49, 1.87)***	1.68 (1.50, 1.88)***	1.66 (1.48, 1.85)***	1.67 (1.49, 1.87)***
Education						
Elementary or less		1.28 (1.06, 1.54)*	1.28 (1.06, 1.54)*	1.27 (1.06, 1.54)*	1.28 (1.06, 1.55)*	1.28 (1.06, 1.54)*
Less than high school		1.15 (0.92, 1.43)	1.15 (0.92, 1.43)	1.15 (0.92, 1.43)	1.16 (0.93, 1.44)	1.15 (0.93, 1.44)
High school		0.83 (0.65, 1.07)	0.83 (0.65, 1.07)	0.83 (0.65, 1.07)	0.85 (0.66, 1.09)	0.85 (0.66, 1.09)
College or more		0.83 (0.64, 1.07)	0.82 (0.64, 1.07)	0.82 (0.63, 1.06)	0.85 (0.65, 1.10)	0.85 (0.65, 1.10)
No education		ref	ref	ref	ref	ref
Region						
Southeast		0.68 (0.58, 0.80)***	0.68 (0.58, 0.79)***	0.68 (0.58, 0.79)***	0.67 (0.58, 0.79)***	0.68 (0.58, 0.79)***
Southwest		0.68 (0.58, 0.79)***	0.68 (0.59, 0.79)***	0.68 (0.59, 0.80)***	0.68 (0.59, 0.80)***	0.68 (0.59, 0.80)***
West-Central		0.69 (0.59, 0.81)***	0.69 (0.59, 0.81)***	0.69 (0.59, 0.81)***	0.69 (0.59, 0.81)***	0.69 (0.59, 0.81)***
Northeast		1.15 (0.98, 1.36)	1.15 (0.98, 1.35)	1.15 (0.98, 1.35)	1.14 (0.97, 1.34)	1.14 (0.97, 1.35)
Northwest		ref	ref	ref	ref	ref

Population size					
Metropolitan areas (>=10,000)	1.30 (1.15, 1.47)***	1.32 (1.16, 1.49)***	1.32 (1.17, 1.49)***	1.32 (1.17, 1.49)***	1.31 (1.15, 1.48)***
Urban areas (15,000-9,999)	1.17 (0.98, 1.40)	1.18 (0.99, 1.41)	1.18 (0.99, 1.41)	1.18 (0.99, 1.41)	1.17 (0.98, 1.40)
Small urban areas (2500-14,999)	1.32 (1.10, 1.58)**	1.33 (1.11, 1.59)**	1.33 (1.11, 1.59)**	1.33 (1.11, 1.59)**	1.32 (1.10, 1.59)**
Rural (<2500)	ref	ref	ref	ref	ref
Smoker					
Yes	1.05 (0.91, 1.22)	1.06 (0.91, 1.22)	1.06 (0.91, 1.22)	1.06 (0.91, 1.23)	1.06 (0.91, 1.22)
Perceived socioeconomic status	1.11 (1.04, 1.18)**	1.11 (1.04, 1.18)**	1.11 (1.04, 1.18)**	1.11 (1.05, 1.19)***	1.11 (1.05, 1.18)***

*** significant at the .001 level, **significant at the .01 level, *significant at the .05 level