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Synthesizing Reviews for a Holistic Understanding of Real Causes and Potential Effect Sizes of Studies on Child and Adult Obesity: A Systematic Review

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Abstract

Purpose: Obesity is a growing epidemic in the United States, and interventions developed to date have not been sufficient to solve it. The influence of obesity worldwide has been on the rise with several impacts on the health and economic condition of affected individuals. This study conducts a systematic review and applies the socio-ecological model (SEM) to do a narrative synthesis of the impacts of the different levels of determinants (and their interaction) on adult and child obesity.

Methods: This study paper seeks to add more evidence and uncover missed research areas by synthesizing existing evidence in systematic reviews and meta-analyses within the SEM and identifying levels that have not been studied extensively. Four electronic databases were searched for relevant articles until August 2020.

Results: 84 articles were included in this review for the narrative synthesis. The analysis showed that 41.67% of studies addressed the individual level of the determinant, 20.24% the interpersonal level, 11.90% the community level, and 2.38% addressed aspects from the societal & policy level. It was also found in this study that interactions between the individual (genetics) and interpersonal (relationships) levels are viable pointers as to why there is a difference in the development of obesity among individuals living in the same environment.

Conclusion: This paper further highlights that incorporating multiple levels of the SEM has a greater impact on designing interventions to reduce the impact of obesity risk factors.

Keywords: Obesity; Systematic review; Socio-ecological framework; Public Health

Introduction

Obesity has been growing in prevalence and effect throughout the world with severe associated health risks, high medical costs, and reduced quality of life [1]. The World Health Organization (WHO), in its global status report on noncommunicable diseases (2014), stated that comorbidities related to obesity constitute the highest threat to good health. This impairment leads to diseases including diabetes, high blood pressure, kidney disease, coronary heart disease, osteoarthritis, and stroke, which consequently increases medical costs[2]. In a National Center for Health Statistics (NCHS) report, obesity is considered an epidemic, with about 40% prevalence among adults in the United States.1 The Centers for Disease Control (CDC) revealed that in 2009-2010, the prevalence of obesity amongst adults in the United States was 42%, with an associated annual estimated cost of $147 billion [3].

Considerable research has been carried out to design and formulate interventions to reduce the incidence of obesity in addressing this epidemic. Still, there is no clear solution despite the research invested and the growing problem [4-6]. At this point, a helpful approach would be to organize the results in a consistent framework to consider what is effective. To this purpose, the socio-ecological model (SEM) was selected to organize the research, consider overlapping influences and potentially uncover neglected areas. The SEM, in general, provides a holistic understanding of the causes of adult obesity and improves healthy behaviors and outcomes by integrating the effect of multiple sets of influences. The aim, however, is to study the effects of these sets of influences (genetics, behavior, and environment) and their interactions. Before this research, much work has been conducted to address this problem, with insufficient solutions discovered as the epidemic continues.

This paper, different from other studies, systematically reviews systematic reviews by summarizing existing knowledge and uncovering missed research areas by synthesizing existing evidence in systematic reviews and meta-analysis within the SEM. This study synthesizes the effect size of different factors and interventions on obesity and seeks to find areas that have not been studied extensively. The findings should point to where existing research has shown promise and identify overlooked areas.

The socio-ecological model

As developed by the Centers for Disease Prevention and Control (CDC), the SEM comprises four levels: Individual, Interpersonal, Community, and Societal levels. The SEM is a framework that allows us to address the factors that put individuals at risk of being obese or factors that protects them against this epidemic. With this model, more information is obtained regarding prevention strategies at each level of influence. This model serves as a tool for policymakers in the bid to prevent health issues. In the formulation of interventions to combat

health issues, policymakers need to implement policies limiting risk factors and promoting preventive practices at all levels of the model [7]. Researchers have used the SEM to investigate several complex health issues and addictive habits [8-11].

Individual

The individual level of influence in the socio-ecological model comprises attitudes and beliefs that influence an individual's behavioral patterns. This level of determinant also focuses on biological/genetic factors and personal experience factors including age, gender, level of education, income level, socio-economic status that influence choices and daily habits which increase the likelihood for individuals to be at risk of obesity.

Interpersonal

The socio-ecological model states that the health of individuals is not only influenced by their characteristics and biological factors (genetics), but also by the interaction of individuals with their environment [7]. The interpersonal level of determinant in this model highlights relationships that may increase (or decrease) the possibility of being obese. At this level of determinant, an individual's relationship with their family members, friends, and school/work peers is all analyzed. The interpersonal level focus is on how these relationships either encourage or prevent habits that put children and adults at risk of being obese.

Community level

The community level of determinant in this model comprises the physical setting of the environment and its social relationship with individuals. This level explores the environmental setting like schools, institutions, workplaces, and neighborhoods and how their physical characteristics impact the social relationship and consequently behavioral patterns of individuals. Studies have shown a direct relationship between the physical environment and obesity [12]. This level of determinant is based on the premise that geographic and physical characteristics of the environment expose individuals to obesity risk factors. In addition to the physical characteristics of the environment, the income level of the neighborhood, rate of neighborhood migration, lack of community recreational infrastructure, and opportunities all have impacts on an individual's social relationships.

Societal/Policy level

The individual, their relationship with close peers, family and friends, and the community all affect the behaviors of individuals which exposes them to obesity risk factors. The societal/policy level defines societal/policy factors including economic, health, social and educational policies that create an atmosphere to either promote or mitigate obesity-causing factors. The interaction of factors between different segments of society is also captured in this level of determinant.

Methodology

Search strategy

The literature search for this systematic review was conducted on three databases: 1) MEDLINE (accessed by PubMed), Web of Science, Google scholar, and the Embase database. The search included full-text articles/abstracts in the databases mentioned above of all systematic reviews and meta-analysis on the risk factors that influence adult obesity published between August 2000 to August 2020. The search for literature in the databases was conducted by searching using the combination of the terms ((obesity*) OR (overweight*) OR (body mass index*) AND (systematic review*) OR (meta-analysis*)). Table 1 shows the results of the searches at the respective databases.

Language and data restrictions

Searches for this study include publications from August 2000 to August 2020. However, most publications that are relevant to this study were conducted after the year 2014. All studies used in this research were written and reported in the English language.

Selection criteria

The inclusion criteria will aim at addressing the heterogeneity of outcomes. The inclusion criteria directly address the effect of certain factors on adult obesity. The selection criteria for this study were: 1) it must be a systematic review or meta-analysis, 2) it must be a systematic review of child/adult obesity risk factors. The exclusion criteria were researched that did not determine the effect of a risk factor on obesity, literature reviews and not systematic reviews and/or meta-analyses, and research not written in the English language.

Data extraction and synthesis

Titles and abstracts resulting from the systematic search were screened to identify potential studies in the review. A table was created in the first screening set, and data with the following headers were extracted: authors, publication year, research objectives, and significant results. This table gives the characteristics of the selected paper. The extracted data file was checked to ensure completion and accuracy. For this study, a narrative synthesis was carried out to explain the synthesis findings [13]. As used by authors [14-19] in the past, the idea is to develop a synthesis of the findings and find commonalities and relationships between studies, and narratively explain these relationships.

Results

Of the 84 included in this review were studies where only systematic reviews (n = 41) had been conducted and studies where systematic

Table 1: Study's search strategy.

Website/Database	Search Terms	Filters Applied
Medline/Embase/Web of Science	*Overweight systematic review* *Overweight meta-analysis* *Obesity systematic review* *Obesity meta-analysis* *Body mass index systematic review* *Body mass index meta-analysis*	*2000-2020 Abstract Text Full Text Journal Article Systematic Review
Google Scholar	Allintitle: Overweight systematic review Allintitle: Overweight meta-analysis Allintitle: Obesity systematic review Allintitle: Obesity meta-analysis Allintitle: Body mass index systematic review Allintitle: Body mass index meta-analysis	*2000-2020 *include citations* *sort by relevance*

review and meta-analysis (n = 43) had been conducted. The narrative synthesis was done for 84 papers grouped based on the socio-ecological model's four (4) levels. Furthermore, included in this scoping review, 35 studies (41.67%) addressed the individual level of the SEM, 17 (20.24%) the interpersonal level, 10 studies (11.90%) the community level, and, 2 studies (2.38%) addressed aspects from the societal & policy level.

A total of 76.19% (n = 64) addressed factors from one SEM level, and 23.81% (n = 20) laid emphasis on two SEM levels. However, in this systematic review, we found that no study assessed all three or four levels of the socio-ecological model jointly. Figure 1 shows the proportion of papers per SEM level and interactions. The flow diagram for the 84 included papers is shown in Figure 2, with the search results from the respective database included. This table also shows the search strategy, which indicates the search terms combination and number of hits at the respective database.

Narrative synthesis

Socio-ecological model

Taking stock of existing research and outcomes using the socio-ecological model (SEM) as a framework synthesizes prior research and potentially under covers neglected areas of research. This provides knowledge on the relationship between an individual and their environment and how both impact each other. The socio-ecological model describes those factors that affect health at the individual, interpersonal, community, and societal levels.

Individual level

The majority of the studies included in this synthesis (35; 41.66%) focused on the individual level of influence. The individual level of influence comprises the synthesis of all biological and personal history factors that increase the chances of an individual being obese. At the individual level, studies have shown that a significant contributory factor to obesity is genetics. Many studies have shown that there are obesity risk genes, and these genes make it possible for obesity to be inherited [20-22]. Obesity is hereditary, and some genetic factors play crucial roles in childhood obesity. They further stated that genetic differences between individuals in childhood explain a significant amount of body mass index (BMI) variation in adulthood [23].

At this level of influence, strategies to prevent obesity also center
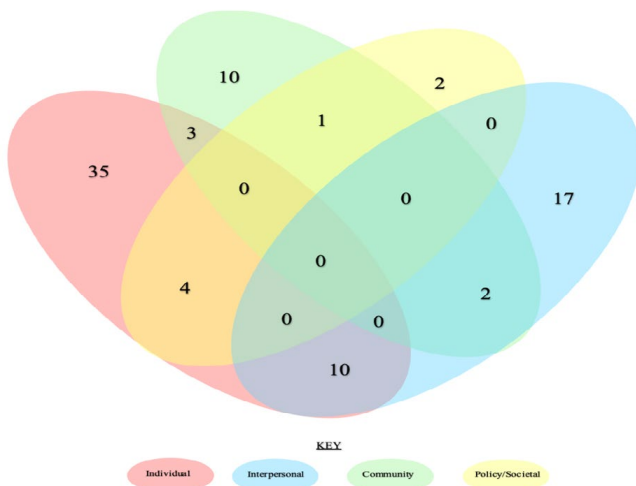

Figure 1: Number of studies in each level of the socio-ecological model and the interactions.
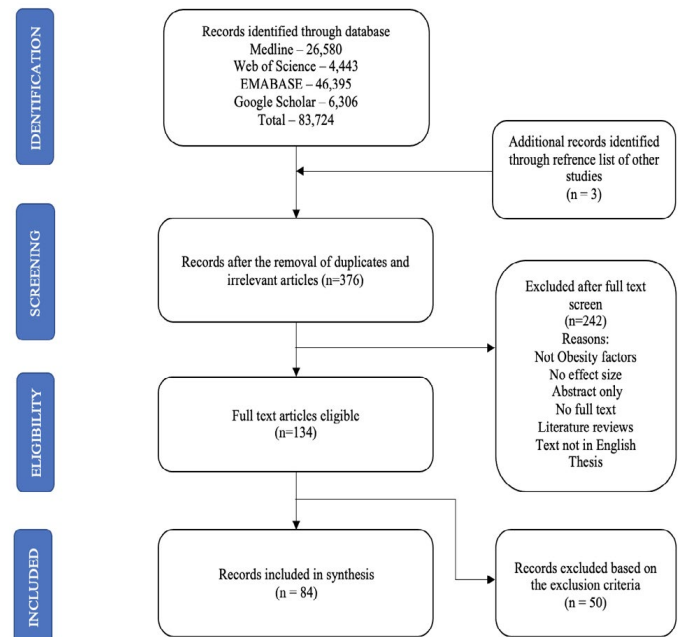

Figure 2: Study selection flowchart. The process includes the identification of potential studies in the review, screening, eligibility criteria, and inclusion criteria.

on promoting the attitudes, knowledge, skills, and behaviors of an individual. Individuals need to be informed about several aspects of the disease, such as susceptibility, fatality, and general threats. This information plays a vital role in influencing attitudes, behavior, and critical decisions.

Factors within this level include eating rate, income, maternal smoking habits, sedentary behavior, sleeping habits, diet education, childhood poverty, and eating out. Selected literature showed a significant effect of the obesity factors as mentioned above. The systematic reviews conducted on the relationship between an individual level of determinant specifically income and obesity revealed that the income level of adults significantly impacts their eating habits. The studies also found that individuals with low income are likely to be obese. Synthesis of the studies also showed a positive and significant relationship between educational attainment and obesity [24-26].

Interpersonal level

Studies have shown that the environment is a leading cause of the upsurge in obesity rates in the world. The interpersonal level of determinants highlights the relationships that increase the likelihood or risk of an adult being obese. Factors within this level are related to an individual's relationship with their environment, social circles, peers, and work relationships. These environmental factors include but are not limited to increased consumption of energy-dense foods and pervasive food advertising. An increase in westernization and economic development has an impact on the choices of individuals as they are exposed daily to foods that have high calories, are cheap, and are readily available. Such an environment subconsciously encourages individuals to consume higher calories and unhealthy food and engage in less physical activity and exercise [27, 28].

Systematic reviews that analyzed the relationship between the environment and obesity found environmental factors such as energy-dense food intake (OR=1.27), westernization (OR=1.34), increased carbohydrate intake (OR=1.04), eating rate (OR=2.15), and pervasive

advertising (OR=1.67) to have a positive and significant effect on obesity in adults. These studies highlight the impact of social and cultural environments have significant effects on the risk of obesity [27-30].

Households with poor socioeconomic status are more susceptible to obesity risks. This goes to highlight the impact shared social environments have on the risk of obesity [31]. Individuals are subconsciously impacted by their immediate political, economic, and social environment – the place of birth, daily choices, socioeconomic status, and health behavior all impact obesity status. For example, among siblings or family members, unhealthy lifestyles such as sleep deficit, lack of exercise, poor nutritional education, and skipping meals may have negative influences on an individual's feeding and exercise patterns. Therefore, the presence of these social relationships increases the likelihood of members of the household being obese. Information and beliefs about what composes a healthy weight and healthy lifestyle and its effect on said individuals' weight management and obesogenic behaviors are therefore altered [32-36].

Community level

Moving beyond the individuals' relationships and personal history is the community level that focuses on the relationship with the physical environment they live in. In this systematic review, ten studies (11.9%) addressed factors within the community level of influence. This level of determinant analyzed factors including the effect of neighborhood crime rate on obesogenic behavior, the relationship between the urban environment and obesity, built environment, physical activities, and obesity risk, the impact of the local food environment on eating behaviors, access to convenience stores and fast-food restaurants, street connectivity [37-41].

Evidence on the impact of the built environment on obesity showed that many features of the built environment alongside adequate urban planning may promote habits that lead to improved physical activity and conversely reduction in obesity risk. The studies also reveal that the presence and inherent awareness of the physical features of the environment are crucial to effecting positive behavioral change. Different from the impact of the built environment, the local food environment is an important factor affecting the healthy behaviors of children and adults. From the evidence included in this review, it is found that availability and access to supermarkets and fast-food restaurants had a negative association with obesogenic behavior. In addition, evidence showed a positive relationship between fast food availability and obesity, especially among children from both low-income households and low-income neighborhoods [38,39].

Societal/Policy level

This study shows that the evidence on the societal/policy level is relatively low (2; 2.38%). The societal level of influence comprises societal factors including health, economic, educational, and social policies. Ideally, the government should understand the trends and causes of obesity and formulate strategies to prevent obesity and systematically reverse the epidemic, and these policy-level choices are incorporated on some level into obesity interventions.

In this synthesis, the societal level of determinants includes factors such as social capital [40], neighborhood crime rate [42], air pollution [43], child poverty [44], and urban planning [45], all significantly impact the risk of individuals being obese. These studies jointly opined that government policy plays a vital role in preventing and reversing the obesity epidemic. They further stated that a healthy environment

for the inhabitation of the populace engineered by the implementation of policies is the government's role. Through leadership (by showing a commitment to take necessary actions), funding (by the provision of funding to create a healthy environment) and implementation of policies, the government can be an essential agent for change [46].

An example of a government-led intervention is the "Let's move campaign" initiated by Michelle Obama. This program was established to reduce the incidence of obesity in children and promote a healthy lifestyle and choice among children. To change the lifestyle habits of children, the campaign introduced fresh & healthy foods, exercise, and daily 'fun' activities that involved daily physical activities [47].

Interaction of level of determinants

As discussed earlier, one potentially relevant approach to addressing obesity is to address multiple levels of the SEM framework simultaneously. In this review, 20 studies (23.81%) focused on the interaction between multiple levels. This could imply that the interaction between different SEM levels has been understudied compared. The literature selected in this synthesis showed two main interactions: individual and interpersonal interaction and individual and societal interaction.

Individual and interpersonal interaction

According to [48] genes determine obesity when interacting with the obesogenic environment and behavior. Different environmental factors (both social and cultural) in interaction with genetics affect obesity rates differently [20,49,50] showed that the interaction between several genetic factors and the environment is a leading cause of obesity.

Obesity risk factors in this category (individual and interpersonal interaction), include childhood maltreatment and depression, family functionality, maternal depression, and biophysical environment. These factors significantly impact the risk of being obese. Findings from the literature that focused on childhood maltreatment and depression (as an interaction between the individual and interpersonal) had an odds ratio ranging between 1.0-1.58 implying a medium to a significant effect on obesity risks. Furthermore, results indicate that the interaction between a child's genetics and household state was associated with an elevated risk of developing obesity over their life course. Studies showed the highlighted role of family environment on obesity risks and further established a correlation between a child's mental state (as impacted by parent-child relationship) and obesity risk.

Individual and societal/policy interaction

In this study, there also exists an interaction between the individual and societal/policy level of determinants. Four studies (4.76%) of the selected 84 studies showed this interaction. A risk factor in this category is the impact of individuals' urban environment and socioeconomic characteristics on obesity risk. The synthesis of studies showed a consistent positive relationship between urbanicity and obesity in different demographics. In the different regions in the United States, for example, obesity outcomes differ by socioeconomic characteristics.

Conclusion

This study's findings are aligned with the SEM framework, which serves as a tool to understand better and formulate preventive programs for obesity. This paper synthesized the effect size of different factors and interventions on obesity using the SEM model. This study revealed that the individual level of the determinant is the most studied level of all four levels. The effect size of most factors at the individual level had a

range between 0.5 – 0.8. Studies that incorporate interactions between multiple levels (in this case, the interaction between the individual and interpersonal level of determinants) showed that these interactions are a viable pointer for why there is a difference in the development of obesity among individuals living in the same environment. The individual-interpersonal had effect sizes of 1.27-1.82 and individual-societal interactions had effect sizes above 1.0. These levels are the most common interactions found in this study and incorporating additional levels in a study appears to have greater impacts than those focusing only on the individual level.

A key objective of this paper was to identify levels of SEM that have been understudied. This review has revealed a number of gaps in the literature. From the evidence in this analysis, only two studies (of 84) focused on the societal level of determinant, only one study discussed the interaction between the community and societal levels and two studies analyzed the interpersonal and community interaction. These areas appear to be areas that could usefully receive more research. Incorporating the societal level in solutions seems to be mostly overlooked by interventions and may be the reason why the obesity epidemic has not been solved up to this point. The findings from this research point to the need of changing the focus of intervention from a sole level of determinant to utilizing interactions between levels. This provides information for public health decision-makers and researchers to focus efforts on an effective solution.

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Citation: Uche SC, Rajbhandari-Thapa J, Lyford C (2023) Synthesizing Reviews for a Holistic Understanding of Real Causes and Potential Effect Sizes of Studies on Child and Adult Obesity: A Systematic Review. J Obes Weight Loss Ther 13: 600.

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