A Scoping Review Mapping the Effects of Environmental Factors on Obesity

Comparative Analysis of Mexico and the United States

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Summary

Purpose
The purpose of this study was to conduct a literature review to determine the relationship between the development of the obesity (BMI≥30) epidemic and environmental factors in two selected countries: Mexico and the United States.

Methods
An internet review on MEDLINE electronic database was conducted. The search strategy was mainly focused on the use of MeSH terms to find relevant publications, followed by an abstract and full-text review. Articles were classified by content according to the type(s) of environmental factor(s) they analyzed (e.g. individual, socioeconomic, built environment, food environment, technological, and political).

Results
The search identified 47 research articles published from July 2013 to July 2018. The publications varied in terms of purpose, methodology, and detail of reporting. More than half of the articles referred to socioeconomic characteristics (45.2%) as a relevant cause of obesity. Built environment was the second addressed topic within the articles (38.1%). Evidence-based research showed that for the United States the most studied environmental factors causing or associated to the obesity epidemic are the built environment (44.4%) and food environment (36.1%); most, referring to urban planning, insecurity, absence of pedestrian paths and lack of healthy food availability and affordability. For the study of obesity in Mexico the most studied associated environmental factors to obesity are socioeconomic issues (62.5%) such as education and wealth; higher education was always negatively correlated to obesity, and for wealth, disparities were presented in the literature.

Conclusions
The high prevalence of obesity in Mexico and the United States calls for action due to the amount of people affected by this disease in these countries. There are environmental factors that affect similarly Mexican and American populations. Socioeconomic and built environment characteristics are the main drivers of obesity in both countries. Relevant differences were not encountered as there was not enough evidence. The increase of obesity is a consequence of societal, cultural and environmental factors. Combating the obesity epidemic demands environmental, public health and social policy changes, particularly in the areas of education, neighborhood infrastructure, availability of healthy foods and promotion of physical activity. Further research is needed to expand and sustain the findings of the present scoping review.

Key words: overweight; obesity; BMI; environmental factors; Mexico; United States; socioeconomic; built environment; food environment; physical activity

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Conflicts of Interest

The author declares no conflict of interest. The findings and conclusions in this research are those of the authors and do not necessarily represent the views of the Department of Health Management and Health Economics, University of Oslo.

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TABLE OF CONTENTS

CHAPTER I: INTRODUCTION AND LITERATURE REVIEW

Introduction

Obesity and overweight are defined as the abnormal accumulation of fat, which may lead to further health deterioration. The difference between the two relates to the amount of fat accumulated, usually determined by the body mass index (BMI). The BMI is the result of the total body weight in kilograms divided by the height squared in centimeters ($BMI=w/h^2$). Overweight and obesity are diagnosed when a person's BMI is >= 25 and >=30 respectively (CDC, 2017). A high BMI is a risk factor for developing other non-communicable diseases (NCDs) such as cardiovascular diseases, diabetes, and cancer (WHO, 2017).

Obesity on its own is now recognized as a chronic or non-communicable disease (Purnell J.,2018). Mortality and morbidity data reveal the severe impact of the NCDs epidemic, not only in high-income countries, but also in middle- and lower-income countries. Overweight and obesity account for at least 2.8 million deaths each year (WHO 2011). Therefore, it is also relevant to consider how to tackle the high and increasing prevalence of overweight and obesity among children, as they are the adults of the future. NCDs have a large economic impact on multiple levels (Chaker, L. et al., 2015). Obesity and its consequences cease to be a personal health issue when they begin to affect not only job performance due to a reduced ability to work, but also overall labor productivity linked to absenteeism (DiBonaventura, M., et al., 2017). One's own weight stops being a personal responsibility when it starts to create a burden on the expenditure of healthcare; either directly through costs due to obesity or indirectly through costs due to comorbidities and diseases associated with it.

Essentially, obesity results from an imbalanced caloric intake and expenditure (Greenwald, P., et al., 2017); the accumulation of body fat that underlies obesity is basically the result of a positive energy balance, where the energy consumed through food and drink exceeds that expended through metabolism, thermogenesis (the heat produced in response to and following the consumption of a meal) and physical activity (Amin, T., et al., 2016). Altogether, the result of the caloric surplus accumulated day by day, year by year, is in the form of body fat. Nevertheless, obesity has proven to be more complex than that. Some variables proposed as contributors to fluctuations in body weight and body composition are genetics and metabolic phenotype, activity (including non-exercise activity thermogenesis), and diet composition. Recent evidence also suggests that the "obesogenic environment", which involves 24-hour access to high-energy foods, large portion sizes, and social environments promoting a sedentary lifestyle, is also contributing to obesity (Smilowitz J., et al., 2010). Being overweight or obese then is a multifactorial issue, which stops being a personal responsibility when most of these multiple factors are beyond the individual's control.

Genetic, environmental and behavioral factors play an important role in the development, prevention and treatment of obesity. Early detection leads to early improvements in behavior, inducing weight-loss (Stotland, S. C. et al. 2005). The early management of overweight through novel technologies and the introduction of healthy environments, together with a behavioral

change intervention, is of utmost importance to increase productivity while decreasing the prevalence of NCDs. To tackle obesity through solely relying on the individuals' behavioral change is a naive approach, as informational campaigns work only as far as the environment allows. It is important to understand the complex nature of obesity and its root causes to be able to create strategies and policies that will eventually change the environment in which obesity thrives.

Overweight and Obesity Characterization and Diagnosis

As mentioned earlier, the most basic definition of obesity is having excess body fat. The common definition of obesity has mainly been based on measurements that gauge total body fat (Tchkonia T. et al., 2013). This description can be cumbrous as it does not account for the type of fat that is accumulated. Different studies have shown that not all fat is equally harmful. It has been proven that accumulation of fat in the gluteo-femoral region, in contrast to the accumulation of fat around abdominal viscera and intraabdominal organs, is strongly associated with obesity-related complications like coronary artery disease and type II diabetes (Hamdy, O. et. al., 2006). Moreover, it has also been debated that the accumulation of visceral fat imposes a higher metabolic risk for the individual in comparison to subcutaneous fat, to the extent where subcutaneous adiposity has been suggested to be benign (Ding, H. et. al., 2016) and in some cases even protective against the development of metabolic complications compared to visceral adiposity (Del Parigi, A., 2010). The association between visceral fat and other obesity-related diseases was shown to be independent of the amount of subcutaneous fat (Hamdy, O. et. al., 2006), albeit both adding extra weight and affecting mobility. As a result, the practice of measuring body fat to categorize obesity can be an inaccurate method.

The most common method to assess population overweight and obesity is by calculating the body mass index (BMI); this is a screening tool that is inexpensive, easily measured and reproduceable, and does not require specialized equipment. There are only two variables for the calculation of BMI: weight and height. More specifically, it is the result of the total body weight in kilograms divided by the height squared in meters, or the product of 703 times the total body weight in pounds divided by the height squared in inches:

$$BMI = w_{kg} / h_m^2$$
$$BMI = (w_{lb} / h_{in}^2) * 703$$

According to the World Health Organization (WHO), there are different levels of obesity, classified as per BMI (Table 1: BMI Socres); obesity class I for a BMI between 30 and 34.9 kg/m^2, obesity class II for a BMI between 35 and 39.9 kg/m^2, and class III for a BMI ≥ 40 kg/m^2 (Del Parigi, A., 2010). Obesity classifications are associated with moderate, high and very high risk of mortality, respectively. BMI, however, should be considered a rough guide as it may not correspond to the same degree of fat accumulation in different individuals (WHO, 2018).

WEIGHT STATUS	BMI ADULT
Underweight	<18.5
Normal	18.6-24.9
Overweight	25-29.9
Obese I	30-34.9
Obese II	35-39.9
Obese III	>40

Table 1: BMI Scores (CDC, 2017)

BMI does not measure body fat directly, but there is research showing that it is moderately correlated with other, more direct measures of body fat obtained from skinfold thickness measurements, bioelectrical impedance, densitometry, dual energy x-ray absorptiometry (DXA) and other methods (Centers for Disease Control and Prevention, 2017). In addition, BMI appears to be as strongly correlated with various metabolic complications and diseases as these more direct - but specialized measurements (CDC, 2017). BMI may thus be more accessible as the more specialized methods are usually expensive, have reduced availability, and need to be conducted by highly trained personnel. Furthermore, the results obtained may be difficult to standardize across observers or machines, making comparisons complicated across studies and time periods.

Besides BMI, supplementary assessments by waist circumference, height-to-waist ratio and hip-to-waist ratio measurements are also performed to compensate for the lack of fat differentiation as an additional valuation of body fat distribution. These measurements assess the central deposition of excess weight, most commonly known as waist circumference, which has been proven to be a stronger, independent predictor of risk factors of obesity, morbidity and mortality, compared to overall obesity (Li, W.C., et. al., 2011).

The Problem with Obesity

Simultaneously, whilst millions in the world are considered undernourished due to food shortage and macronutrient deficiency (World Hunger, 2018), obesity has acquired an epidemic status, according to the WHO. This refers to a sudden increase in the number of cases of the disease above the normal or expected number of cases in a specific area. Although obesity has been present since prehistoric times, even related to health risks by Hippocrates in circa 400 BC, it has exploded into pandemic proportions in the last few decades (Del Parigi, A., 2010). The epidemic has grown faster than expected, nearly tripling since 1975 (WHO, 2017) and it is not tied to a given region any more, affecting most countries - developed and developing - and expanding throughout all the continents (CDC, 2012).

Obesity poses a threat to national and global public health in terms of prevalence, incidence and economic burden. In 2014, more than 2.1 billion people - nearly 30% of the global population - were overweight or obese, and 5% of the deaths worldwide were attributable to obesity.

In 2015, 19.5% of the adult population was obese in the OECD region (OECD, 2017). According to the WHO, in 2016 more than 1.9 billion adults were overweight; of these, over 650 million were obese. This means that 39% of all adults in the world aged 18 years and over were overweight in 2016, and 13% of the adult population was obese. Research and projection studies have shown a steady increase in overweight obesity rates until at least 2030, even though both diseases are preventable (OECD, 2017). Indeed, if the incidence continues at the present rate almost half of the world's adult population will be overweight or obese by 2030. (Tremmel M. et al., 2017)

Causes of Obesity

The complex nature of obesity and overweight is vast, as it does not rely on one cause or have one specific consequence. Obesity and overweight are detrimental to health, either alone or as a predisposing risk factor for developing other chronic diseases, shortening life expectancy.

There is a combination of social causes and individual factors, such as individual behavior and genetics, which contribute to the actual obesity epidemic. Behaviors can include unhealthy food habits, lack or reduction of physical activity, and medication use, among others. Additional contributing social factors include the food and physical activity environment, education and skills, and food marketing and promotion (CDC, 2012).

Among the main causes of obesity and other non-communicable diseases is the consumption of hyper-caloric foods with high saturated fat and sugar content, and little to no physical activity (World Bank, 2017). Changes in dietary patterns and new lifestyles are the main drivers of the increase in overweight and obesity. Studying why and how dietary patterns have changed, and understanding the drivers of a sedentary lifestyle, could provide an interesting insight into what has changed in the environment during the last few decades.

Various countries have experienced severe changes that have drastically affected the feeding habits of the population. Many countries have experienced a so-called "nutritional transition", which refers to a series of quantitative and qualitative modifications of lifestyle habits including economic, social, demographic and health-related changes. The shift in nutrition is accompanied by development and urbanization (Popkin, B. et al., 2001). From relatively monotonous diets, nutrition has shifted toward an industrialized diet that is usually more varied. Variety itself is not supposed to be harmful; on the contrary, a varied and balanced diet can easily provide all the daily nutrient requirements when consumed in the right proportions (National Health System [NHS], 2016). The crunch is when the varied diets include pre-processed foods, non-organic food of animal origin (e.g. use of growth hormones, etc.), added sugar and fats, and an increased alcohol consumption. Changes in the food available limits choices for the consumer, and when

accompanied by a shift in the structure of occupations and leisure reducing physical activity this contributes to a rapid increase in overweight and obesity (Popkin, B. et al., 2001).

Behavior

Being overweight or obese is known to be harmful to a person's health, although this knowledge is not usually reflected in the individual's response, and hence does not affect the population levels of obesity. Considering that a large part of the population knows being fat is bad, a vast number do not act upon it. Obesity, then, occurs as a result of individual behavior rooted in societal, cultural, demographic and economic determinants.

Traditional diets have been rapidly replaced by different diets with a higher energy density, which usually include more saturated fats and trans fats, more added sugars, and the reduction of complex carbohydrate and roughage intake. As feeding habits change, behaviors towards physical activity also change; this is an issue as both behaviors lead to obesity. In a utopic world, human behavior would change to eating healthy and having an active lifestyle. Even only changing eating habits would lead to a different outcome. However, bad eating habits are accompanied by changes in behavior, such as the reduction of physical activity during both work hours and leisure time.

The human body is biologically programmed to resist prolonged fasting. Fasting helps reduce other disorders such as hypertension, asthma and rheumatoid arthritis, as well as obesity (Longo V., et al., 2014). But the human body does not tolerate excess inactivity and abundant calorie consumption; an example of this can be observed in the "Super Size Me" documentary.

"In only 30 days of eating nothing but McDonald's I gained 24.5 lbs., my liver turned to fat, and my cholesterol shot up 65 points [to 230]. My body fat percentage went from 11 to 18%, still below the average of 22% for men and 30% for women. I nearly doubled my risk of coronary heart disease, making myself twice as likely to have heart failure. I felt depressed and exhausted most of the time, my mood swung on a dime, and my sex life was non-existent. I craved this food more and more when I ate it, and got massive cravings when I didn't. In my final blood test, many of my body functions showed signs of improvement, but the doctors were less than optimistic."

– Morgan Spurlock, Subject of Study and Director

Physiological mechanisms of satiety exist within the human body and are controlled through a complex metabolic process. Evidently, these are not enough to prevent weight gain, and are proof that besides metabolism, individual behavior plays a major role in the obesity epidemic (Amin, T., et al., 2016).

Following a balanced diet without processed foods and added sugars and incorporating regular physical activity into the day are considered healthy behaviors; this is based on the belief that the

caloric surplus or deficit created by an energy imbalance might be the key to adding or losing excess weight. Guidelines for healthy eating habits are made available in different countries. The European Association for the Study of Obesity offers obesity management guidelines; the Center for Disease Control and Prevention (CDC) in the US also offers nutrition, physical activity, and obesity prevention strategy guidelines; in Mexico the Mexican Dietary and Physical Activity Guidelines for the general population are presented by the Mexican Ministry of Health.

What the dietary guidelines have in common is that they all emphasize eating healthy foods such as whole grains, fruits, vegetables, lean protein, and no-added sugar products (stressing the importance of avoiding sugary drinks) along with drinking plenty of water. Similarly, there are given guidelines for physical activity, most of which recommend adults do at least 30 minutes of moderate intensity activity five days a week and a combination of strength training in between (CDD, 2018) (Yumuk V., et al., 2015) (Pérez-Escamilla, R., 2016). Having a healthy diet pattern and regular physical activity is also important for long term health benefits and prevention of chronic diseases such as Type 2 diabetes and heart disease. (CDC, 2012)

Food and beverages are subliminally associated with positive emotional states, and for that reason food and drink are used as a compensation mechanism for low self-esteem, depression, or just as a way to feel “better” in the case of sadness, disappointment or other feelings with unpleasant connotations. This is done either unconsciously or knowingly in spite of being satiated even though it might be harmful in the long run. Food has long been used as a way to reward children, whether by parents or teachers; this behavior creates the sense that food is good, especially with the instant gratification caused by foods with high sugar contents. Frequently, the act of eating acquires a specific value and food is not seen as an energy source anymore. It acquires the value of emotional gratification, which is independent of the humanly caloric needs to survive. This behavior is a relevant individual issue and must be tackled through education and care. (Ministerio de Sanidad y Consumo: Estrategia NAOS, 2011)

Diseases and Drugs

In addition to an imbalanced caloric intake and expenditure, the development of obesity is also associated with several diseases; most are common endocrine disorders such as hypothyroidism and polycystic ovarian syndrome, but there are links with other less common diseases such as Cushing's syndrome, central hypothyroidism and hypothalamic disorders (NHS, 2017). Mechanically, the development of obesity varies depending on the condition. Hypothyroidism is associated with accumulation of hyaluronic acid within various tissues, additional fluid retention due to reduced cardiac output and reduced thermogenesis. The pathophysiology of obesity associated with polycystic ovarian syndrome remains complex as obesity itself may simultaneously be the cause and the effect of the syndrome. Net excess of androgen appears to be pivotal in the development of central obesity. In Cushing's syndrome, an interaction with thyroid and growth hormones plays an important role in addition to an increased adipocyte differentiation and adipogenesis (Weaver J.U., 2008). Other causes of weight gain can be fluid retention (oedema), ageing, tiredness and stress. (NHS, 2017)

Drugs are also known to cause weight gain, which eventually might lead to obesity. The method by which they cause this gain differs. In some cases, drugs stimulate appetite, causing a person to eat more. Other drugs might affect a person's metabolism, slowing the rate at which the body metabolizes nutrients and storing the unused energy as fat. Other drugs might affect how the body stores and absorbs sugars and other nutrients (CDC, 2012). Some of the drugs that may lead to weight gain are: drugs for diabetes, antipsychotics, antidepressants, drugs for epilepsy, steroid hormone drugs, birth control drugs, and blood pressure-reducing drugs, among others (University of Rochester, 2018).

Scientific studies have tried to find other relevant factors in energy balance and weight gain such as chemical exposures and the role of the microbiome (Tinahones F., 2017).

Genetics

The human genome changes over both short and long timescales, but changes affecting populations usually occur slowly (Walsh, C., et a., 2015). Therefore, the idea that genetics are solely responsible for the obesity epidemic considers only nature and lacks the effect of nurture. Nevertheless, variations in how individuals respond to their surroundings, to physical inactivity and to intake of high-calorie foods suggests that genes do play a role in the development of overweight and obesity (Leońska-Duniec, A., 2016). The genotype of the fat phenotype has increasingly gained interest as a consequence of the obesity epidemic (Xia, Q. et. al., 2013).

Studies have identified variants in several genes that may contribute to obesity by increasing hunger and, as a consequence, food intake (CDC, 2012). A clear pattern of inherited obesity within genetically related individuals can be caused by a specific variant of a single gene (though this is rare) and is referred to as monogenic obesity. Most obesity, however, results from multiple and complex interactions of different genes and environmental factors that are yet not completely understood; this is called multifactorial obesity (Grundy, S.M., 1998).

A common practice by clinicians is to routinely collect familial health history to identify whether a patient is at high risk of obesity-related diseases such as diabetes, cardiovascular diseases, and some forms of cancer. Family health history reflects the effects of shared genetics and a common environment among close relatives. Although genes cannot be changed, the environment in which a family lives can, through improving or worsening eating habits and physical activity. A better understanding of obesity genetics came with twin study models which helped assess the genetic components of given traits. Results show that the fat concordance among monozygotic twins, commonly known as identical twins, ranges from 70–90%, while in twins who share 50% of their genetic material, called non-identical dizygotic twins, the fat concordance has been reported to range from 35% to 45%. (Stunkard, A.J. et. al., 1986). Although such data may indicate strong evidence of the genetic component of obesity, this type of studies have limitations and are largely dependent on how they are performed (Xia, Q. et. al., 2013).

Interesting findings from adoption and family studies show evidence of strong correlation between BMI of adoptees and biological parents, but not between adoptees and adoptive parents. Additionally, it has been shown that while there is no association between BMI of nonidentical twins separated at birth, there is a significant relationship for identical twins raised apart. (Stunkard, A.J. et. al., 1986)

The study of how obesity affects different groups has found that there are variations in the prevalence of obesity among racial and ethnic groups. Arguably, ethnicity does not necessarily refer only to genetic characteristics; it is a term attached to culture, traditions and environment. Nevertheless, an insight into how obesity affects different racial and ethnic groups is given by how body composition varies among races. For example, BMI cutoffs have been redefined for Asian populations, as they presented increased risk of metabolic diseases within what was a normal range of BMI (Lancet, 2004); this implies that the standard relationship between weight status and metabolic health is not applicable for some subtypes of individuals (Lee, K. et. al., 2009). Body composition among racial and ethnic groups varies, as adipose tissue accumulation differs from race to race; understanding body composition is thus a key factor to predicting metabolic risk within races. Such findings strongly support the concept that genes play a central role in the determination of BMI and body composition, and as a result, in the pathogenesis of obesity (Lee, K. et. al., 2009). It has been proved there is a genetic component to obesity, but it is has generally proved challenging to identify the specific underlying genetic cause.

The consequences of obesity make this disease one of the biggest public health challenges of our time. The rapid and visible increase in prevalence of overweight and obesity throughout the past three decades cannot be solely attributed to genetics. Although hereditary factors are important, the human genome has not changed in such a short span of time to attribute this pandemic to genes. Therefore, environmental and demographic factors play an important role in the development of the obesity epidemic by creating an “obesogenic environment” characterized by the abundance of hyper-caloric food and a sedentary lifestyle. Although it is given that genetic changes in an individual’s genome may provide novel insights into obesity and metabolic disorders, this study will focus only on the environment and surroundings.

Environment

Obesity is the result of complex and interacting dynamics that create an obesogenic environment. Besides genetics, environmental factors are possibly the biggest determinants of the prevalence of adult and childhood obesity (Obesity Society, 2013). Two main contributors are the reduction in physical activity and the availability of nutritious food. As more people move into urban communities they tend to take up sedentary jobs; with increasing working hours and longer commutes, the time for exercise or physically active hobbies becomes limited (Brantjes, T., 2017). Environmental factors affecting obesity are all the external elements and conditions that affect, either positively or negatively, the prevalence of obesity. Recent hypotheses suggest the current obesity epidemic is mostly driven by environmental factors rather than biological ones (Brantley P.J. et. al., 2005).

The environment, including the community, is a major determinant for the development of obesity. Individuals make decisions based on what surrounds them, what they have available and what others around them do. Walking paths, safe sidewalks and bike trails influence people's decision to walk or take a bicycle, instead of using a car or public transport. Location and accessibility of schools, offices, child care, health care and living spaces can influence people's daily behaviors (McGue, M., et al., 1998). Settings and design of these spaces can also influence people's behaviors, and the changes in the design of living and working spaces in the past few years have promoted a sedentary lifestyle. For example, elevators are now required in every construction, due to accessibility for the handicapped (Riley, L., 2016). Elevators offer a solution to a problem but also create one by promoting less physical activity.

Similarly, in the past, most jobs were more physical, and people had to be active, whether it was to get back and forth from home to work or doing actual physical labor. Growing cities have transformed the way people live and commute. Today the use of cars, buses, elevators, and labor-saving devices means people do not expend as many calories to complete daily routines and communications. Hence, the importance of creating friendly environments and accessible locations, allowing people to engage in physical activity and healthy eating habits, cannot be understated.

There have been changes in the food environment as well. Increased accessibility of foods, declining food prices and increased portion sizes have been key components of the environmental change that led to the obesity epidemic (Cohen D., 2008). Despite the fact that the variety of food available in the marketplace has increased, the variety in nutrient composition has not necessarily been affected. As many as 10,000 food products are introduced solely in the United States every year, but these have only changes in flavorings and textures; they still contain the same sugar, starches and fat ingredients (Cohen D., 2008).

Another environmental factor that may contribute to the development of obesity is stress. Chronic social stress, often arising from poor interpersonal relationships, job or unemployment stress, poor self-esteem, and unmet socioeconomic status aspirations, has been associated with obesity and its associated diseases (Scott K. et al., 2012).

The Issue with Food

Nowadays, people follow diets full of meat, dairy, processed foods and other foods with high caloric density, such as fats, white bread and sugary carbonated drinks. These diets are also characterized by a low intake of fruits, vegetables and cereals (Ministerio de Sanidad y Consumo: Estrategia NAOS, 2011). The main two drivers of these diet patterns are cost and accessibility; junk food is perceived as cheap and the healthy food is not readily accessible. The article "Is Junk Food Really Cheaper?", published in the New York Times by Mark Bittman, tries to debunk the myth of junk food being cheaper than healthy unprocessed food. He makes several comparisons of well-known fast food chain menus and a regular cooked-at-home family meal, proving that cooking at home in the United States is still cheaper than junk food. He acknowledges that junk

food is cheaper when by the calorie; however, given that half of the population already consumes more calories than they need, measuring food's value by the calorie makes no sense. Considering Bittman's findings, it seems relevant to study food costs and accessibility jointly. If time is money, preparation of food increases its price. Equally, having to drive for 30 minutes to find a supermarket also increases food prices by this principle. It may be that overall, junk food that is readily available might be cheaper than a healthy meal prepared at home.

Individuals are bombarded with images and offers of high fat, high calorie, highly palatable, convenient, and inexpensive foods. These foods are packaged in portion sizes that far exceed federal recommendations. Yet, when it comes to losing weight, marketed dietary products can be more expensive and not always work. For these products to work the subject must be on a caloric deficit, or at least not in a caloric surplus; if in surplus, weight loss cannot be achieved.

Consequences of Obesity

Affecting Health

The most relevant consequences of overweight and obesity are related to health. People who are obese, in comparison to those with normal weight (according to BMI), are at increased risk of overall mortality, reduction of life expectancy and of developing many serious diseases and chronic health conditions (CDC 2012). According to the WHO in 2015 there were 56.4 million deaths globally, out of which 39.5% were due to noncommunicable diseases (NCDs). The four main NCDs are cardiovascular diseases, cancers, diabetes and chronic lung diseases. As mentioned earlier, out of the four main global NCDs, three have a direct causal association with obesity. There is a disproportionate rise in the burden of these diseases among lower- and middle-income countries and populations. In 2015, over three quarters of NCD deaths - around 30.7 million - occurred in low- and middle-income countries, with about 48% of these deaths occurring before the age of 70. The WHO also stated that the leading causes of NCD deaths in 2015 were cardiovascular diseases (17.7 million deaths, or 45% of all NCD deaths), cancers (8.8 million, or 22% of all NCD deaths), and respiratory diseases, including asthma and chronic obstructive pulmonary disease (3.9 million). Diabetes caused another 1.6 million deaths.

Physical disorders linked to obesity range from metabolic to musculoskeletal ones, including hypertension, high LDL cholesterol, low HDL cholesterol, high levels of triglycerides (dyslipidemia), Type 2 diabetes, coronary heart disease, stroke, gallbladder disease, sleep apnea and breathing problems, some forms of cancer (endometrial, breast, colon, kidney, gallbladder, and liver), osteoarthritis and body pain and difficulty with regular physical functioning (National Heart, Lung and Blood Institute [NHLBI], 2013). However, obesity does not only affect the physical health of the individual; it is also the cause of mental illness such as clinical depression, anxiety, and other mental disorders (Luppino F.S., et al., 2010). Overall quality of life is affected, as there is an important association between obesity, physical and mental illness, which impacts all aspects of an individual's life (Taylor V. et al., 2013).

Obese employees tend to be absent from work due to illness significantly more often than non-obese workers (Australian Department of Health, 2009). Besides health issues, obese individuals face social reject labor discrimination (Flint, S., et al., 2016). In some cases, discrimination is disguised with performance and ability arguments, because obese candidates can be perceived as less suitable for physical jobs compared with normal weight candidates. Flint et al. (2016) also concluded that obese women are more likely to be discriminated against than obese men.

Economic and Social Burden

The increased prevalence of obesity has a significant impact on countries' GDPs as the costs of treatment and care for people with NCDs are high and growing rapidly (VISES, 2014). In poorer countries, healthcare costs are usually paid by patients out-of-pocket; the cost of health care for NCDs thus creates significant strain on household budgets. In middle- and high-income countries, the costs to health-care systems from NCDs are high and projected to increase. A major reduction in the burden of NCDs will come from population-wide interventions, which are cost effective and may even be revenue-generating (WHO, 2011).

Health problems related to excess weight impose substantial economic burdens on individuals, families and communities. Society as a whole, bears the economic brunt (Australian Department of Health, 2009). Obesity is responsible for a significant part of the costs incurred in health care systems and for society in general (Tremmel M., 2017). Health costs associated with obesity usually involve direct and indirect costs. Direct medical costs may include preventive, diagnostic, and treatment services related to obesity. Indirect costs relate to morbidity and mortality costs including productivity. Productivity measures include 'absenteeism' (costs due to employees being absent from work for obesity-related health reasons) and 'presenteeism' (decreased productivity of employees while at work) as well as premature mortality and disability (Dee, A., et al., 2014).

For example, the medical care costs of obesity in the United States are high. Costs were estimated to be from $147 billion to as high as $210 billion per year (Cawley J. et. al., 2009). The annual nationwide costs of obesity-related absenteeism range between $3.38 billion and $6.38 billion; this is $79-$132 per obese individual (Spieker, E. et al., 2016).

The individual burden of obesity refers to expenses that might increase for the obese individual, such as life insurance, medical insurance and medical expenses. Life insurance premiums can be two to four times more expensive than those of an individual with normal weight. When considering unpaid absenteeism, decreased productivity and short-term disability, obese people have less acquisitive power. Other expenses that the overweight or obese individual bears are the imposed increased costs on their daily lives. The raise in costs vary depending on the amount of extra weight and different needs of the person. Transportation, food, clothing, and medical bills, among others, are examples of direct costs people with a BMI over 25 spend more money on (Seidell JC, 1998). Additionally, transportation costs could increase even more when the excess

weight of an individual has impaired their movement and caused the requirement of special services.

All the previously mentioned causes deserve attention and must be considered in order to create and implement novel public health strategies that would help control and reduce overweight and obesity in the general population. A major public health effort based on evidence-based research is urgently needed to tackle obesity by modifying behavior through changes in the environment.

Health Systems in Mexico

Mexico is one of the most populated countries in the world with 127,540,000 inhabitants as of 2016 (World Bank, 2016). Mexico is the second most obese country among the OECD countries, with over 70% of the adult population overweight or obese; approximately 35% are classified as obese individuals (OECD, 2017).

The Mexican healthcare system, similarly to the United States, is a segregated system. It is divided into several different systems (Brantjes, T., et al., 2017). The first system is classified as a social health insurance (SHI) system, run by the Institute for Social Services and Security for State Employees (ISSSTE) and the Mexican Social Security Institute (IMSS). It is a system directly related to employment, covering those working in the private sector as well as the federal and the state governments (38.9% of the population) (Perez-Cuevas, et. al., 2017; OECD, 2016). The SHI is partially covered by the beneficiary, as a percentage of the salary, while the remainder is provided by the government and the employer. The second system is run by the National System for Social Protection in Health (commonly known as Seguro Popular). It covers those who would otherwise be left uninsured by the traditional SHI system, e.g. informal economy sector workers, household workers, housewives and children; mainly low-income individuals (Perez-Cuevas, et. al., 2017). Seguro Popular is funded by federal and state governments, as well as insured participants (Brantjes, T., et al., 2017). The third form of insurance, which covers roughly 6% of the population, is private insurance; this is expensive and thus unpopular, mainly covering major medical expenses and working on the basis of high deductibles and/or co-payments. Many choose not to buy insurance; these are required to pay out-of-pocket for services (Brantjes, T., et al., 2017).

Efficient is not the best word to describe the integration of these three systems. Therefore, extensive variabilities in the quality and coverage of public healthcare services exist within the whole country. Access to healthcare in rural areas is still a major issue and concern. Even though Seguro Popular covers almost one third of the population in Mexico, it focuses on treatment of illness rather than prevention at the primary and secondary levels (OECD, 2016).

Strategies to Prevent Obesity in Mexico

In the last couple of years there have been initiatives to stop the growth of obesity and reduce the prevalence of other NCDs in Mexico. Some of the strategies already implemented are presented below. One of these initiatives was developed and implemented by Fundación Carlos Slim, and was called Casalud – a primary healthcare sector screening and prevention program for NCD's, running as part of the Seguro Popular system (Thuomi, et. al., 2015). There is also the National Strategy for the Prevention and Control of Overweight, Obesity, and Diabetes (NSPCOOD). Launched in 2013, the strategy aims to reduce the incidence of NCDs, in particular obesity and diabetes, through a comprehensive medical care model and effective public policies (WHO, 2014). As part of the NSPCOOD initiative, in 2014, Mexico started taxing foods high in sugar and fats. Evidence shows that there has been an average reduction of 7.6% in purchases of taxed (sugary) beverages during the first two years (Arantxa-Cochero, et. al., 2017).

Obesity threatens to become the foremost cause of chronic disease in the world (Grundy, S.M., 1998). Being overweight or obese increases the risk of an individual developing other chronic diseases such as cardiovascular disease, diabetes mellitus, and cancer. The increasing prevalence of obesity is not a local problem any longer, but has become a global issue. Reasons for the rising prevalence include urbanization of the world's population, increased availability of food, and reduction of physical activity. Furthermore, the physical demands of our society have changed due to technology assisted labor and communication, resulting in an imbalance in energy intake and expenditure. These compound externalities associated with the current obesity situation merit appropriate interventions as the complex issue of obesity is affected by multiple factors and involves multiple industries and sectors.

Health Systems in the United States

The United States healthcare system is large and vastly complex compared to other systems in the world. The total health care expenditure in the U.S. is over $3.3 trillion, or $10,348 per person per year. As a share of the nation's Gross Domestic Product, in 2016, health spending accounted for 17.9 percent (Centers for Medicare and Medicaid Services [CMS], 2016). Despite the United States being among the wealthiest nations in the world, it is far from the healthiest. Compared to people in other high-income countries, Americans live shorter lives and experience more injuries and illnesses (Institute of Medicine, 2013). The United States does not offer its citizens universal health insurance coverage; in 2010, 50 million people were uninsured. Emergency departments become the go-to option for acute, chronic, and even preventive care because of the lack of family doctors (Woolf, S., et al., 2013).

There is an increase in out-of-pocket payments, which makes all healthcare services and medical supplies more and more unaffordable (Karaca-Mandic et al., 2012). Health care delivery is deeply fragmented across thousands of health systems and financed by a complex mixture of public payers, Federal, State, and local governments (Nancy De Lew, 1992), as well as private

insurance and individual payments (Woolf, S., et al., 2013). This way of organizing the system creates inefficiencies, inequalities and immense coordination problems.

Based on the current population survey by the Census Bureau in March 2010, the uninsured account for 17% of the total population. This leaves around 55 million people vulnerable to out-of-pocket payments or, in the worst-case scenario, without access to care. Most people in the United States are privately insured (approximately 50%) and obtain their health insurance through their employer. Another significant part of the United States population is publicly insured. Public insurance can be provided by CHIP, Medicare, Medicaid, or TRICARE (military funded care e.g. the Veteran's Administration and the Department of Defense) (Shi, L., et al. 2015). These public funded programs are run by federal, or in some cases, by state and local government agencies.

Strategies to Prevent Obesity in the United States

The complex nature of obesity requires a multifaceted approach to reduce its prevalence. Throughout the U.S., resources have been made available to help disseminate consistent public health recommendations and evidence-based practices for state and local public health organizations and practitioners. In recent years, state and local governments have adopted a range of obesity-related public policies (Chriqui J., 2013). The Prevention Institute's ENACT local policy database provides obesity-related policies implemented by local governments. Guidelines such as Clinical Guidelines for the prevention, diagnosis and management of obesity are available.

Moreover, there are several local and state strategies for obesity prevention. There is a vast list of nutrition and physical activity guidelines available for the general population. With different approaches, these guidelines intend to help people be more active or help policy makers to change the environment in a way that enables people from different communities to be more active. For example, the Community Preventive Services Task Force recommends built environment strategies that combine one or more interventions to improve pedestrian or bicycle transportation.

There is a special interest in implementing policies and strategies within school environments and early care and education. One example is the School Health Guidelines to Promote Healthy Eating and Physical Activity. As with every other disease, obesity prevention should start from the early stages, preferably during childhood. In the case of Early Care and Education Strategies, the CDC's framework for obesity prevention is known as the Spectrum of Opportunities. It helps identify how communities can support child care and early education facilities to achieve recommended standards and best practices for obesity prevention (CDC, 2018).

CHAPTER II: METHODS

Purpose of the Study

The purpose of this study was to conduct a literature review to determine the relationship between the development of the obesity epidemic and environmental factors in two selected countries: Mexico and the United States.

Justification of the Study Components

Why obesity? Summarizing some of the key facts from the World Health Organization about obesity should give enough arguments to support the relevance of studying the underlying causes of obesity. The WHO states that obesity has almost tripled since 1975 worldwide; that 52% of the adult population - more than 1.9 billion adults - are overweight or obese; and lastly, that obesity is preventable. To be able to prevent obesity it is essential to understand why and how this disease has propagated so rapidly.

Why environmental factors? In his article on human evolution, Jay T. Stock mentions that "humans display greater genetic unity than most other species, which has led many to assume that human evolution ended with the origin of modern humans". And whether this statement is true or false, it is known that variations in the human genome and the process of evolution do not happen in one day, not even in a few decades. So, what happened in the last 45 years that made the obesity epidemic grow to such proportions that more than half of the adult population is overweight or obese? If it is not within the individual's genome, it must be something from the outside. This is why it is of utmost importance to study and understand the environment in which the so-called obesity epidemic developed so rapidly.

Why Mexico and the US? Adult obesity rates are highest in the United States, Mexico, New Zealand and Hungary, while they are lowest in Japan and Korea (OECD, 2017). The United States ranks first in the number of obese adults and Mexico, its neighboring country, does not fall far behind with fifth place. Both countries are high up the ranks on adult and childhood obesity. The fact that they share a border might be a reason to believe that they are influenced by each other. It would be interesting to see what type of environmental factors they have in common, and if these factors have similar or different effects in these two different populations.

Research Method: Scoping Review

The methodological framework followed by this study was a scoping review. Reviewing scientific and health research evidence through scoping reviews has become a popular approach. (Levac, D. et al., 2010). As with any other research tool, scoping reviews are far from perfect. They offer a broad understanding of the different subjects, allowing the reader to comprehend and make decisions based on the vast sources these reviews are based on. It is not without limitations, as scoping study definitions range widely from one another. Scoping studies, generally, aim to map

-*in a rapid manner*- key concepts of a specific research topic, utilizing different types of evidence and sources available. Many of these scoping studies attempt to analyze novel or complex subjects that have not been reviewed, or else have not been extensively and comprehensively reviewed; in this case a scoping study can be undertaken as stand-alone project in its own right (Arksey, H. et. al. 2005).

The present scoping study aims to gather useful evidence regarding all other factors that may be causal to obesity that are not biological or genetic. Addressing these issues, including the lack of evidence, will give the individual (but most importantly policy and decision makers) relevant information to be used as a tool to comprehend the roots of the obesity epidemic. The two main objectives of this scoping study are:

1. To summarize and disseminate research findings, while describing in detail a range of sources from different areas of study.

2. To identify research gaps in the existing literature.

Through these objectives, the study will provide summarized and disseminated research findings to policy makers, clinicians and individuals who have scarce time or resources to undertake this type of research work on their own. It is safe to say that there is a significant amount of evidence that has not yet been collected within the subject of obesity and its causes. Pointing out areas of opportunity for further studies is also important in this study. The ability to describe the limitations that are to be faced and what is yet to be understood in order to tackle obesity is as important as the known conditions and the already-made progress on this matter. This review will take one step further by proposing relevant research in the future and identifying different research methods and models to be included in future research in specific areas.

Scoping reviews, because of their broad nature, usually lack a specific methodology. Some authors have tried to unify methodologies by creating a single, inclusive one. The framework used for this study was a five-stage (six, in some cases) methodological framework developed by Arksey and O'Malley (2005).

Stage 1: Identifying the research question
Stage 2: Identifying relevant studies
Stage 3: Study selection
Stage 4: Charting the data
Stage 5: Collating, summarizing and reporting the results
Stage 6: Consultation (optional) (Arksey, H. et. al. 2005)

Research Design

Stage 1: Identifying the research question

Within scoping reviews, identifying the research question is essential as it marks the starting point of the study. Developing a clear, well-defined research question is crucial to the quality and

relevance of the findings, serving as a guideline for the strategy of the study; how the research should be conducted and what data aspects should be included. Study population, interventions and/or outcomes (Center for Reviews and Dissemination [CRD], 2001) are aspects to be included in this question.

The central research question for this study was:

What are *some* of the environmental factors that occurred in the United States and Mexico that influenced the growth of the [adult] obesity epidemic during the last three decades?

Supplementary research question:

What effects do environmental factors have on obesity development?

It is necessary to state that the term "environmental factors" comprises all biotic and abiotic factors; that is, any causal factor that had or still has an effect on the increase of obesity. Environmental factors must be external and unrelated to an individual's biology or genetics. The way the question is formulated, specifically the word *some*, is due to the understanding that the study could not possibly encompass *all* environmental factors affecting the increase of obesity. It does, however, intend to cover the most relevant and significant factors reflected by evidence-based research. The contributory factors to be included in this study as 'environmental factors' were to be determined through the establishment of a study framework. This framework aims to integrate the individual, social, economic, and spatial factors that led to the development of the obesity disease and epidemic. Such parameters had to be properly defined at the outset of the study, considering implications and adopted positions, in order to select only relevant studies that would answer the research question.

Stage 2: Identifying relevant studies

What is defined as "environment" in this study is all the external elements and conditions which surround, influence, and affect the life and development of an organism or population (MeSH Database, 2018). Environmental factors affecting obesity, then, are all the external elements and conditions that have an effect, either positive or negative, on the prevalence of obesity.

The broad definition of environmental factors may reduce the chances of missing relevant articles whilst simultaneously allowing the inclusion of a large number of references. Maintaining a wide parameter span helped to expand the amount of relevant data. Eventually, after reviewing the volume of publications and research available and gaining some sense of the scope of the field, these parameters were reduced according to relevance.

1) Construction of the framework

   In order to be able to categorize environmental causal factors of obesity, factor parameters had to be defined. The parameter definition focused on the personal and surrounding

environment as a key driver of change. Policy, regulation or behavioral changes in any of these environmental "levels" would affect the development of obesity. The environmental levels were based on Amarasinghe and D'Souza's (2012) model for obesity prevention, known as the Individual, Social, Economic and environmental model (ISEEM). This model proposes the examination of not only the possible causes, but also consequences and policy implications for prevention; however, for the purposes of this study it is used on the basis that in order to prevent the disease, one must analyze its causes. There were three main levels included: individual, socioeconomic, and environmental. The latter consists of two sub-factors: built environment and food environment.

A second analysis framework was used alongside the main framework to increase the breadth of the scoping review; this is The Political, Economic, Social, Technological, Legal and Environmental (PESTLE) framework. From this model the technological and political levels were included in addition to the other three main environmental levels already chosen from the ISEE model.

In summary, five environmental levels were chosen for the study to be as comprehensive as possible:

- Individual
- Socioeconomic
- Environmental
  - Built Environment
  - Food Environment
- Technological
- Political

These levels are used to broadly review evidence-based research which would answer the research question.

Factors that fall into the *individual* category refer to social and cultural institutions, forms, patterns, and processes that influence the life of a person. All publications regarding race or ethnicity are categorized as individual factors. There are publications included in this category that consider perception, which is also classified as an individualized trait. The *socioeconomic* category refers to social class and poverty level, and usually entails data related to education and income (Booth, J., et al., 2016). The *food environment* represents the spatial availability, accessibility and affordability of food, the distribution of food sources, and the type of food within a given region (Caspi C., et al., 2012). The *built environment* encompasses all the physical spaces (buildings, parks, pedestrian and bike paths, city design, etc.) that people are exposed to and that influence their lifestyles by permitting, promoting or limiting specific patterns of behavior (Collins Purdue W., et al., 2003). The *technological* category includes all external factors within information and communication technology that impact obesity. Changes in technology affect, for example, how people work, commute and spend leisure time. Within the *political* category fall all the government actions that might have affected the environment in which obesity prevalence increased. These actions and/or policy implementations may be on the local, regional, national or international level.

The main search strategy was conducted in the life sciences and biomedical electronic database MEDLINE. Due to Spanish being the main language in Mexico, publications in both English and Spanish were included in the search.
The decision to only review publications from a single electronic database was made from a practical point of view. Reflecting time constraints, the study focuses on documents published in the last 5 years with information regarding the United States and Mexico. Although the amount of publications for the United States within this 5-year range is larger, it was considered appropriate to use the same timeline for both countries to make results more comparable. This time constraint was considered to simplify the search. As it is common for publications to use data from previous years, it may be the case that some publications are based on information gathered many years ago, sometimes decades. In order to keep publications current, and thus relevant to the research question, publications with data before 1988 were excluded. The cut-off date of 1988 was chosen because it covers major changes in the obesity prevalence in both United States and Mexico. In the US, the prevalence of obesity increased significantly among adult men and women between 1980-2000 and between 2005-2014 the prevalence of overall obesity and extreme obesity increased significantly among women (National Institute of Diabetes and Digestive and Kidney Diseases [NIDDK], 2017). The prevalence of obesity in Mexico has also risen substantially since the 1980s (DiBonaventura M. et al., 2017), and from 1999 to 2012 obesity prevalence rates rose by 13% for men and 9% for women (Secretaría de Salud, 2015).

Selected publications were also based on the overweight and obesity disease definition. According to the tenth revision of the International Statistical Classification of Disease and Related Health Problems, the codes for all endocrine, nutritional and metabolic diseases fall between the E00–E90 categories. Overweight, obesity and other hyperalimentation disorders are coded from E65-E68. More specifically, the ICD-10 code for overweight and obesity is E66 (See Annex 1: Overweight and Obesity Coding ICD-10-CM). This coding enables differentiation during research and data analysis, the correct saving of documentation, and accurate and standardized medical records. Many of the publications in this study were not based on the most specific classifications, but mainly referred to general overweight and obesity, classified as E66. Therefore, the obesity-related analysis carried out in this study, for future referencing, shall be considered as E66.

2) Inclusion and exclusion criteria

The inclusion and exclusion criteria are presented in Table 2. These criteria were based on the ISEE Model and the PESTLE Analysis framework, and the central research question; the criteria was selected at the beginning of the review, to ensure homogeneity throughout the whole search and further on during the analysis. It should be noted that the criteria may have excluded relevant studies; increasing familiarity with the topic during the review identified areas of opportunity that could be studied in future research.

In order to be relevant for inclusion, studies needed to be published between June 2013 and June 2018 and be based on data collected at any point between January 1988 and

June 2018. English and Spanish publications were included. Publications had to be original research articles published in a peer reviewed journal, that included at least one of the environmental factors above (Individual, Socioeconomic, Built Environment, Food Environment, Technological, Political) and its impact on the adult population in either the United States or Mexico (or both). Articles not meeting these criteria were excluded.

Criterion	Inclusion	Exclusion
Publication Time Period	From June 2013 to June 2018	Any study published outside these dates
Data Set Time Period	From January 1988 until June 2018	Any study using data recovered outside these dates
Language	English. And for publications regarding to Mexico, English and Spanish	Non-English, Non-english or non-Spanish for publications regarding to Mexico
Type of Article	Original research article published in a peer reviewed journal that provides information about environmental factors affecting obesity	Any publication that was not original research, peer-reviewed journal article, literature reviews, and/or unpublished articles
Study Focus	Factors regarding the individual, socioeconomic, built and food environment, political and technological environment affecting the prevalence of adult obesity	No reference to causes or effects on obesity; reference to childhood obesity; relationship of obesity with workspace environment, climate, noise, microbiota and smoking
Geographical Area of Interest	Local, regional or national studies done within Mexico and/or the United States or international studies including specific data from these two countries	Studies from other countries that did not include data for Mexico or the United States
Settings	Any	Nil

Table 2: Inclusion and Exclusion Criteria

3) Search protocol

To identify relevant papers, a preliminary broad search was conducted in the MEDLINE PubMed database strategy (Table 3: Preliminary Searching Strategy). The preliminary search strategy was developed from the research question and the understanding of the main key concepts about the topic. The searching strategy was developed with the view to obtain specific studies that included the relevant key concepts, which in turn would answer the research question. This type of review, whether scoping or systematic, requires a more specialized search, hence the need of technical research skills. Researchers may not have the skills necessary for designing and executing sensitive search strategies that qualified librarians have (Arksey, H. et. al. 2005). Therefore, a specialized librarian from the University of Oslo Medical Library helped identify the relevant keywords and MeSH terms and differentiate them from each other, as not all keywords are MeSH terms; they also helped in devising the initial search protocol. The study greatly benefitted from this specialized experience and guidance.

MeSH Terms/Filters Activated	Full-Text	Published Last 5 Years	Humans	Total Publica-tions
Obesity		x		104581
Obesity		x	x	68747
Obesity	x	x	x	68605
Obesity + Environment		x	x	4752
Obesity + Environment	x	x	x	4721
Obesity + Environment + US	x	x	x	257
Obesity + Environment + Mexico	x	x	x	91
Obesidad + México	x	x	x	124

Table 3: Preliminary Searching Strategy

To maintain the broad scope of the study in the preliminary search, the two main medical subject headings (MeSH) that were chosen were “obesity” and “environment”, and their respective Spanish translations “obesidad” and “ambiente” (considered as key words rather than MeSH terms in Spanish). The search was followed by adding “United States” or “US” and “Mexico”, also as MeSH terms. This allowed inclusion of regional searches without actually having to search, for example, by state. All articles that were not available as full-text were excluded. The MEDLINE database search produced 472 hits in total, and the titles and abstracts were screened for relevance following the inclusion and exclusion criteria. Of these, 80 full-text articles were then assessed for inclusion.

Following this, the developed preliminary search strategy was implemented and refined to include the environmental levels discussed above by adding different MeSH terms and other keywords to the search after consultation with a specialized librarian. Utilizing other

related MeSH terms and keywords, for example “overweight” (“sobrepeso”), “social” (“social”), “food” (“comida”), “socioeconomic” (“socioeconómico”), “lifestyle” (“estilo de vida”), “adult” (‘adulto”), “technology” (“tecnología) and “environmental factors” (“factores ambientales”), allowed inclusion of other relevant publications. The keywords “obese”, “built environment”, “food environment” “technological” and “political” were also used to further refine the search strategy. Other key concepts like “obesity causes” and “individual” were included, but they lacked specificity, and generated too broad of a search on the topic. Below is an example of the conducted refined search for publications regarding socioeconomic factors:

("Obesity"[Majr:NoExp] OR "Obesity, Morbid"[Majr] OR obesity[Title]) AND ("Socioeconomic Factors"[Majr] OR environment[Title] OR environmental[Title] OR socioeconomic[Title] OR socio-economic[Title]) AND ("Mexico"[Mesh] OR "United States"[Mesh] OR mexico[Title] OR mexican[Title] OR united states[Title]) AND "last 5 years"[PDat]

From the refined search 1122 hits were obtained and 23 were deemed relevant after screening titles and abstracts. Thus, in the screening phase, a total of 1594 articles were evaluated, and 1491 articles were discarded because they did not meet the inclusion criteria, leaving a total of 103 articles to be assessed for inclusion. Of these, 42 were included in the review (Figure 1: PRISMA Flowchart of Systematic Methodology).

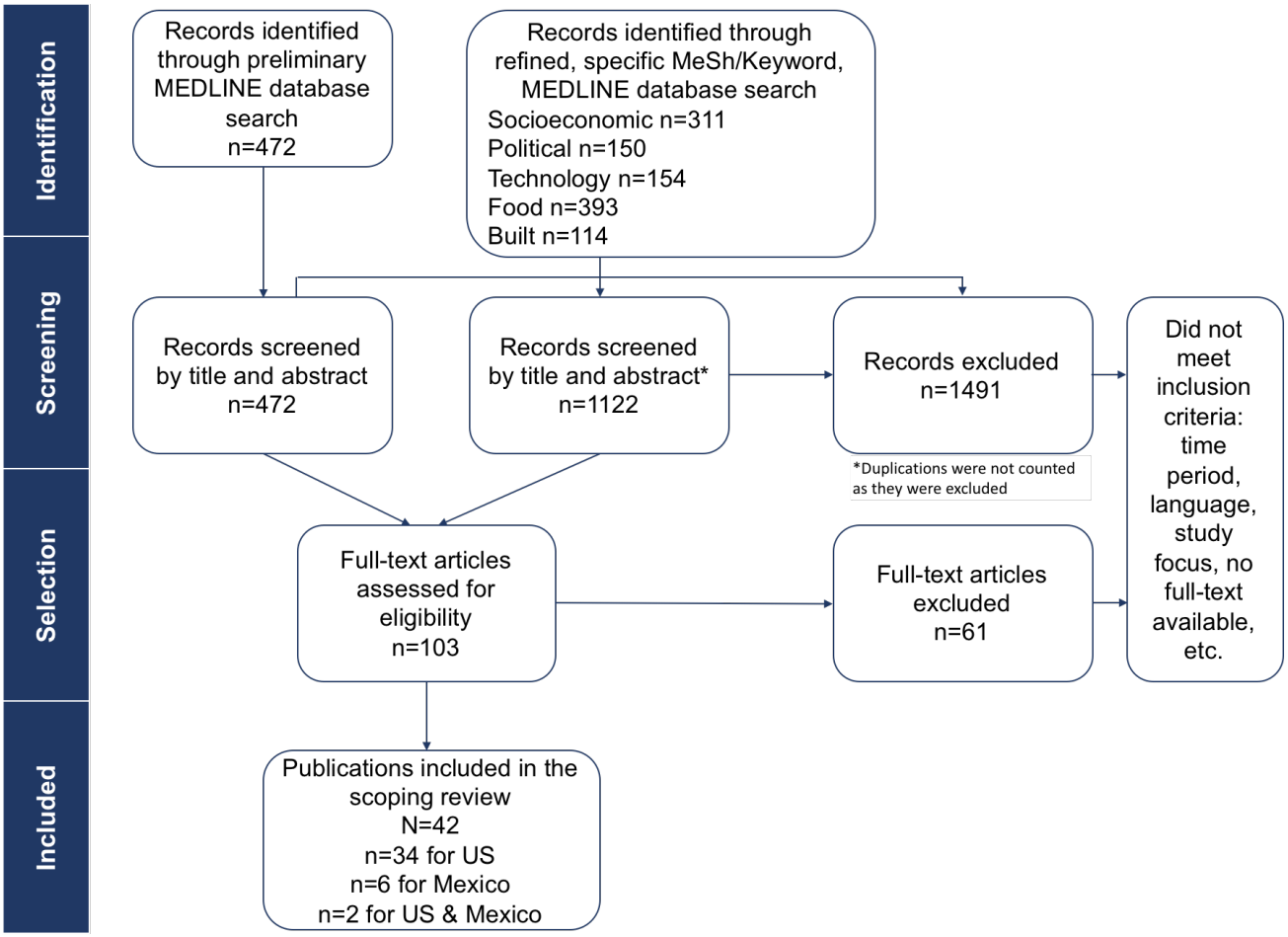

Figure 1: PRISMA Flowchart of Systematic Methodology

Potential costs of the creating this paper were not considered as the online access to the MEDLINE electronic database and its publications through the University of Oslo is open, meaning that most publications are free; thus, no payment was required for access to included studies.

Stage 3: Study selection

The strategy for the searching process was to start as broadly as possible to understand the extent of the research on environmental factors within the obesity topic. The first search made had no year limitation, which provided information on when researchers started to notice a correlation between obesity and the environment (Annex 2: Obesity and Environment MeSH Terms Through the Years). The first obesity publication available in MEDLINE is from 1880. The first hit using "obesity + environment" MeSH terms in MEDLINE is a publication from 1948 by Margaret L. Turner: "Hereditary Obesity and Temperature Regulation". In this paper Turner states that "Adiposity is of further interest since it furnishes readily available material to illustrate the interaction of hereditary and environmental factors in the production of a hereditary trait". Publications linking obesity to environment increase year by year. From 1988 to 2008 the amount of publications including both MeSH terms increased by almost 12 times, from 37 to 434 respectively.

As shown in Table 3: Preliminary Searching Strategy, only approximately 7% of the obesity-related publications in the last 5 years included the MeSH term "environment". This first search demonstrated that there were many irrelevant publications for the scoping study; thus, more refined searches were made to obtain relevant studies for the countries under study, the United States and Mexico. At this point, it was of great importance to have a well-defined terminology and key concepts. Following the preliminary search, the refining of the search strategy was done through the use of the different MeSH terms and keywords mentioned above in order to eliminate studies irrelevant to the central research question.

All articles that appeared in the searches were scrutinized against the inclusion and exclusion criteria outlined above. Titles and abstracts were screened, and only the ones that fit with the proposed criteria were downloaded as full-texts. A deadline of July 15th, 2018 was set for the retrieval of the studies. Studies that appear on MEDLINE electronic database after this date would not be included in the present review. Subsequently, after abstracts were reviewed, a full article assessment proceeded to ensure the relevance of potential studies. The later search stages were crucial for the study result analysis, as the initial search was very broad and inclusive. Eventually, a total number of 47 articles were included in the study analysis.

Stage 4: Charting the data

Charting the data - in other words, the data extraction - is the step where all the gathered information comes together. Key concepts and information from the retrieved reviews are "charted", organized and sorted, with the view of developing a structured analysis of the data.

This sorting process is conducted according to key issues and topics the analysis will focus on. After extracting data from the previously retrieved unstructured data sources which came in different formats, it has to be compiled in a structured and uniform, yet differentiable manner. The analysis will be based on the data compilation, hence the importance of a correct structure while charting the data.

The primary charting of the study was to divide the publications by country; of the 47 studies included, 39 were focused on the US and 6 were focused on Mexico. Three publications had relevant information for both countries. A summary table was implemented, where characteristics of each study that was considered relevant for the review were included. The summary system PICOS (Population, Intervention, Comparison if any, Outcomes, Study Design Type; University of Wisconsin, 2017) was used for charting. As is to be expected, not all relevant data was available for every included study.

Weighing information and deciding what to add to the summary chart from each publication was of utmost importance. The analysis, comparisons and discussion, which in turn answer the research question, are based on the extracted and summarized data. A simple or unstructured summary does not always give the reader, whether an individual, a clinician or a policy maker, the necessary information to make educated decisions. For this reason, a charted and organized summary with a descriptive analysis will appear more useful for future research or decision making. Microsoft Excel was used as the main tool for charting and summarizing the retrieved studies. Besides the PICOS summary system, other information such as author, year of publication, location and aims of the study (Arksey, H. et. al. 2005) were included. Whenever it was found relevant, other types of data like economic implications were also included.

It is important to mention that there were two articles which reported relevant information for both the United States and Mexico, but for easier charting purposes they were included only in the Mexico result chart. Charting the articles in this manner did not affect their consideration in each country analysis. The results were considered for both countries and discussed accordingly.

Thousands of bibliographic references can be generated with this type of search. These references need an assessment to see whether or not they should be included in the final study selection (Arksey, H. et. al. 2005). The bibliographic software for text retrieval used in this study was Zotero, which proved to be a very useful data management tool. It helped to keep track of the studies retrieved including publication date and journal, and also produced the list of references for the final report.

Stage 5: Collating, Summarizing and Reporting the Results

This stage of the scoping study involves the collection, comparison, examination, summarizing and reporting of the results. In contrast to a systematic review, a scoping study seeks to present all the evidence gathered during the data collection and synthesis. The purpose of this scoping study is to present an overview of all (if not all, most) environmental factors affecting obesity, not leaving any potentially relevant material out as it can be critical for decision makers. The scoping

study does not intend to present weighted evidence by giving certain studies a “more relevant” or “less relevant” status among other studies, nor is it intended to analyze the quality of the evidence, but rather report it.

The fifth stage was broken down into three different parts: analysis, reporting of the results, discussion for future research, practice and policy (Levac D., et al., 2010). The analysis part included both a numerical summary analysis and a qualitative thematic analysis. Reporting the results was done in a manner that enabled the outcomes of the study to answer the central research question. The implications of the results in different areas were considered in the discussion. An analysis of contradictory and missing evidence was also included in this latter stage.

1) The analysis section included both a qualitative analysis of the retrieved studies and, depending on the type of study, a numerical summary if necessary. To understand the nature of the selected publications, charts and graphs were generated to map the studies in various ways; geographically, population-based (male, female, black, white, Hispanic, age range, etc.), type of methodology used. This part of the analysis enabled insight into the research gaps, areas of opportunity and areas of interest within the main topic, environmental factors as a cause of obesity.

   Secondly, the literature was organized by their environmental factors. Following the ISSE Model and PESTLE analysis, studies were sorted in accordance with their content, specifically what type of environmental factor the study comprised. Accordingly, this analysis created six different main categories. Several studies fell into two or more categories; for visually explanatory purposes, a complex network diagram was selected for mapping these categories. Complex networks show connections between different environmental factors as well as the weight each term had within the review. The weight was calculated by the number of times an article was related to a specific factor. Weighing the connections and generating the diagrams was time-consuming due to the diversity of the studies compiled. The environmental factors categorization was the primary unit of analysis, and the final discussions and review report were structured according to these six categories.

2) Results reported were research question driven. All the data was examined in such a manner that would answer the central research question. Collecting data from different studies, matching, relating and comparing it to the different evidence obtained was no easy task. Even though all publications went through a thorough selection process, there was still a lot of information to be reviewed. Prioritization of data is essential for a clean and understandable review. By adopting an approach based on six categories of environmental factors, our findings lacked the ability to analyze other factors and report potential effects of other factors. It is important to mention this point as the analysis was done based on parameters chosen previous to the study selection. This might be considered a possible limitation to the applicability of the results and should be taken into consideration by the reader. In spite of the limitations of the review, the study provides a

consistent reporting of the findings. The report entails the characteristics of each study, the category(s) they belong to and whether the factor under study affects the development of obesity positively or negatively (if at all). The reporting of results, as with the analysis, is divided in two. The same analysis was made for Mexico as for the United States, although these analyses were made independently.

3) Throughout the discussion two types of comparisons were made. The first one was comparisons across the different environmental factors affecting obesity and their specific effect, if mentioned in the literature. The second comparison is across the two countries of study. The latter included the different factors and whether they affected the two different populations in the same way. By assessing the results of the studies included in the review, areas of opportunity for future research and gaps in the available literature were then identified. These results also allowed the determination of which environmental factors were essential and which were contributory to obesity development. Implications related to practice and policy were also identified, recognizing the main stakeholders who should participate and/or benefit from taking action against obesity causing factors.

Methodology Limitations

Research-wise, one of the biggest limitations of the study was that the search strategy was based only on one electronic database, MEDLINE PubMed. In not using other electronic databases, it may be that relevant articles have been missed from scientific journals which would have required a manual search. Information gathered from research organizations, institutes, universities or conferences would have been a complementary source of valuable information and insight. Electronic data is not always up-to-date, and the different sources mentioned above could balance this handicap. Additionally, the inclusion of local organizations and institutes can give the study a better structure by giving it a specific target and making it goal oriented, as they know the research areas that are lacking evidence in their field of study. Going through the selected studies' bibliographies and searching for other publications can be valuable for review papers, allowing further identification of relevant material. Due to time constraints, a proper reference list search was not conducted in this study.

Another important limitation of the present review is that it focuses only on adult obesity. During the search, hundreds of hits were publications related to childhood obesity; specifically, publications related to Mexico. Including childhood obesity in further research could give a better insight of the environment and the role it plays in obese people's life and lifestyle, including some possible factors that arise in childhood and may lead to obesity in later life. Together with analyzing publications only regarding the adult population, another limitation was encountered. The inclusion criteria specified that relevant articles included research on an adult population, but it did not differentiate between sub-populations. For example, some of the studies are divided by gender, and study women alone; others study specific indigenous populations. For this reason, it may be difficult to compare studies fully due to homogeneity between study populations.

Time period was an important criterion for the selection of publications. When a specific time period is selected for both publication date and date of the data retrieval, it limits the amount of papers that are eligible to be considered for the review. Due to this constraint on publication date, the number of articles related to Mexico were greatly reduced. The time had to be set equally for both countries so that the study could be comparable. PubMed allows the inclusion specific filters while doing the search. Besides time period, the other filter included in the search was publications that referred to human studies. Applying this filter can also leave out relevant publications, because if an author uses synonyms or other words such as people or person or men or women, then an article might be discarded by using the “human” filter.

Focusing only on English language publications when searching for articles regarding the United States and focusing on Spanish and English for articles regarding Mexico seemed a better choice than focusing only on English for both countries. Including the official language of each country in the searching process permitted the inclusion of more relevant studies, although there might be publications in other languages that were not included due to language limitations.

The type of study selection and inclusion of only research articles was done to better understand the effect of environmental factors on obesity using conclusive evidence-based research. Valuable insight might have been lost when disregarding review articles, but it was considered that original research would give more valuable information to this paper.

Whilst constructing the framework it was important to have a very broad search scope. With that in mind, it was impossible to be able to include every single environmental factor; hence why the six main levels of environmental factors were selected using the ISEE and PESTLE models. By choosing these six levels some important factors might have been left out, such as climate change and global warming. Another factor left out was work environment, as specifying the type of work would have been very time-consuming and unattainable given the time constraints on this study. It may however be that the type of occupation is an influencing factor and that omission of this limits the results. Interestingly, during the search process a large number of publications about or including gut microbiota and its relation to obesity were found. Leaving this specific factor out was a conscious decision, although it is strongly recommended for inclusion in further research. It seems to be a very complex topic and a striking breakthrough in the study of obesity and its causes.

Lastly, an important limitation of this scoping review is that it was carried out by a single researcher. Even though it was peer-reviewed, the identification, screening and selection process was done only by one person. For this reason, it is important to mention that a one-person study, such as the present review, might generate an article selection bias that can be reflected in the results.

CHAPTER III: RESULTS AND DISCUSSION

Data Charting

Table 4: Environmental Factors Affecting Obesity in Mexico and Table 5: Environmental Factors affecting Obesity in the United States, are added as supplementary materials.

Report and Analysis

The final selection consisted of a full-text assessment of screened articles (n=103), which, after screening for inclusion and exclusion criteria, led to the inclusion of 42 publications in the final review. Out of these 42 research articles, two had relevant information regarding both countries, 8 publications were specific to Mexico and 36 were specific to the United States. The studies included in the review were split into the respective countries and arranged according to the six environmental factor categories previously discussed. As can be seen in Table 6: General Characterization of Included Studies, some of the articles fell into more than one category.

Environmental Factor Characterization	Number of Studies for Mexico (Total n=8)	Percentage %	Number of Studies for the US (Total n=36)	Percentage %
Individual	2	25%	12	33%
Socioeconomic	5	63%	14	39%
Food Environment	1	13%	13	36%
Built Environment	2	25%	16	44%
Political	0	0%	0	0%
Technological	1	13%	1	3%

Table 6: General Characterization of Included Studies

Results and Findings Related to Mexico

In terms of research into environmental factors affecting obesity in Mexico, the category in which most publications fell into was *Socioeconomic*; this category included almost 63% of the publications. Environmental factors mentioned in the articles categorized as socioeconomic were education, socioeconomic status, wealth, low-income neighborhood, social disorder and food insecurity. 25% of the publications were included in the categories *Built Environment* and *Individual*. Built environment publications discussed factors such as safe pedestrian ways, safe neighborhoods and general urban planning, whilst those in the Individual category mainly encompassed cultural traditions. The categories *Food Environment* and *Technological* only had one article each, representing 13% of the publications for each category. As the review did not

find any evidence-based research on whether the political environment in the last 30 years has led to an increase of the obesity prevalence, no publications were included in the *Political* category.

Figure 2: Weighted Relation of Environmental Factors Affecting Obesity in Mexico shows in which combinations more than one environmental factor category is mentioned in a publication. This allows an overview of whether environmental factors are studied together and how they are related. In the case of the review for Mexico, built environment was investigated alongside individual factors in one study, whilst another combined it with socioeconomic factors. Socioeconomic factors were also studied together with food environment factors in one article. The size of each circle in the diagram represents the amount of studies included in that category. The larger the circle, the more studied the topic is, and thus it can be inferred these more studied topics are most relevant in terms of obesity causes in Mexico.

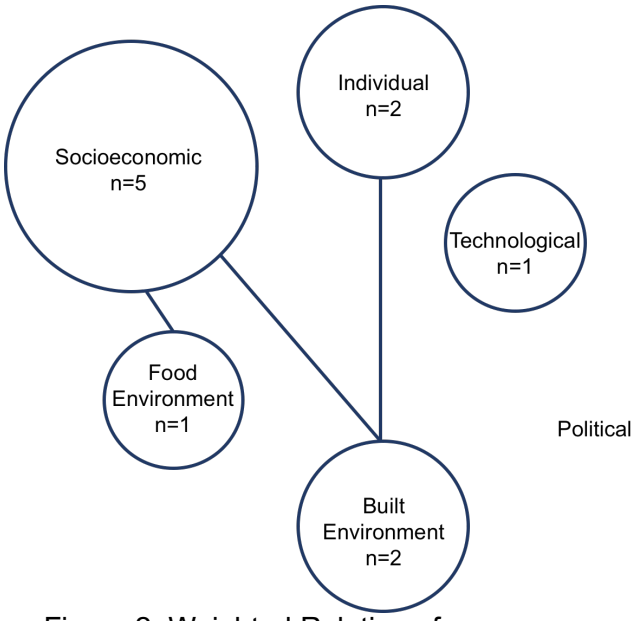

Figure 2: Weighted Relation of Environmental Factors Affecting Obesity in Mexico

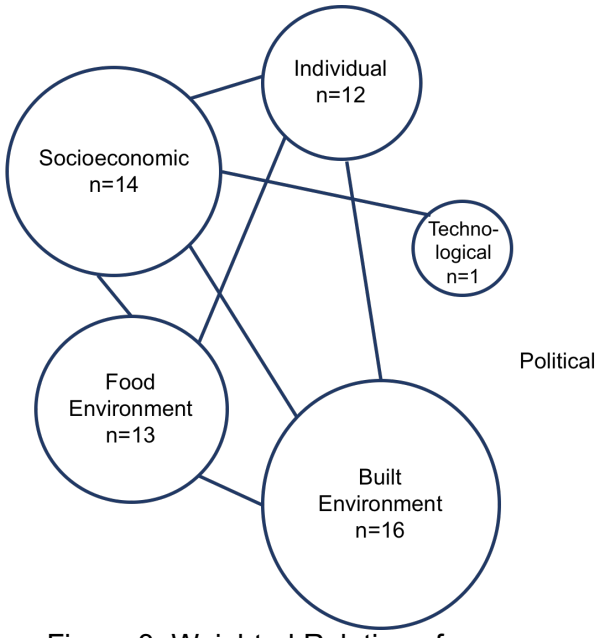

Figure 3: Weighted Relation of Environmental Factors Affecting Obesity in the United states

The two main general characteristics of the studies relating to Mexico were that all study designs were cross-sectional, and that most used national surveys as their source of data (with one exception). Due to the studies' design, all authors reported the limitations that cross-sectional studies bring with them. The majority of articles reported a main purpose or objective of examining, comparing, understanding and describing the associations and relationships between environmental factors and obesity, overweight and weight gain.

After reviewing 8 articles (see Table 4: Environmental Factors Affecting Obesity in Mexico), several main environmental factors affecting obesity in Mexico emerged. The findings suggest that perceived general safety and traffic safety have a negative relation with obesity (De

Bourdeauduij et al. 2015); the safer individuals feel, the lower the obesity rate. Proximity, defined as a close widespread and distribution of neighborhood components, was also associated with reduced obesity (De Bourdeauduij et al. 2015). In a comparison study among indigenous people, it was found that the transition from a traditional life to a modernized lifestyle with access to technology was positively associated with overweight and obesity (Esparza-Romero et al., 2015); as access to technology increased, so did obesity.

Food insecurity, low socioeconomic status, and lower education levels are also associated with obesity, particularly among women (Morales-Ruán et al 2014). Among men, education seems to have no association with obesity in urban areas; conversely, in rural areas, lower education levels were associated with increased obesity (Perez-Ferrer et al., 2018). Wealth was associated with increased obesity in men at all levels of income; amongst women, wealth is only associated with obesity after a certain threshold. This threshold considered as moderate wealth (Quezada and Lozada-Tequeanes, 2015).

Social disorder (a lack of proper facilities, graffiti and vandalized areas, insufficient street lighting etc.), was a factor in waist circumference increase but was not associated with an increase in BMI (Ortiz Hernández and Janssen, 2014). However, residing in a low-income neighborhood was found to be a predictor for obesity (Jimenez-Cruz et al. 2013). Finally, one study suggests that immigration from Mexico to the United States was positively correlated with an increase in BMI (Guendelman et al. 2013); this means that moving from one physical and cultural environment to a another may be positively associated with weight gain.

Results and Findings Related to the United States

As shown in the Table 6: General Characterization of Included Studies presented above, the environmental factors category in which most publications investigating obesity in the United States were included was *Built environment*; meaning that most publications studied the neighborhood-built environment as a factor associated with obesity. Nearly half of the studies (44%) fell within this category. Urbanization, green spaces, proximity, safety, density and street connectivity were investigated as some of the built environment factors related to obesity.
The second most relevant environmental category was *Socioeconomic*, which included 39% of the studies; in this category, the main factors included were education, income, and perception of neighborhood. The study of *Food Environment* factors was mentioned in 36% of the studies, where factors related to food deserts, type of food stores (fast food, supermarkets, specialty food shops), and food insecurity were assessed in relation to obesity.

One third of the literature (33%) consisted of publications relevant to the *Individual* category. This category was very complex, as several individual factors such as ethnicity, race, immigration status and gender were interacting in their relation to obesity. The multicultural nature of the United States was reflected in the variations in results within this category. Only one article,

representing 3% of the publications, studied the implications of the use of *Technological* devices or programs and their relationship with obesity. The political category, just as in the analysis for Mexico, was not relevant for any of the included articles, indicating that there has been no interest in studying the political environment in relation to increased obesity in the United States.

Figure 3: Weighted Relation of Environmental Factors Affecting Obesity in the United States again shows the relationship between different environmental factor categories studied together within publications. In terms of publications related to the United States, built environment factors were studied together with individual factors in four studies, with socioeconomic factors in three studies, and with food environment in two studies. Socioeconomic factors were studied together with food environment factors and individual factors four times respectively, and with technological factors once. Finally, individual factors were studied together with food environment factors in one publication. The size of each circle in the diagram represents the amount of studies included in each category. The larger the circle, the more relevant the factor is perceived to be in terms of relationship with obesity in the United States.

General characteristics of the studies analyzed for the United States include that most studies (89%) were cross-sectional analysis studies, with the rest comprising modeling simulations, longitudinal studies and cohort studies. All studies utilized national or regional surveys. All of the cross-sectional studies reported the common limitations inherent in these types of study. Study authors reported that a main purpose or objective for the majority of articles was to examine, compare, understand and describe the associations and relationship of environmental factors with obesity and overweight; an additional objective was to evaluate possible interventions and scenarios that might affect weight loss or gain.

After reviewing 36 articles (Table 5: Environmental Factors affecting Obesity in the United States), different environmental factors affecting obesity emerged within the reviewed studies. Findings related to built environment showed that obesity prevalence in the United States is inversely associated with elevation and urbanization (Voss et al., 2013), after adjusting for individual and demographic factors. This means that the prevalence of obesity decreased with increasing urbanization. There is an association between green space and physical activity, where increased availability of green space has a beneficial effect on the level of physical activity (Villeneuve et al., 2018); furthermore, neighborhoods with more green spaces also tended to have a smaller number of obese individuals. Availability of recreational spaces made individuals more likely to be physically active and to maintain activity as they aged (Jones et al., 2015). Even the perception of having available open spaces and belonging to associations or groups was negatively associated with obesity (Sullivan et al., 2014). Positive changes in neighborhoods that were previously considered “bad” were associated with reduction of BMI in obese patients (Barrientos-Gutierrez et al., 2017). On the one hand, unfavorable perceptions of the physical environment were associated with an increased likelihood of prevalent obesity (Powell-Wiley et al., 2013); on the other, perceived aesthetics of the neighborhood environment, and perceived higher property values, were associated with lower BMI (Drewnowski et al., 2014). These factors, along with access to safe recreational areas (De Bourdeauduij et al., 2015), appear to play a key role. The

literature also suggested that the place where people live is more strongly associated with changes in BMI than with their household income (Oka et al., 2013).

In terms of traffic factors, long commutes and distances and automobile dependency was associated with an increased obesity risk in urbanized areas, but not in rural areas (Zhang et al., 2014). Longer neighborhood commuting time and poor perceived traffic safety were associated with an increased obesity risk. Demographic factors such as density and proximity showed a slow increase or reduction of BMI (Barrientos-Gutierrez et al., 2017) (De Bourdeauduij et al., 2015) (Congdon, 2017), in parallel with changes in variables such as a good urban design and infrastructure (Gittner et al., 2017). Among the built environment variables, a poorer street connectivity and a more prominent presence of fast-food restaurants were associated with a higher obesity risk (Xu and Wang, 2015).

When considering food environment factors, study findings were not homogenous and some were also inconclusive. Neighborhood food environment factors, such as food desert status, were associated with obesity (Chen et al., 2016). The obesity rate increased when considering supercenters and convenience stores, but decreased in grocery stores and specialized food stores (Yan et al., 2015). Areas of comparatively higher socioeconomic status tend to have greater access to grocery stores, and in line with this, residents of these areas show significantly decreased BMI levels and lower odds of developing obesity (Frankfeld et al., 2015). Another study shows that primary food stores, particularly supermarkets, are associated with healthy eating but not with BMI (Jilcott Pitts et al., 2016).

An analysis conducted in Los Angeles county suggested that the food environment within walkable distance is not related to overweight, fruit and vegetable consumption, sugar-sweetened beverage consumption, or fast-food intake (Mejia et al., 2015). However, other findings suggest that people living in neighborhoods with a higher density of fast-food outlets and storefronts are more likely to be obese (Pruchno et al., 2014). The literature pointed out that adults living in cities with a large share of supermarket and full-service restaurant workers are less likely to be obese, while those living in cities with a large share of convenience stores and fast-food restaurant workers are more likely to be obese (Michimi and Wimberly, 2015). This exposure to fast food has an effect on obesity rates in both sexes (Congdon, 2017).

Neighborhood economic hardship is associated with an unfavorable retail food environment (Singleton et al., 2016), although there were no consistent associations between characteristics of the retail food environment and obesity prevalence (Laxy et al., 2015). Nevertheless, changes in the food environment and the perception of a better food environment increased individuals' consumption of fruits and vegetables (Gase et al., 2016). Food insecurity is positively associated with obesity, mostly among females (Congdon, 2017). A very bold finding and statement from one study was that dietary food choice based on price per calorie best matches actual consumption patterns, and thus may be the most salient price metric for low-income populations (Beheshi et al., 2016). This statement addresses the problem of fast-food and its abuse in consumption. If people follow a price-per-calorie pattern they will choose fast-food, high caloric foods that contain

added sugars and fat, which are cheaper by the calorie but not always cheaper by serving (Rao M., et al., 2013).

Individual environmental factors such as race, ethnicity and gender are highly associated with obesity prevalence. One study found that living in high-density black neighborhoods can be a significant predictor of the risk of obesity (Li et al., 2014). According to another study, the strongest predictor of obesity was the length of residency in mainland US; immigration to the United States is associated with increased BMI, although acculturation was not significantly associated with obesity (Isasi et al., 2015). Among women, having an undocumented status increased the risk of obesity and overweight; the opposite was true for men (Wen and Maloney, 2014).

A study analyzing the relationship between obesity and depression found that African Americans were more likely than non-Hispanic Whites and Caribbean Blacks to be overweight or obese even when depression is not present (Lincoln et al., 2014). It was mentioned that black race individuals and low socioeconomic status, who are continually confronted with stressful conditions, are more likely to engage in unhealthy behaviors. The study overall, however, concluded that there is an increased risk of obesity for depressed people regardless of race (Lincoln et al., 2014).

There were some interesting findings related to income; the relationship between high income and obesity was negative for women but had a more complex relationship for men. Here, a U pattern was observed, meaning that both low income and high income increased the odds of obesity in men. Black men were an exception; these individuals were more likely to be obese in the highest income bracket but not in the lowest (Ogden et al., 2017). Related to income, education level had a negative association with obesity; those with college education or higher had a significant increase in obesity risk (Sddiqi et al., 2015).

Neighborhood poverty and perceived discrimination were both associated with an increase in central adiposity over time; this was more significant in top quartiles compared to lower ones (Kwarteng et al., 2016). In married couples, the husband's education was associated with lower odds of obesity for both him and his wife; furthermore, never-working women's husbands had lower odds of obesity than employed women's husbands (Chen et al., 2014).

Another expected outcome was that low socioeconomic status was a strong risk factor for obesity. Lower SES, lower education, lower income, lower surrounding property values, and shopping at lower-cost stores were all associated with a higher obesity risk (Drewnowski et al., 2014) (Sddiqi et al., 2015). Obesity was positively associated with unemployment, outpatient healthcare visits, physical inactivity, female-headed families, black populations, and lower education (Congdon, 2017) (Slack et al., 2014). Obesity was negatively associated with physician numbers, natural amenities, and a larger population size (Slack et al., 2014).

The usage of ICT-based health resources was found to be useful for people in high-poverty urban communities with obesity prevalence; this is a population that is at high risk for poor health outcomes.

Discussion

A comparative analysis of two neighboring countries

After a thorough review of the literature available, there were very few articles comparing the effects of several environmental factors at once on obesity prevalence in different countries. None of the articles included in this review presented relevant evidence-based findings on the effects of environmental factors whilst comparing the two countries focused on in this study, Mexico and the United States, despite their proximity. According to the Organization for Economic Cooperation and Development, the United States and Mexico are the leading countries in both obesity prevalence and income inequality (Su D., et al., 2012). Following the analysis of this scoping review's results, it can be furthered that inequalities are associated with an increase in obesity prevalence. As of July 2018, according to World Bank data, Mexico and the US are in the top ten most populated countries. Together they represent 6% of the total world population, which means that if there is a reduction or increase in the prevalence of obesity within these countries, these changes will significantly affect the worldwide prevalence of the disease. According to the World Bank (2018), both countries are within the top fifteen economies in the world. Moreover, if health is wealth, economic and political considerations should be made regarding the productivity of the population. Analyses on how environmental factors affect the obesity epidemic in Mexico and the United States are relevant for local communities and policymakers due to several reasons besides this; for example, cultural homogeneity in the United States might give an insight into how the community, the built environment configuration, and the individual factors such as race and ethnicity and cultural influence populations towards a higher (or lower) obesity prevalence. Mexico, on the other hand, might give an insight into how culture, including traditions and food, and socioeconomic inequalities affect the prevalence of the disease. Rich cultural traditions and high levels of inequality are characteristics of all Latin American countries, including Mexico. Analyzing the effect these specific characteristics have on obesity in the second largest Latin American country can help develop a better understanding of the progression of the disease and open doors for the implementation of policies on the regional level.

Although the United States and Mexico are far from similar with regards to population, size, demographics, culture and ethnicity, it is important to study their cultural, human, economic and political relationships, as they share a 3,145 km border. Everyday activities in Mexico and the United States are dependent on immigration, trade and cultural influences. In this review, the relevance of the dynamic between environmental factors and obesity within these two countries was assessed and the countries were compared on the strength of each factor's influence.

The results showed several similarities in terms of how environmental factors influence obesity patterns in Mexicans and Americans. Differences were not found; one main reason for this is that there was not enough evidence from studies relating to Mexico. Socioeconomic characteristics was the main driver of obesity prevalence in both countries; low income and low education were both directly associated with obesity. Wealth was also related to a person's risk of obesity, although this displayed different patterns depending on gender and economic status. For

example, men in both Mexico and the United States that were in the higher wealth category were at a higher risk of obesity, whereas among American and Mexican women wealth is only associated with obesity after a certain threshold. This threshold was identified as moderate wealth, meaning that if a relatively wealthy woman increases her wealth it also increases her risk of obesity. Characteristics related to neighborhood and the build environment were also associated with obesity prevalence. Similarly, living in low-income neighborhoods in both countries or black neighborhoods in the United States (usually perishing neighborhoods) was associated with increased obesity. In the recent years there has been a boom in urbanization; approximately 54% of the world's population now lives in urban areas (United Nations, 2014). The movement of countries towards the creation of urbanicities has been accompanied by greater pockets of poverty within these cities and in the countries overall, creating a risk factor for obesity.

A safe neighborhood, or even one that is merely perceived as safe, along with proper infrastructure, reduced the risk of obesity in both countries. The availability of green spaces around the neighborhoods also reduces the risk of obesity in its inhabitants. Both countries also appeared to have an association between proximity, defined as the closeness of neighborhood components such as school, supermarket, pharmacy, parks, and residential areas, and a reduced risk of obesity; one benefit of proximity is that it results in a reduced dependence on vehicles.

A fascinating finding was that there was a direct increase in the risk of obesity if an individual immigrated from Mexico to the United States; this implies that changing the environment in which one lives does have an effect on obesity. Unfortunately, there was no available data to review the opposite case (immigration from the United States to Mexico), although it would have been interesting to have this comparison and it is an area that could be included in future research. The studies also found that having an undocumented immigration status (e.g. undocumented immigrants in the United States) had an opposite effect in men and women, reducing and increasing the risk of obesity respectively.

This review does not allow comparison of food environments between the United States and Mexico, as there is no available evidence on the role food environment plays in Mexico. It is a pity that a country famous for its culinary richness, which happens to be in the top rankings of obese countries, does not have enough research to understand the effects of food and food environment in the increased prevalence of obesity. In the United States, inconclusive information was found on these factors; in some studies, the availability and closeness of fast food shops were related to an increased risk of obesity, but in other studies there was no significant relationship. Nevertheless, the availability of healthy foods, supermarkets and specialty food stores were related to a reduced risk of obesity. A study conducted by Xu X., et al. (2014), retrieving data from 1976 until 2001, studies how the reduction in food prices during this period of time could plausibly explain about 18% of the increase in obesity among the United States; this implies that it is not only the availability of food but also the accessibility that is a factor directly related to the development of the obesity epidemic. Whilst the findings of this study are not conclusive, it is still important that work is done to improve food environments by eliminating food deserts and making healthy foods available.

Technological environmental factors were also not found to have a significant effect on obesity, but it is good to mention that the digitalization of marketing might have an effect on the way individuals look at food and food environments. Food environments are related to food perception and to food marketing. There are mechanisms that facilitate automatic and unconscious eating, which are a critical link in the chain of causation between the environment and behavior (Sato W., et al., 2016).
Automatic and unconscious behaviors are triggered in the real or perceived environments. The digital age has altered the way the consumer looks at products and services, as they are always online. Due to the shift in customer behavior, it is easier to hit a target audience with advertisements that do not look like advertisements. Marketing channels have shifted from television, radio and large billboards to online ads (Forbes, 2016). This means that the consumers are faced with advertisements about food not only when they see a restaurant ad, but also when the person they follow on social media platforms is eating. Two recent terms have been identified in the food culture: "*Foodies"*, who are food celebrities, and "*comfort food*", which is food giving some type of emotional gratification (AECOSAN, 2008). In summary, food environments and food marketing may be part of the explanation of why individuals eat more than they need to. Although there were no conclusive results on the relation between food environment and technology influence in the present review, it is nevertheless important to create awareness and formulate specific strategies to halt the corporate interests directly implicated in these trends.

The inclusion of political environmental factors in this review aimed to assess the amount of research into political associations of both countries and the similarities in obesity prevalence. Although there is no evidence in the literature relating to the political environment in which the obesity epidemic developed, it is pertinent to mention how the United States and Mexico are closely related politically. In 1994, the North American Free Trade Agreement (NAFTA) came into effect. It marked the creation of one of the largest free trade zones worldwide and laid the foundations for strong economic growth and rising prosperity for Canada, the United States, and Mexico (NAFTA, 2012). NAFTA has helped increase wealth and competitiveness but might also have opened doors for these three countries to share their vices. NAFTA increased trade of all goods including foods, promoted immigration and offered business and investment opportunities. In future research, it would be interesting to study how the free trade with the United States affected the food environment in Mexico and vice versa.

The literature review presents evidence that the obesity epidemic and the increased risk of obesity is multifactorial. It suggests the necessity of a broader view of the causalities of obesity and focuses on determinant environmental factors, rather than a lifestyle, as the specific causes of modern chronic disease (Egger G., et al., 2014).

Previously, it was mentioned that genetics and health play an important role; that obese and overweight phenotypes are the representation of a predisposed obese genotype, and that several endocrine disorders might affect an individual's body weight. However, when talking about populations and not individuals, there are essential and contributory non-genetic factors to this epidemic. These essential factors are the "simple math" factors; namely, that excess calorie intake and insufficient calorie expenditure due to inactivity results in an overall caloric surplus.

Contributory factors are comprised of all the external factors that provide environments and generate situations in which one would behave in a specific way leading to weight gain, e.g. a sedentary lifestyle, eating high-caloric foods, and drinking insufficient water, among others. Fundamentally, all the environmental factors encountered and mentioned in this review are considered contributory factors, as all of them provide settings in which individuals change and adopt certain behaviors, whether they choose to willingly or not.

Policy and Public Health Implications

It could be stated that obesity is one of the most relevant issues for public health. Since the 1980's, the WHO estimates that obesity has reached global epidemic status. Regardless of the country's economic status, or whether it is a developed or developing country, it can be assumed that obesity is present in its population. There is a high prevalence of obesity in developed countries, but there is also a high prevalence in low- and middle-income countries, where sometimes malnutrition and obesity coexist (Gonzalez A., 2017). These countries are facing the double burden of malnourishment and obesity.

Given that most people nowadays are overweight or obese, and that obesity is no longer a single sub-group disease but exists across rich and poor countries, across minority and majority populations and across low educated and high educated people, it should be considered that unhealthy food choices (in both quality and quantity) and physical inactivity may not be the result of conscious behavior. To the contrary, they are probably the result of automatic and uncontrolled responses to unappreciated environmental factors. This is one of the reasons why it is important to tackle obesity from a social public health perspective and not solely as an individual responsibility. Unlike communicable diseases, non-communicable diseases lack a specific organism or actor that promotes an outbreak and generates an epidemic. Even though obesity is an epidemic, there is not a simple solution such as vaccination or quarantine, making it harder to solve the chronic disease problem.

In the last few years, the OECD countries have set new policies to achieve obesity and overweight reduction among their populations. There is no adequate policy or one-size-fits-all regulation, and countries have used different approaches and diverse policies to tackle the rise of overweight and obesity. Policies such as fiscal measures, school and work interventions, interventions in the primary care setting, reformulation of products, changes in portion sizes, and transport policies (OECD, 2017) have been widely implemented.
Assessment and constant evaluation of the results of implemented policies and strategies should be made in order to follow up the return of the invested resources. Social gains and economic benefits derived from a single policy should be considered when the impact is analyzed as an integral package of policies (WHO- HELI, n.d.); this would relate not only to individual performance at work or school and equal opportunities in the job market, but also to the long term economic social gain of a more productive and less impaired society, as well as to the direct impact on overall health costs of diseases associated with being overweight or obese.

Resources are not infinite, and for decision makers the usage of limited resources when addressing public health approaches is a struggle. Therefore, an economic impact evaluation is vital to understand and respond to policy impacts; an evaluation allows the calculation and valuation of potential costs and anticipated benefits of a given policy, regulation or program (WHO- HELI, n.d.). Previous assessments as well as further analysis allow others to estimate costs and, if relevant, the returns. For example, a 2008 study by the Urban Institute, The New York Academy of Medicine and TFAH found that an investment of $10 USD per person in proven community-based programs to increase physical activity, improve nutrition and prevent smoking and other tobacco use could save the country [the United States] more than $16 billion USD annually within five years. That's a return of $5.60 USD for every $1 USD invested (Trust for Americas Health, 2008). Evaluations such as this one might help stakeholders and decision makers in the planning and structuring of new policies, including those related to obesity and overweight reduction.

In Mexico, health policies focused on preventing overweight and obesity are gaining popularity in the public and private sector. The Ministry of Health implemented a national policy for obesity prevention, and now it became the National Strategy for Prevention and Control of Overweight, Obesity and Diabetes (Martinez-Andrarde G., et al., 2014). Fiscal policies have also gained considerable attention in recent years, including the taxation of highly caloric or sugar added foods and beverages. Mexico has already implemented fiscal policies to tackle obesity, with a special focus on the reduction of childhood obesity. In September 2013, an excise tax on sugar sweetened beverages and a sales tax on several highly energy dense foods were passed by the Congress and came into effect on 1 January 2014 (Colchero A., et al., 2016). Compared to expected purchases, by December 2014 the average reduction of purchases of taxed beverages reached 17.4% (Colchero A., et al., 2016). Along the same line, not only taxation but subsidies for healthier choices might also promote behaviors favorable to the reduction of obesity. A systematic review on built environment policy changes suggests policies related to built environmental interventions, such as improvements in active transportation infrastructure, bans or restriction on unhealthy foods, can increase certain types of physical activity and improve the diet (Mayne S., et al., 2015).

Increased body mass, overweight and obesity are likely to overtake tobacco as the leading modifiable cause of disease burden as smoking rates decline (Australian Health Department, 2009). It has been proved that policy implementations in public health are able to affect behavior. One of the best and most recent examples not in the field of obesity is the implementation of restrictive policies regarding smoking and access to tobacco in general. Cigarette use in the United States has significantly declined since the 1960's, as have rates of lung cancer, due to various tobacco control policies that have made smoking less affordable, less convenient, and less socially acceptable (Paoletti L., et al., 2012).

Proposed Suggestions

Obesity has developed in both micro- and macro-environments. Micro-environments are usually controlled by the individual and represent close contact familial environments. Macro-environments are more complex as they have different levels of interactions, from communities, to regions, to nations. Policy implementation and public health approaches must consider the environment in which obesity continues to develop. Strategies should include targeting both micro-environments, such as through healthy cook-books and personal and family physical activities, and macro-environments, through interventions like fiscal policies.
The following, specific guidelines to tackle obesity are proposed, based on the results of this scoping review and considering policy implementations for both Mexico and the United States.

1. To increase fiscal policies which aim to restrict the consumption of added sugars and highly-caloric foods.

2. To increase policies and implement plans of action designed to better eating habits and improve physical activities in the population. Policies must be integral, involve all age groups, minorities and different ethnicities, be sustainable with short- and long-term goals and promote active participation from the whole population.

3. To increase prevention programs that sensitize and inform the population about the positive impacts that healthy eating habits and regular physical activity have on their health.

4. To improve urban design policies making it obligatory to include safe pedestrian and bike lanes as well as green environments and recreational spaces in city planning, thus indirectly promoting physical activity.

5. To sensitize and educate healthcare professionals on obesity, in order to improve the systematic detection of obesity and follow the necessary course of action required to reduce/eliminate the disease.

Besides these five proposed actions, the results in the present review also suggest that improving overall education and impoverished neighborhood infrastructure will have a direct effect on the reduction of obesity. While creating and implementing policies, it is also important to consider that not all external factors and man-made environments have the same effect on all people. However, the identification of factors that have negative health effects and a deeper understanding of how the influence of these factors vary according to individual characteristics is relevant for policy creation and implementation.

Favorable conditions have to be created in order to have effective legal and civil society institutions and frameworks to support policy implementation. Further analysis of the impacts of obesity and comorbidities will require economic evaluations that map the advantages and disadvantages inherent to the new policies and proposed solution alternatives. Outcome measures should be very specific, as the impact of social policies on health and on human well-

being is not always easily quantifiable and specification of these allows for transparent research and easy comparability between studies (WHO- HELI, n.d.).

Lastly, it is important to mention that obesity occurs in some people in a way that is insidious and undetectable. An imbalance as low as 20 excess calories per day will cause the average person to gain about one kilogram per year (Cohen D., 2008). This makes understanding the environment in which obesity develops of utmost importance to decision makers, in order for them to implement and design suitable policies and strategies to fight against obesity whilst conscious that decisions made by the individuals are shaped by their communities, families and the environment.

Limitations of the Scoping Review

As previously mentioned, the main methodology limitations of this scoping study are the time period, research type, the number of electronic databases used, and the focus on only adult obesity.

Another limitation encountered during the review was that the results obtained are not homogenous and were very complicated to chart and thus compare. The different types of studies and the variations in populations used in each study (differences in gender, age groups, sample numbers, region, etc.) made the analysis harder. Although a PICOS method was originally intended for use when charting results, some of the categories did not fit for this review, in particular the *intervention* category. This review focused on effects of environmental factors on obesity itself and not on the effects interventions had on environmental factors, making the charting of results using this method confusing and resulting in the removal of the intervention column from the chart. The category *comparison* was also not used, as many population studies compared results from every ethnic group and gender and even age groups. If the given comparisons were between the United States and Mexico that column would have been relevant but there was no specific comparison between these two countries in any of the articles. Due to time constraints and to simplify the charting this category was therefore not included. As articles differed in population and age ranges, the most relevant findings were stated as per group analyzed and were not standardized.

It is important to mention that obesity results are measured on the population level and not the individual level. As has been mentioned before, obesity can be caused by several factors including drugs and genetic factors; these factors would have important considerations on an individual level, but in a population that is statistically adjusted for different variables, only the ones that are being studied are those that reflect an effect on obesity in the reviewed studies.

Consultation, the sixth stage of the methodology framework, was not performed in this study. Clearly, consultation in any publication or project can play an important role. Insights gained from consultation are different from those gained from the literature, which makes this step extremely valuable. Consulting allows the study to move forward, offering assistance, skills and intelligence during the planning, development, and implementation stages and even with technical issues.

Consultants are any in-house experts that can help identify issues or changes that should be made to improve the quality and validity of the research. Beyond academics, consultation encompasses all stakeholders that are involved or are somehow associated with the key areas of the review. For this review, consultations would have had been with healthcare specialists such as nutritionists, psychologists and bariatric surgeons. The identification of research gaps in our study relied on identifying areas of overall weakness within the field by comparing across mentioned environmental factors not in the selected literature. The consultation exercise could have disclosed other relevant research gaps within this review.

Time constraints and study design made it impossible to include consultations in this study. However, including stakeholders such as clinicians, psychologists, policy makers, urban developers and designers, health ministry personnel and fellow academics would help to validate and enhance findings. Their involvement and contribution from the outset of the study, a goal oriented planification, and an assisted data collection would mean that results were of a higher quality and more relevant to the area and current opinions.

Further studies

Focusing on adult obesity was considered a limitation due to the amount of research available on childhood obesity. Whilst conducting the systematic article screening and selection, there were a large number of articles that had to be discarded due to their assessment of environmental factors affecting childhood obesity. Childhood obesity, then, is an area of opportunity for future research and may provide further support for the findings in this review.

Although this study aimed to study the relationship between obesity and the external environment, the natural environment was not considered. The reason is in part due to the second objective of the study, which was to propose strategies and policies that could be implemented based on the findings. The impact of the natural environment on obesity can be assessed, but it might not be possible to influence it. Variables such as elevation and weather might have an effect on the prevalence of obesity, but changing these variables through policies would be nearly impossible. With this said, obesity and its relationship with the natural environment is another area of opportunities for future research. On the other hand, the environmental impact of obesity can also be studied. David L. Katz in his article “The Mass of Humanity and the Weight of the World: Obesity and the Environment at a Confluence of Causes” proposes very interesting findings on how obesity has an effect on the environment.

CHAPTER IV: CONCLUSIONS

The obesity epidemic started rapidly spreading amongst a large number of people in different populations. Today, the breadth of the area it stretches over is wider, it is global. It affects millions of people worldwide and together with other NCD's, obesity is associated with high mortality rates driven by comorbidities such as type 2 diabetes mellitus, cardiovascular disease and some types of cancer (Abdelaal M., et al., 2017). Thus, prevention of obesity should be a priority in public health. The high prevalence of obesity in Mexico and the United States calls for action due to the amount of people affected by this disease in these countries. With the data obtained from this review it can be concluded that there are environmental factors that affect similarly both Mexican and American populations. Socioeconomic and built environment characteristics being the main drivers of obesity in both countries, according to the data available for this review. Relevant differences were not encountered as there was not enough evidence.

The increase in obesity is not a consequence of individual desire to gain weight; societal, environmental and cultural conditions have all contributed to the rise of obesity. Combating the obesity epidemic demands environmental, public health and social policy changes, particularly in the areas of education, neighborhood infrastructure, availability of healthy foods and promotion of physical activity. This requires formulation and coordination of efficient wide-reaching multi-sectorial strategies and policies to promote healthy behaviors and lower the risk of obesity at a local, regional and national level. Recommendations include that future literature research involve consultation with stakeholders such as policy makers, clinicians and the community throughout the entire research process. Further research is needed to expand and sustain the findings of the present scoping review.

CHAPTER V: REFERENCES AND ANNEXES

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Annexes

Annex 1: Overweight and Obesity Coding ICD-10-CM

ICD-10 CODE	DISORDER
E00-E89	Endocrine, nutritional and metabolic diseases
E65-E68	Overweight, obesity and other hyperalimentation
E66	Overweight and obesity
E66.0	Obesity due to excess calories
E66.01	Morbid (severe) obesity due to excess calories
E66.09	Other obesity due to excess calories
E66.1	Drug-induced obesity
E66.2	Morbid (severe) obesity with alveolar hypoventilation
E66.3	Overweight
E66.8	Other obesity
E66.9	Obesity, unspecified

Annex 2: Obesity and Environment MeSH Terms Through the Years

PubMed search "obesity"		PubMed search "obesity" "US"		PubMed search "obesity" "Mexico"		PubMed search "environment"		PubMed search "environment" "US"		PubMed search "obesity" "environment" "Mexico"	
year	count	year	count	year	count	year	count	year	count	year	count
2018	13726	2018	472	2018	227	2018	654	2018	40	2018	14
2017	21197	2017	653	2017	358	2017	1402	2017	70	2017	30
2016	21459	2016	689	2016	355	2016	1481	2016	64	2016	23
2015	20815	2015	639	2015	343	2015	1374	2015	76	2015	29
2014	19886	2014	618	2014	291	2014	1250	2014	57	2014	18
2013	18302	2013	604	2013	221	2013	882	2013	44	2013	14
2012	15900	2012	439	2012	169	2012	776	2012	37	2012	12
2011	14179	2011	393	2011	141	2011	681	2011	34	2011	11
2010	13150	2010	446	2010	137	2010	561	2010	25	2010	6
2009	11731	2009	343	2009	104	2009	551	2009	24	2009	4
2008	10954	2008	319	2008	115	2008	434	2008	26	2008	5
2007	10052	2007	275	2007	102	2007	383	2007	15	2007	1
2006	8899	2006	263	2006	91	2006	337	2006	24	2006	4
2005	7874	2005	241	2005	76	2005	290	2005	12	2005	3
2004	6940	2004	216	2004	72	2004	229	2004	8	2004	5
2003	5670	2003	152	2003	72	2003	186	2003	10	2003	3
2002	4924	2002	110	2002	42	2002	138	2002	5	2002	1
2001	4325	2001	114	2001	37	2001	144	2001	7	2001	1
2000	3842	2000	106	2000	37	2000	107	2000	1	2000	1
1999	3397	1999	79	1999	38	1999	104	1999	3	1999	1
1998	3120	1998	66	1998	36	1998	79	1998	2	1998	3
1997	2752	1997	50	1997	21	1997	52	1997	1	1997	1
1996	2483	1996	44	1996	28	1996	52	1996	2		
1995	2305	1995	44	1995	15	1995	44			1995	2
1994	1915	1994	21	1994	13	1994	44			1994	1
1993	1990	1993	28	1993	12	1993	44			1993	1
1992	1917	1992	33	1992	22	1992	34	1992	1	1992	1
1991	1738	1991	27	1991	26	1991	49	1991	2	1991	2
1990	1704	1990	18	1990	23	1990	50	1990	1	1990	1
1989	1537	1989	18	1989	12	1989	36	1989	1	1989	1
1988	1510	1988	18	1988	10	1988	37				
1987	1381	1987	7	1987	7	1987	24				
1986	1387	1986	15	1986	7	1986	45				
1985	1375	1985	17	1985	8	1985	46	1985	1		
1984	1320	1984	9	1984	8	1984	42				
1983	1276	1983	12	1983	2	1983	37	1983	2		
1982	1331	1982	5	1982	3	1982	36				
1981	1246	1981	9	1981	2	1981	29				

PubMed search "obesity"		PubMed search "obesity""US"		PubMed search "obesity" "Mexico"		PubMed search "environment"		PubMed search "environment" "US"		PubMed search "obesity" "environment" "Mexico"	
year	count	year	count	year	count	year	count	year	count	year	count
1980	1230	1980	13	1980	3	1980	34				
1979	1212	1979	2	1979	3	1979	23				
1978	1148	1978	3	1978	3	1978	27				
1977	1142	1977	3	1977	3	1977	24	1977	1		
1976	1103	1976	5	1976	1	1976	27				
1975	1096	1975	9	1975	2	1975	35			1975	1
1974	1028	1974	2			1974	29				
1973	970	1973	1	1973	3	1973	17			1973	2
1972	910			1972	2	1972	30				
1971	870					1971	13				
1970	773					1970	10				
1969	790					1969	8				
1968	813			1968	1	1968	23				
1967	622			1967	3	1967	11				
1966	487					1966	4				
1965	515					1965	5				
1964	560			1964	1	1964	16				
1963	408			1963	2	1963	3				
1962	273					1962	6				
1961	226					1961	6				
1960	198					1960	4				
1959	184										
1958	192										
1957	230					1957	2				
1956	199					1956	2				
1955	185										
1954	156										
1953	192	1953	1			1953	2				
1952	169										
1951	129					1951	1				
1950	93					1950	1				
1949	75										
1948	55					1948	1				
1947	55										
1946	53										
1945	10										
1943	1										
1942	1										

PubMed search "obesity"		PubMed search "obesity""US"		PubMed search "obesity" "Mexico"		PubMed search "environment"		PubMed search "environment" "US"		PubMed search "obesity" "environment" "Mexico"	
year	count	year	count	year	count	year	count	year	count	year	count
1941	2	1941	1								
1940	1										
1938	4										
1936	7										
1935	4										
1934	6										
1933	1										
1932	8										
1931	2										
1930	3										
1929	4										
1928	5										
1927	4										
1926	2										
1924	2										
1923	1										
1922	5										
1921	2										
1915	3										
1914	1										
1913	1										
1911	2										
1910	1										
1908	2										
1907	3										
1904	1										
1903	1										
1902	1										
1901	2										
1898	1										
1896	1										
1892	1										
1891	2										
1890	1										
1889	1										
1885	1										
1880	1										

Supplementary Materials

Table 4: Environmental Factors Affecting Obesity in Mexico

#	TITLE	AUTHOR	YEAR	CHARACTERI-ZATION	AIM	POPULATION (SAMPLE)	n=	OUTCOMES	STUDY DESIGN TYPE	DEFINITION AREA	RESULTS
1	International study of percieved neighborhood environmental attributes and body mass index: IPEN Adult Study in 12 countries	De Bourdeauduij et al.	2015	built environment/ individual	To examine associations between perceived neighbourhood built environmental attributes and BMI/weight status in a multi-country study	Adults aged 18–66 years	n = 14222	Safety (traffic and overall), proximity and their relation to Obesity and overweight	Multi-site cross-sectional study	Regional: Australia(Adelaide), Belgium (Ghent), Brazil(Curitiba), China(Hong Kong), Colombia(Bogota), Czech Republic (Olomouc, Hradec Kralove), Denmark (Aarhus), Mexico(Cuernavaca), New Zealand(North Shore, Waitakere, Wellington, Christchurch), Spain(Pamplona), the UK (Stoke-on-Trent) and USA(Seattle, Baltimore).	Three environmental attributes were associated with BMI or weight status in pooled data: Safety from traffic was the most robust correlate. Close proximity to several destinations was associated with lower BMI across all countries, and safety from crime, perceived crime safety was related to lower BMI. After adjusting for environmental predictors and socio-demographic covariates, Cuernavaca (Mexico) had the highest prevalence of overweight/obesity
2	Environmentally driven increases in Type 2 diabetes and obesity in Pima indians and Non-Pimas in Mexico over a 15-year period: The Mayacoba Proyect	Esparza-Romero et al.	2015	technological	To compare the prevalences of type 2 diabetes and obesity in Mexican Pima Indians, whith presumed genetic predisposition to these diseases, to those in their non-Pima neighbors, both of whom over a 15-year period experienced a transition in lifestyle	Mexican Pimas and non-Pima Mexicans adults aged 20+ years	n = 359 n = 251	Obesity prevalence and diabetes prevalence	Cross-sectional study	Regional: Mayacoba Region, Sonora, Mexico	During this 15-year period, age-adjusted prevalence of obesity increased significantly in all groups (6.6 vs. 15.7% in Pima men; 8.5 vs. 20.5% in non-Pima men; 18.9. vs 36.3% in Pima women; 29.5 vs. 42.9% in non-Pima women). Prevalence of obesity increased among Pimas and non-Pimas of both sexes.
3	La inseguridad alimentaria está asociada con obesidad en mujeres adultas de México	Morales-Ruán et al	2014	socioeconomic	To describe the association of food insecurity (FI) and obesity in adults in Mexico.	Adults aged 20–59 years	n=29 344	Levels of food insecurity and low socioeconomic status	Cross-sectional study	National: Mexico	70.6% of the population had some level of food insecurity, 42.6% mild insecurity, 17.7% moderate insecurity and 10.3% severe insecurity. Adults with mild FI had higher probability of obesity (OR: 1.66; 95%CI 1.11-2.50). Women were slightly more likely to be obese (OR: 1.78; 95%CI 1.01-3.12). Prevalence of obesity is affected by food insecurity in both, men and women, although it is more common in women.
4	Social disorder, physical activity and adiposity in Mexican adults: Evidence from a longitudinal study	Ortiz Hernández and Janssen	2014	built environment/ socioeconomic	To analyze the prospective relationship of community social disorder with sedentary behavior, sport participation, and adiposity in Mexican adults	Adults aged 20+ years	n=8307	Time spent watching television, participation in sports and recreation, BMI, and WC.	Cross-sectional study	National: 145 communities in Mexico	During a three-year follow-up, participants from communities with high social disorder had a 1.36 cm larger increase in waist circumference than participants from communities with low social disorder. However, there were no differences in body mass index, television, or sport participation.
5	The nutrition transition in Mexico 1988-2016: The role of wealth in the social patterning of obesity education	Perez-Ferrer et al.	2018	socioeconomic/ food environment	To investigates whether the reversal of the social gradient in obesity, defined as a cross-over to higher obesity prevalence among groups with lower education level, has occurred among men and women in urban and rural areas of Mexico.	Adults aged 20–49 years	n=54 816 women n=20 589 men	Association between education and obesity, Association between wealth and obesity	Cross-sectional study	National: Mexico	The study showed that upon reaching a threshold level of household wealth, the relatively poorest women became vulnerable to the obesogenic environment. A full reversal of the education gradient is expected among women in rural areas. Among men, obesity prevalence increased over the study period but was not socially patterned by education in urban areas and there was no evidence to suggest emerging inequalities in obesity. In rural areas, there was a direct associa- tion between education and obesity among men. In the latest surveys, higher education was protective across all wealth groups. Among men, education level was not associated with obesity in urban areas; there was a direct association in rural areas. Wealth did not modify the association between education and obesity.
6	Poverty is the Main Environmental Factor for Obesity in a Mexican-Border City	Jimenez-Cruz et al.	2013	socioeconomic	To assess the environmental factors that have the strongest association with obesity and abdominal obesity among adults in Tijuana.	Adults mean age= 39 years	n=322	Prevalence of obesity and abdominal obesity in different neighborhood strata	Cluster randomized cross-sectional study	Regional: Tijuana, Mexico	The prevalence of obesity and abdominal obesity was 27% and 43.5% respectively. The odds ratio for obesity and abdominal obesity among those living in the lowest-income neighborhood was 2.4 and 7.8 respectively, compared with those living in a middle-class neighborhood.
7	Time trends and sex differences in associations between socioeconomic status indicators and overweight-obesity in Mexico (2006–2012)	Quezada and Lozada-Tequeanes	2015	socioeconomic	To contribute to a better understanding of the nature and evolution of the associations between SES indicators and OWOB in the Mexican adult population.	Adults aged 20-75 years, 2006 and 2012	13,358 men and 20,426 women 15,997 men and 22,231 women	Associations between socioeconomic status, education and wealth with excess body weight	Cross-sectional multi-stage stratified cluster sample	National: Mexico	For men, the association between wealth and OWOB remained positive in general. The wealth-OWOB association in women showed an inverted-U pattern at both years with a positive slope that turned into a negative one as wealth increased. Among women, OWOB prevalence at the college/university education level was approximately 12.0 ± 2.4 lower compared with the elementary education level. We did not find differences between educational categories for men in 2006, but in 2012 OWOB tended to be higher among the more educated. The prevalence of obesity in women increased at wealth levels from the middle and upper-middle section of the wealth distributions. Overall OWOB prevalence was near 70 % in 2012 for both sexes.
8	A population-based comparison of weight and weight perceptions among overweight and obese Mexican and Mexican-American men	Guendelman et al.	2013	individual	To examine actual and perceived weight in national cohorts of Mexican-origin adult men in Mexico and the United States	Adult males aged 20-59 years	5 257 Mexican men 979 Mexican-American	BMI perception and association to actual BMI, environmet and culture	Cros-sectional study	National: US and Mexico	Mexican-Americans low access to health care, and to educational, economic or informational resources, may be showing delayed adoption of healthy dietary and lifestyle behaviors. Mexican men who are newcomers in the US have lower BMI than US-born Mexican-American men and, after controlling for age, each additional year in the US is associated with an increase in BMI in immigrants. Weight misperceptions were common in both populations but more prevalent in Mexico.

Table 5: Environmental Factors affecting Obesity in the United States

#	TITLE	AUTHOR	YEAR	CHARACTERI-ZATION	AIM	POPULATION (SAMPLE)	n=	OUTCOMES	STUDY DESIGN TYPE	DEFINITION AREA	RESULTS
1	A multifactorial obesity model developed from nationwide public health exposome data and modern computational analyses	Gittner et al.	2017	socioeconomic/built environment	To design a clear model for the evaluation of interventions to prevent and reduce obesity.			Latent constructs to study hidden networks and relationships in the environment data concerning low and high obesity rates	Exposome Modeling Study	National: US	Latent variables concentrated around social deprivation, community infrastructure and climate, and especially heat stress were connected to obesity. Infrastructure, environment and community organisation differed in counties with low versus high obesity rates.
2	Area-Based Variations in Obesity Are More than a Function of the Food and Physical Activity Environment	Oka et al.	2013	built environment/ individual	To examine the area-based variations in obesity from a community-based epidemiologic survey of Boston, MA, USA,	Adults aged 30–79 years	n=5485	Demographic, environmental, social, and physical characteristics ans theirrelationship to obesity risk	Multi-level Modeling study	Regional: Boston	BMI was due to individual-level variations and partially due to neighborhood-level variations. This suggests that the place where people live is more strongly associated with changes in BMI than with their household income. Due to neighborhood disadvantages and deprivations, the predominantly Hispanic neighborhoods have been found to associate with increased body weight of residents.
3	Association of elevation, urbanization and ambient temperature with obesity prevalence in the United States	Voss et al.	2013	built environment	To examine the relationship between obesity and elevation, ambient temperature and urbanization.	Adults aged 18+ years	n=422 603	Association between obesity prevalence and urbanization, ambient temperature and elevation.	Cross-Sectional	National:US	There was an approximately parabolic relationship between mean annual temperature and obesity, with maximum prevalence in counties with average temperatures near 18C. Urbanization and obesity prevalence exhibited an inverse relationship (30.9% in rural or nonmetro counties, 29.2% in metro counties with >250 000 people, 28.1% in counties with population from 250 000 to 1 million and 26.2% in counties with 41 million). After controlling for urbanization, temperature category and behavioral and demographic factors, male and female Americans living o500 m above sea level had 5.1 and 3.9 times the odds of obesity, respectively, as compared with counterparts living X3000 m above sea level.
4	Association of food environment and food retailers with obesity in US adults	Yan et al.	2015	food environment	To study association of density of food retailer type with obesity rate in U.S. adults in local regions controlling for socioeconomic factors.			Associations food environment, and sociodemographic variables with county level obesity rate	Cross-sectional	National:US	Obesity rate increased in supercenters (0.25–0.28%) and convenience stores (0.05%) and decreased in grocery stores (0.08%) and specialized food stores (0.27– 0.36%). T
5	Association of residential greenness with obesity and physical activity in a US cohort of women	Villeneuve et al.	2018	built environment	To characterize associations between residential greenness and both obesity and physical activity in a women population cohort in the US	Female Adults aged 35–74 years	n=50,884	Associations between greenness and obesity and physical activity	Cross-sectional	National:US	Women who lived in areas with the highest tertile of greenness had a reduced risk of obesity (body mass index (BMI) ≥ 30) relative to those in the lowest tertile. We also found that those the upper tertile of greenness were 17% more likely to expend more than 67.1 metabolic equivalent (MET) hours per week when compared to those in the lowest tertile. Beneficial associations between greenness and both obesity and physical activity were observed in urban and rural areas, and regionally, stronger associations were observed in the western census region in the US.
6	Built Environment and Obesity by Urbanicity in the U.S	Xu and Wang	2015	built environment/food environment	To examine the association of neighborhood built environments with individual physical inactivity and obesity in the U.S.	Adults aged 18+ years	n=328,156	Prevalence of obesity and its association with built environment, poverty level and urbanicity at the county level.	Cross-Sectional Multi-level modeling study	National:US	There is a significant association between built environment variables and physical inactivity/obesity. Both street connectivity and walk score reflect walkability, whose variability is most likely to play a role in people's health behavior across large cities but to a less extent in small-medium cities or rural areas. Food environment seems to be more of a factor in areas of middle urbanicity levels. The racial gaps in obesity risks as suggested by the general models are attributable to only a specific gender in selected geographic areas. Benefit of high income for lowering obesity risk is only evident for women
7	Diabetes, obesity, and recommended fruit and vegetable consumption in relation to food environment sub-types: a cross-sectional analysis of Behavioral Risk Factor Surveillance System, United States Census, and food establishment data	Frankfeld et al.	2015	food environment	To identify food establishment sub-types and evaluate prevalence of diabetes, obesity, and recommended fruit and vegetable consumption in relation to these sub-types in the Washington DC metropolitan area.	Food stablishments	n=13,326	Prevalence of diabetes and obesity and its association to food stablishments	Cross-sectional	Regional: The Washington DC Metropolitan area	The healthier options category clustered into three sub-types: 1) specialty food, 2) grocery stores, and 3) restaurants. The unhealthier options category clustered into two sub-types: 1) convenience stores, and 2) restaurants and fast food. Within the healthier options category, diabetes prevalence in the sub-types with high restaurants and high specialty food was lower than the grocery stores sub-type. The high restaurants sub-type compared to the high grocery stores sub-type had significantly lower obesity prevalence and higher FV5 prevalence. However, restaurants (including fast food) sub-type was significantly associated with lower diabetes and obesity, and higher FV prevalence compared to grocery store sub-type.
8	Disparities in Physical Activity Resource Availability in Six US Regions	Jones et al.	2015	built environment	To determine physical activity resource availability overall and by sociodemographic groups in parts of six states	Census tracts in 37 counties, corresponding to 9.5% of the 2010 US population	n=7139	Parks and recreational facilities associated with demographic characteristics and their relation to physical activity	Cross-sectional	Regional: 6 states CA, IL, MD, MN, NC, NY	Overall the availability of parks and recreational facilities was lower in predominantly minority relative to non-Hispanic white census tracts. Low-income census tracts and those with a higher proportion of children had an equal or greater availability of park resources but fewer recreational facilities. Stratification revealed substantial variation in resource availability by state. The availability of physical activity resources varied by sociodemographic characteristics and across regions.
9	Environments Perceived as Obesogenic Have Lower Residential Property Values	Drewnowski et al.	2014	socioeconomic/ built environment	To determine the relation between residential property values and multiple perceived (self-reported) measures of the obesogenic environment.	Adults aged 18+ years	n= 2001	Property values ans their association to BMI	Cross-sectional	Local: King County	Perceived measures of the environment such as crime, heavy traffic, and proximity to bars, liquor stores, and fast food were all associated with lower property values. By contrast, living in neighborhoods that were perceived as safe, quiet, clean, and attractive was associated with higher property values. The observed associations between perceived environment measures and BMI were largely attenuated after accounting for residential property values.
10	Food Environments and Obesity: Household Diet Expenditure Versus Food Deserts	Chen et al.	2016	food environment	To examine the associations between obesity and multiple aspects of the food environments, at home and in the neighborhood.		n=38650	Obesity and overweight status influenced by individual-level factors; household-level factors, a home food environment; and neighborhood-level factors, including county-level	Cross-sectional	National: 2104 US counties	After controlled number of confounders at the individual, household, and neighborhood levels, USDAScore (novel home food environment measure) was negatively linked with obesity status, and a census tract–level indicator of food desert status was positively associated with obesity status.
11	Food Shopping Behaviors and Socioeconomic Status Influence Obesity Rates in Seattle and Paris	Drewnowski et al.	2014	socioeconomic/ food environment	To compare the associations between food environment at the individual level, socioeconomic status (SES) and obesity rates in two cities: Seattle and Paris.	Adults aged 18+ years	n=1340	Distances between home and the supermarket, prices of goods at the supermarket, surrounding property values and their association to obesity risk	Cross-sectional	Regional: Metropolitan Seattle and King County	Lower SES was linked to higher obesity risk in both Paris and Seattle, despite differences in urban form, the food environments, and in the respective systems of health care. Physical distance to supermarkets was unrelated to obesity risk. By contrast, lower education and incomes, lower surrounding property values, and shopping at lower-cost stores were consistently associated with higher obesity risk.

#	TITLE	AUTHOR	YEAR	CHARACTERI-ZATION	AIM	POPULATION (SAMPLE)	n=	OUTCOMES	STUDY DESIGN TYPE	DEFINITION AREA	RESULTS
12	Is Acculturation Related to Obesity in Hispanic/Latino Adults? Results from the Hispanic Community Health Study/Study of Latinos	Isasi et al.	2015	individual/ built environment	To examine the association of obesity with acculturation in a large and diverse sample of US Hispanic/Latino adults.	Adults aged 18–74 years	n=16415	Acculturation ant its association to overweight, moderate obesity, and extreme obesity	Cohort Study	Regional: Chicago, IL; Miami, FL; Bronx, NY; San Diego, CA	The prevalence of obesity was 42.4% for women and 36.5% for men and varied by field center and Hispanic/Latino background. The strongest predictor of moderate and extreme obesity was length of residency in mainland US. Acculturation was not significantly associated with obesity. The study findings suggest that prolonged exposure to the environments in these US communities, rather than acculturation, is an important risk factor for obesity in this population.
13	Neighborhood commuting environment and obesity in the United States: An urban–rural stratified multilevel analysis	Zhang et al.	2014	built environment	To examine the urban–rural differential effects of neighborhood commuting environment on obesity in the US	Adults aged 18+ years	n=277,292	Association of obesity and vehicle ommuting on specific urban–rural geographic contexts.	Cross-sectional	National:US	ur study found that the complex links between neighborhood commuting environment and the obesity epidemic in the US differed widely across the levels of regional urbanization, while adjusting for significant individual level demographic and socioeconomic factors and neighborhood poverty that were associated with obesity. The neighborhood commuting environment could directly affect residents' physical activity and food intake. More frequent vehicle-based trips and longer commuting times could result in lower physical activity levels and increased fast food access and less frequent home cooking.
14	Neighborhood environments and obesity among Afro-Caribbean, African American, and Non-Hispanic white adults in the United States: Results from the National Survey of American Life	Sullivan et al.	2014	built environment	To examine possible associations between perceived neighborhood environments and obesity among a U.S. nationally representative sample of Afro-Caribbean, African American, and Non-Hispanic white adults.	Adults aged 18+ years	n=6082	Perception of environment and the involvement in groups and associations, and obesity risk.	Cross-Sectional	National:US	The odds of obesity were significantly lower for adults who reported involvement in clubs, associations, or help groups and perceived that they had a park, playground, or open space in their neighborhood. These associations remained significant after adjusting for leisuretime physical activity. Race/ethnicity appeared to modify the association between involvement in clubs, associations, or help groups and obesity.
15	Neighborhood Food Environment, Diet, and Obesity Among Los Angeles County Adults, 2011	Mejia et al.	2015	food environment	To examine whether an association exists between the number and type of food outlets in a neighborhood and dietary intake and body mass index (BMI) among adults in Los Angeles County.	Adults aged 18+ years	n=8036	Associations between walkable neighbohood food environment and healthy and unhealthy eating behaviors and BMI	Cross-Sectional	Local: Los Angeles County	There was no association between the intake of fruits and vegetables or sugar-sweetened beverages and any type of food outlet in all buffers analyzed. Similarly, there was no association between BMI and fast-food outlets, small food stores, midsize grocery stores, or supermarkets.This study does not provide evidence to support the hypothesis that the food environment within walkable distances affects BMI and diet of adults. Fast-food outlets within nonwalkable distances (3.0 miles) were positively associated with fast-food intake.
16	Neighborhood Physical Environment and Changes in Body Mass Index: Results From the Multi-Ethnic Study of Atherosclerosis	Barrientos-Gutierrez et al.	2017	built environment	To investigated whether changes in neighborhood physical environments over time are related to changes in BMI in an ethnically diverse study sample.	Adults aged 45–84 years	n= 6,814	BMI increase or reduction associated with changes in neighborhood characteristics	Longitudinal The Multi-Ethnic Study	Regional: 6 US urban areas (Baltimore, Maryland; Chicago, Illinois:	Changes in neighborhood characteristics were not associated with changes in BMI. Evidence suggested that in persons who were obese at baseline, improvements in neighborhood food and physical activity environments were associated with reductions in BMI. People living in neighborhoods that experienced an increase in street connectivity and in social and walking destinations reported an increase in walking for transportation. Paradoxically, increases in recreational density were associated with statistically significant increases in BMI among people who were normal-weight at baseline.
17	Preferred Healthy Food Nudges, Food Store Environments, and Customer Dietary Practices in 2 Low-Income Southern Communities	Jilcott Pitts et al.	2016	food environment	To examine how food store environments can promote healthful eating, including preferences for a variety of behavioral economics strategies to promote healthful food purchases, and the cross-sectional association between the primary food store where participants reported shopping, dietary	Adults aged 18+ years	n=342	Assessment of fruit, vegetable, and sugary beverage availability and price in local food stores, and sugary drinks, fruit and vegetable consumption	Cross-sectional	Local: 2 eastern North Carolina communities	There was a statistically significant association between sugary drink price and consumption, such that stores with higher-priced sugary beverages had customers with higher sugary beverage consumption. There was an inverse (although not statistically significant) association between sugary beverage prices and BMI. There were no other significant associations between prices of fruits and vegetables and consumption of fruits and vegetables or BMI. Significant association between the primary food store and consumption of fruits and vegetables and sugary beverages. There were no significant associations between primary food store and BMI
18	Relationship between Perceptions about Neighborhood Environment and Prevalent Obesity: Data from the Dallas Heart Study	Powell-Wiley et al.	2013	built environment/ individual	To examine the association between perceptions of neighborhood environment and prevalent obesity in the Dallas Heart Study	Adults aged 18–65 years	n=5907	Three identified factors associated with neighborhood perceptions: neighborhood violence, physical environment, and social cohesion and their relation to obesity	Cross-Sectional	Local: Dallas County	Residents identify perceptions about neighborhood violence, physical environment, and social cohesion as psychosocial factors associated with neighborhood environment for Dallas County adults. Blacks and individuals of lower socioeconomic status reported less favorable perceptions of environment, particularly in relation to neighborhood violence and physical environment.Unfavorable perceptions of the physical environment portend an increased likelihood of prevalent obesity; perceived aesthetics of the neighborhood environment and access to safe recreational areas appear to play a key role in this relationship.
19	Residential Racial Composition and Black-White Obesity Risks: Differential Effects of Neighborhood Social and Built Environment	Li et al.	2014	built environment/ individual	To investigate the association between neighborhood racial composition and adult obesity risks by race and gender, and explore whether neighborhood social and built environment mediates the observed protective or detrimental effects of racial composition on obesity risks.	Adults aged 18+ years	n=12730whites n=4290 blacks	Associations between neighborhood racial composition and obesity risk.	Cross-Sectional	Regional: Bucks, Chester, Delaware, Montgomery, and Philadelphia	Black concentration is associated with higher obesity risks only for white women, and this association is mediated by lower neighborhood social cohesion and socioeconomic status (SES) in black-concentrated neighborhoods. After controlling for neighborhood SES, black concentration and street connectivity are associated with lower obesity risks for white men. No association between black concentration and obesity is found for blacks.
20	Simulated Models Suggest That Price per Calorie Is the Dominant Price Metric That Low-Income Individuals Use for Food Decision Making	Beheshi et al.	2016	socioeconomic/ food environment	To assess which price metric is used by low-income individuals in deciding what to eat	Adults aged 20+ years		Price per calorie, PPC ($/100 kcal), price per gram (PPG) ($/100 g), and price per serving (PPS) ($/serving)	Simulation Modeling	National: US	Among the 3 price-metric scenarios in our ABM simulations, the PPC metric produced results that were most similar to data on dietary habits. In addition, the PPC metric produced results most consistent with data on the sensitivity of dietary composition to changes in income. Although all 3 price metric scenarios generated results that were relatively close to the data, the PPC metric generally outperformed the PPG and PPS metrics.
21	The association between neighborhood economic hardship, the retail food environment, fast food intake, and obesity: findings from the Survey of the Health of Wisconsin	Laxy et al.	2015	socioeconomic/ food environment	To investigate the association between neighborhood-level economic hardship, the retail food environment, fast food consumption, and obesity prevalence.		n = 1570	Associations between neighborhood economic hardship, the retail food environment, fast food intake, and obesity	Cross-Sectional	Regional: Wisconsin	The overall obesity prevalence among participants was 38%, and 46% of the sample reported to eat fast food at least twice a week. Obesity prevalence was similar in both genders, but higher for people of older ages, those less educated, of racial/ethnic minorities, and inactive people. The frequency of fast food consumption was higher for people of younger ages and among African Americans and Hispanic
22	The food environment and adult obesity in US metropolitan areas	Michimi and Wimberly	2015	food environment	To examine the larger-scale associations between obesity and food environments in metropolitan areas in the United States	Adults aged 18+ years	n=300,933	Association between urban setthings and therit food environments, and obesity prevalence	Cross-Sectional	National: US	In urban settings, populations served by more full-service restaurant and supermarket workers are less likely to be obese, while populations served by more fast-food restaurant and convenience store workers are more likely to obese.

#	TITLE	AUTHOR	YEAR	CHARACTERI-ZATION	AIM	POPULATION (SAMPLE)	n=	OUTCOMES	STUDY DESIGN TYPE	DEFINITION AREA	RESULTS
23	The Geographic Concentration of US Adult Obesity Prevalence and Associated Social, Economic, and Environmental Factors	Slack et al.	2014	socioeconomic/ built environment	To test the hypotheses that county-level adult obesity prevalence in the United States is regionally concentrated at significant levels, and linked to local-level factors, after controlling for state-level effects.	US Counties	n=3109	Economic, healthcare and recreational contexts, food environment, population structure, education level and spatial effect associations with obesity	Cross-Sectional	National:US	Economic Context: Unemployment showed a significant positive relationship with obesity prevalence, whereas poverty and the poor/ nonpoor segregation did not emerge as significant predictors of local obesity levels. Healthcare Context: The number of physicians per 1000 residents held a significant negative relationship with obesity prevalence, whereas the number of outpatient visits per 1000 residents revealed a significant positive correlation. The model demonstrated no significant effect of percent rural. Education Level: Lower levels of high school completion were shown to be associated with significantly higher local obesity levels. Spatial Effects: Obesity levels among a county's neighbors were significantly and positively associated with local obesity prevalence.
24	Variations in Obesity Rates between US Counties: Impacts of Activity Access, Food Environments, and Settlement Patterns	Congdon	2017	food environment/ built environment	To delineates the main dimensions of geographic variation in obesity between counties: by urban-rural status, by region, by area poverty status, and by majority ethnic group			Obesity variations between US counties	Cross-Sectional	National: US	The impact of the food insecurity is much stronger for females, in line with survey based findings that food insecure adult women were more likely to be obese than food insecure males. Exposure to fast food are both positive. There is a negative impact on obesity of the concentration score, which is a negative index of settlement dispersal and car dependence. Inactivity effects on obesity are pronounced, and greater for females.
25	Socioeconomic and Demographic Factors for Spousal Resemblance in Obesity Status and Habitual Physical Activity in the United States	Chen et al.	2014	individual/ socioeconomic	To examine what factors may affect married spouses' resemblance in weight status and habitual physical activity (HPA) and the association of obesity/HPA with spouses' sociodemoeconomic characteristics and lifestyles	Married adults aged 18+ years	n=22806	Spousal association in weight status, weight status (normal weight, overweight, and obese) and physical activity between spouses associated with education vears. races/ethnicities.	Cross-Sectional	National: US	We found that spousal difference in BMI was smaller for couples with a lower household income, for who were both unemployed, and for older spouses. Never-working women's husbands had lower odds of obesity than employed women's husbands. Men's unemployment status was associated with wives' greater odds of obesity. The population representative survey showed that spousal resemblance in weight status and HPA varied with socioeconomic and demographic factors.
26	Cross-national comparison of socioeconomic inequalities in obesity in the United States and Canada	Sddiqi et al.	2015	socioeconomic	To contrast inequality dimensions on obesity by using.unique data on two highly comparable societies – U.S. and Canada	Adults aged 18+ years	n= 3346 for US	Two main measures of SES, income and education	Cross-Sectional	National: US	In the U.S., every socioeconomic group except the college educated had significant excess prevalence of obesity. At the lower end of the socioeconomic gradient, obesity was more prevalent in the U.S. than in Canada. Our results suggest there is variation between U.S. and Canada in different dimensions of socioeconomic inequalities in obesity.
27	Race and Socioeconomic Differences in Obesity and Depression among Black and Non-Hispanic White Americans	Lincoln et al.	2014	individual/ socioeconomic	To examine the relationships between race, ethnicity, and sociodemographic factors to the joint classification of body mass index categories and depression among African Americans, Caribbean Blacks, and non-Hispanic Whites sing multinomial logistic regression and data from the National Survey of American Life		n=3,570 African Americans n=1,621 Caribbean Blacks n=891 non-Hispanic Whites	Linkage between obesity and depression among African American, Caribbean Black and non-Hispanic White adults	Cross-Sectional	National: US representativ e metropolitan areas	African Americans are more likely to be obese than Caribbean Blacks and non-Hispanic Whites. Women are more likely than men to be obese compared; however, men are more likely than women to be overweight if not obese.Those who have never been married are more likely to have a normal BMI than those married. Those with lower incomes are more likely to have a normal BMI or to be obese than those who have higher incomes, who are most likely to be in the overweight category. African Americans have a lower prevalence of depression than Caribbean Blacks and non-Hispanic Whites. Women have a higher prevalence of depression than men . Higher prevalence of depression is found among respondents who are younger compared with those who are older and among those with low socioeconomic status
28	Neighborhood Food Environment and Obesity in Community-Dwelling Older Adults: Individual and Neighborhood Effects	Pruchno et al.	2014	food environment	To tes different hypotheses about the relationship between neighborhood-level food sources and obesity, controlling for individual-level characteristics.	Adults aged 50–74 years	n=5688	Associtions between prevalent obesity and neighborhood food environmetn	Cross-Sectional	Regional: New Jersey	When controlled for individual-level age, gender, race, education, and household income, densities of fast-food establishments and storefronts were positively associated with obesity. Although evidence regarding the association between obesity and supermarket density is contradictory, our analysis found no significant association between supermarket density and obesity.
29	Neighborhood socioeconomic status and BMI differences by immigrant and legal status: Evidence from Utah	Wen and Maloney	2014	individual/ socioeconomic	To examine the BMI patterns of immigrants in the US by distinguishing between legal and undocumented immigrants.	Adults aged 25–64 years	n= 83627 men n= 359321 women	Associations between immigration, whether leal or illegal and the BMI of the subjects studied	Cross-Sectional	Regional: Utah	We find that undocumented women have relative odds of obesity that are about 10 percentage points higher than for legal immigrant women, and their relative odds of being overweight are about 40 percentage points higher. We also find that the odds of obesity and overweight status vary less across neighborhoods for undocumented women than for legal immigrant women. These patterns are not found among immigrant men: undocumented men have lower rates of obesity (by about 6 percentage points in terms of relative odds) and overweight (by about 12 percentage points) than do legal immigrant men, and there is little variation in the impact of neighborhood context across groups of men.
30	Decomposing Racial Disparities in Obesity Prevalence: Variations in Retail Food Environment	Singleton et al.	2016	individual/ food environment	To quantify how much food environment measures explain racial disparities in obesity at the county level	US Counties	n=3,135	Adult obesity prevalence and its association to food environment	Cross-Sectional	National:US	There were 665 counties (21%) classified as a high African American county. The total gap in mean adult obesity prevalence between high and low African American counties was found to be 3.35 percentage points (32.98% vs 29.63%). Retail food environment measures explained 13.81% of the gap in mean age-adjusted adult obesity prevalence.
31	Neighbourhood poverty, perceived discrimination, and central adiposity: Independent associations in a repeated measures analysis	Kwarteng et al.	2016	individual/ socioeconomic	To examine the independent effects of neighbourhood context and exposure to perceived discrimination in shaping risk of obesity over time.	Adults aged 25+ years	n=157	Percieved discrimination associated with waist circumference of the individuals	Cross-sectional	Regional: Detorit	Residents of neighbourhoods with high concentrations of poverty were more likely to show increases in central adiposity compared to those in neighbourhoods with lower concentrations of poverty. In models adjusted for BMI, neighbourhood poverty at baseline was associated with greater change in central adiposity among participants who lived in neighbourhoods in the second and third quartiles, compared with those in the lowest poverty neighbourhoods. Results from models that included both neighbourhood poverty and perceived discrimination showed that both neighbourhood poverty and discrimination were associated with increased risk of increased central adiposity over time. Residents of neighbourhoods of second, third and fourth quartiles of poverty remained more likely to show greater increases in central adiposity over time, compared with those in the lowest poverty quartile.

#	TITLE	AUTHOR	YEAR	CHARACTERI-ZATION	AIM	POPULATION (SAMPLE)	n=	OUTCOMES	STUDY DESIGN TYPE	DEFINITION AREA	RESULTS
32	Self-Efficacy as a Mediator of the Relationship between the Perceived Food Environment and Healthy Eating in a Low Income Population in Los Angeles County	Gase et al.	2016	individual	To assess the relationship between the perceived food environment, self-efficacy and fruit and vegetable consumption.	Low-income adults aged 18+ years	n= 1,503	Self-efficacy as a mediator of health outcomes associated with the food environment perception	Cross-Sectional	Local: Los Angeles County	For every one point increase on the perceived food environment scale, individuals ate about 5% more fruits and vegetables (95% CI: 1.007, 1.089), controlling for other covariates. Selfefficacy was shown to be a significant mediator (mediated effect = 0.010; 95% confidence interval 0.002, 0.020), accounting for 22.9% of the effect. Efforts to increase access to healthy options may not only improve eating behaviors, but also influence individuals' beliefs that they can eat healthfully.
33	Health-Specific Information and Communication Technology Use and Its Relationship to Obesity in High-Poverty, Urban Communities: Analysis of a Population-Based Biosocial Survey	Gopalan et al.	2016	Technological/ Socioeconomic	To describe health-specific ICT use and its relationship to measured obesity among adults in high-poverty urban communities.	Adults aged 35+ years	n=267	The association of utilizing health-specific ICT with obesity and its comorbidities	Cross-sectional	Local:South Side of Chicago	The survey response rate was 44.6% (267 completed surveys/598.4 eligible or likely eligible individuals); 53.2% were African American and 34.6% were Hispanic. More than 35% of the population reported an annual income of less than US $25,000. The population prevalence of measured obesity was 50.2%. People with measured obesity (BMI≥30 kg/m2) were more likely to report both general and health-specific ICT use. In contrast, among those with measured obesity, being told of this diagnosis by a physician was not associated with increased health-specific ICT use. People with measured obesity alone had higher rates of health-specific use than those with comorbid hypertension and/or diabetes diagnoses
34	Prevalence of Obesity Among Adults, by Household Income and Education — United States, 2011–2014	Ogden et al.	2017	socioeconomic	To analyze obesity prevalence among adults by three levels of household income, based on percentage of the federal poverty level (FPL) and individual education level . and the different patterns between high-income and low-income in the US	Adults aged 20+ years	n=10636	Obesity prevalence variations by income and educational level	Cross-Sectional	National: US	Among women, obesity prevalence was lower in the highest income group. This pattern was observed among non-Hispanic white, non-Hispanic Asian, and Hispanic women, but it was only significant for white women. Among non-Hispanic black women, there was no difference in obesity prevalence among the income groups. Among men, the prevalence of obesity was lower in both the lowest and highest income groups. Among non-Hispanic black men, obesity prevalence was higher in the highest income group than in the lowest income group . There was no difference in obesity prevalence by income among non-Hispanic Asian men. Prevalence of obesity was lower among women and men who were college graduates than among women and men with some college and women and men who were high school graduates or less.
35	International study of percieved neighborhood environmental attributes and body mass index: IPEN Adult Study in 12 countries	De Bourdeauduij et al.	2015	built environment/ individual	To examine associations between perceived neighbourhood built environmental attributes and BMI/weight status in a multi-country study	Adults aged 18–66 years	n = 14222	Safety (traffic and overall), proximity and their relation to Obesity and overweight	Multi-site cross-sectional study	Regional: USA (Seattle, Baltimore).	After adjusting for environmental predictors and socio-demographic covariates, Cuernavaca (Mexico) had the highest prevalence of overweight/obesity. Three environmental attributes were associated with BMI or weight status in pooled data: Safety from traffic was the most robust correlate. Close proximity to several destinations was associated with lower BMI across all countries, and safety from crime, perceived crime safety was related to lower BMI
36	A population-based comparison of weight and weight perceptions among overweight and obese Mexican and Mexican-American men	Guendelman et al.	2013	individual	To examine actual and perceived weight in national cohorts of Mexican-origin adult men in Mexico and the United States	Adult males aged 20-59 years	5 257 Mexican men 979 Mexican-American	BMI perception and association to actual BMI, environmet and culture	Cross-Sectional	National: US and Mexico	Mexican-Americans low access to health care, and to educational, economic or informational resources, may be showing delayed adoption of healthy dietary and lifestyle behaviors. Mexican men who are newcomers in the US have lower BMI than US-born Mexican-American men and, after controlling for age, each additional year in the US is associated with an increase in BMI in immigrants.

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