

FACTORS INFLUENCING CHILDHOOD OVERWEIGHT AND OBESITY IN LOW AND  
MIDDLE-INCOME COUNTRIES: A SYSTEMATIC REVIEW

BY

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THESIS

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## **ABSTRACT**

The purpose of this study was to examine the current literature on childhood overweight and obesity in low and middle-income countries (LMICs) as defined by the World Bank. Many LMICs are experiencing a dual burden of under- and over-nutrition which has a widespread impact on global health. In addition, globalization and changes in food production in LMICs have been associated with the growing prevalence rates of childhood obesity. Although obesity trends have been well documented in developed countries, there is a lack of representative data on childhood obesity in LMICs. For this study, 29 articles were reviewed and analyzed to examine the factors contributing to childhood overweight and obesity in LMICs. This review provides evidence of childhood overweight/obesity in low and middle-income countries. The findings of this review describe the six main factors associated with childhood overweight and obesity including sociodemographic factors, nutrition transition, family household structure, maternal health status, environment, and sedentary lifestyle. Since the studies varied regarding methods and analysis, we cannot generalize key findings across articles or between countries. Therefore, this review will report on the factors associated with childhood obesity by country based on specific studies to avoid generalization. Future research should use an ecological approach to provide health education to eliminate childhood obesity. Additionally, interventions and strategies should be attentive to the cultural and socioeconomic risk factors that are heavily associated with childhood obesity.

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# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 CHILDHOOD OBESITY: A GLOBAL PUBLIC HEALTH CONCERN**

Childhood obesity is a global public health issue, and prevalence rates are increasing in developing countries. In 2010, 35 million children were estimated to be overweight and obese in developing countries (De Onis, Blössner, & Borghi, 2010). In 2020, prevalence rates are expected to reach 60 million (De Onis, Blössner, & Borghi, 2010). Additionally, the rate of increase of childhood overweight and obesity in low and middle-income countries has been over 30% higher than developed countries (WHO, 2015). According to The World Health Organization (WHO), overweight/obesity is the fifth leading cause of global mortality and is responsible for various chronic diseases including type II diabetes, stroke, hypertension and some forms of cancer (WHO, 2009). It is important to analyze these trends because overweight and obese children are more likely to become obese adults and develop non-communicable diseases (NCDs) (WHO, 2010).

Obesity is caused by an energy imbalance between the amount of calories consumed vs. those expended (WHO, 2015). As a result, an excessive amount of calories consumed combined with limited physical activity can lead to overweight and obesity (Anderson, & Butcher, 2006). Low and middle-income countries are facing a dual burden of under and over-nutrition (Bygbjerg, 2012; Corsi, Finlay, & Subramanian, 2011; Kimani-Murage, 2013). Therefore, prevention programs need to focus on health education overall to help shape individual's choices around their health behaviors. Research suggests that health education backed by theory is the most influential way to modify behavior and, therefore, can prevent unhealthy behaviors from reoccurring (Heimlich & Ardoin, 2008). The WHO started The Global Strategy on Diet, Physical

Activity and Health, which is a prevention program focused on reducing the prevalence of NCDs. To better inform childhood obesity, WHO developed The High-level Commission on Ending Childhood Obesity (ECHO) which aims to address gaps in existing policies and strategies and creates awareness to address childhood obesity (WHO, 2015). Although this is a start to reducing the prevalence rates of childhood obesity, local governments have a long way to go regarding developing strategic action plans to solve this epidemic (Malik, Willett, & Hu, 2013).

## 1.2 DEVELOPING COUNTRIES AT RISK

Low and middle-income countries (LMICs) may be less focused on obesity due to the overwhelmingly high rates of other diseases in these countries. Some of the diseases LMICs are dealing with include cardiovascular disease, tuberculosis, diabetes mellitus, and cancer which contribute to about 80% of the total chronic disease burden (Abegunde, Mathers, Adam, Ortegon, & Strong, 2007). In addition, these chronic conditions are causing more than 80 billion in decreased economic production (Abegunde et al., 2007).

Furthermore, the Sustainable Development Goals are an intergovernmental set of goals with 169 targets, a few of which are focused on goals such as eradicating poverty and hunger, universal education, economic growth, environment sustainability, combating HIV/AIDS, and reducing child mortality (United Nations, 2016). Although these issues are important, they overlook the unhealthy behavioral and lifestyle habits of children that can lead to poor health in adulthood and early mortality.

Low and middle- income countries are facing a double burden of communicable and chronic non-communicable diseases which are primarily affecting low-income populations

(Abegunde, Mathers, Adam, Ortegon, & Strong, 2007; WHO, 2009). Also, the nutrition transition which most low- and middle-income countries are currently experiencing has led to rapid increases in obesity. The nutrition transition is explained by decreased consumption of traditional foods to increased consumption of fast food, sugar-sweetened beverages, and excess fats and oils (Popkin, Adair, & Ng, 2012). There are many adverse consequences of childhood and adolescent obesity short and long-term. These consequences include type II diabetes, hypertension, cardiovascular effects, obesity in adulthood, and chronic illness in adulthood (Reilly, Methven, McDowell, Hacking, Alexander, Stewart, & Kelnar, 2003; Reilly, & Kelly, 2011; Suchindran, North, Popkin, & Gordon-Larsen, 2010). Understanding the risk factors for childhood obesity in these countries is critical for developing interventions and strategies to improve global health and combat health disparities.

### 1.3 RESEARCH QUESTIONS

The following research questions were addressed:

- 1. What factors influence childhood overweight and obesity in low and middle-income countries?*
- 2. What prevention methods should be taken to eliminate childhood obesity in LMICs?*
- 3. How can the government and policy makers contribute to these prevention methods?*

## 1.4 SIGNIFICANCE

The current literature is limited with respect to childhood obesity in low- and middle-income countries, as the main focus has been malnutrition in children and poor child development (Black, Morris, & Bryce, 2003; Engle, Fernald, Alderman, Behrman, O'Gara, Yousafzai, & Iltus, 2011). In addition, the extant literature has focused heavily on overweight and obesity among adults in LMICs such as China (Shankar, 2010), India (Kalra & Unnikrishnan, 2012), Brazil (Aquino, Barreto, Bensenor, Carvalho, Chor, Duncan, & Passos, 2012) and South Africa (Mayosi, Flisher, Lalloo, Sitas, Tollman, & Bradshaw, 2009; Ziraba, Fotso, & Ochako, 2009). This not only overlooks childhood obesity in children, but it only represents a small number of LMICs and these results cannot be generalized across all countries. Due to the lack of comparable representative data on childhood obesity from low and middle-income countries, we are unable to examine the contributors in each country (Jaacks, 2015; Poskitt, 2014). However, by providing useful insights on this prevalent issue, public health professionals will be able to better assess risk factors and implement population-based interventions to combat childhood obesity.

The importance and significance of this study are to expand the knowledge of childhood overweight and obesity in low and middle-income countries. It will provide a review of the current literature in regards to the factors associated with growing rates of overweight and obesity in LMICs. Moreover, this study will suggest future prevention methods and policies for local governments to consider in order to combat this health issue. A gap in the literature exists when examining overweight and obesity in children in LMICs, where most of the work has been focused on aspects of malnutrition in children (Heikens, 2007; Hien, & Kam, 2008; Schoonees, Lombard, Musekiwa, Nel, & Volmink, 2013). In addition, recent studies have noted that

childhood obesity is a form of malnutrition and therefore should be studied and treated more effectively (Amuna & Zotor, 2008; Eckhardt., 2006). The goal of the study was to provide an overview of the trends related to childhood obesity in low and middle-income countries and investigate the factors that contribute to this global epidemic. This review is unique because it investigates the underlying factors contributing to childhood obesity in specific LMICs and does not simply report on the prevalence rates and policy implications.



## **CHAPTER 2**

### **LITERATURE REVIEW**

The purpose of this chapter is to review the current literature from 2005 to 2015 on childhood overweight and obesity in low and middle-income countries (LMICs). LMICs are defined based on the World Bank standard, and childhood overweight and obesity is defined by the World Health Organization (WHO) standard, which will be discussed in detail. The dual burden of under- and over-nutrition will be examined in detail along with the nutrition transition. In addition, factors associated with childhood overweight and obesity in LMICs will be described to explain what is currently known about this global health issue. Lastly, prevention methods and the role of government in eliminating childhood obesity will be described. To conclude, the literature review will describe contributions that this study will make to the existing academic knowledge.

#### **2.1 DEFINING LOW AND MIDDLE-INCOME COUNTRIES (LMICs)**

Low and middle-income countries as defined by the World Bank include low-income economies (LI, gross national income US \$1,045 or less per capita ) and middle income (gross national income US of more than \$1,045 but less than \$12,736 per capita) (World Bank, 2016). All countries included in the low and middle-income groups will be listed below in tables 1-3.

**Table1.** Low-income economies (\$1,045 or less) (Word Bank, 2016)

Afghanistan	Gambia, The	Niger
Benin	Guinea	Rwanda
Burkina Faso	Guinea-Bissau	Sierra Leone
Burundi	Haiti	Somalia
Cambodia	Korea, Dem Rep.	South Sudan
Central African Republic	Liberia	Tanzania
Chad	Madagascar	Togo
Comoros	Malawi	Uganda
Congo, Dem. Rep	Mali	Zimbabwe
Eritrea	Mozambique	
Ethiopia	Nepal	

**Table 2.** Lower-middle-income economies (\$1,046 to \$4,125) (Word Bank, 2016)

Armenia	Indonesia	Samoa
Bangladesh	Kenya	São Tomé and Príncipe
Bhutan	Kiribati	Senegal
Bolivia	Kosovo	Solomon Islands
Cabo Verde	Kyrgyz Republic	Sri Lanka
Cameroon	Lao PDR	Sudan
Congo, Rep	Lesotho	Swaziland
Côte d'Ivoire	Mauritania	Syrian Arab Republic
Djibouti	Federated States of Micronesia	Tajikistan
Egypt, Arab Rep.	Moldova	Timor-Leste
El Salvador	Morocco	Ukraine
Georgia	Myanmar	Uzbekistan
Ghana	Nicaragua	Vanuatu
Guatemala	Nigeria	Vietnam
Guyana	Pakistan	West Bank and Gaza
Honduras	Papua New Guinea	Yemen, Republic
India	Philippines	Zambia

**Table 3.** Upper- middle-income economies (\$4,126 to \$12,735) (Word Bank, 2016)

Albania	Fiji	Namibia
Algeria	Gabon	Palau
American Samoa	Grenade	Panama
Angola	Iran, Islamic Rep.	Paraguay
Azerbaijan	Iraq	Peru
Belarus	Jamaica	Romania
Belize	Jordan	Serbia
Bosnia and Herzegovina	Kazakhstan	South Africa
Botswana	Lebanon	St. Lucia
Brazil	Libya	St. Vincent and the Grenadines
Bulgaria	Macedonia, FYR	Suriname
China	Malaysia	Thailand
Columbia	Maldives	Tonga
Costa Rica	Marshall Islands	Tunisia
Cuba	Mauritius	Turkey
Dominica	Mexico	Turkmenistan
Dominican Republic	Mongolia	Tuvalu
Ecuador	Montenegro	

## 2.2 WHY SHOULD WE FOCUS ON LMICs

There is a large disparity among disadvantaged populations in all countries. However, the disparity is even larger in low and middle- income countries (Sommer, Griebler, Mahlkecht, Thaler, Bouskill, Gartlehner, & Mendis, 2015). This can be explained by the fact that LMICs lack economic revenue and production, healthcare access and government resources compared to high-income countries (Sommer et al., 2015). Empirical evidence indicates that socioeconomic inequalities increase the risk for all non-communicable diseases including cardiovascular diseases, lung and gastric cancer, type 2 diabetes, and obesity (Di Cesare, Khang, Asaria, Blakely, Cowan, Farzadfar, & Oum, 2013; Hosseinpoor, Bergen, Kunst, Harper, Guthold, Rekve, & Chatterji, 2012; Sommer et al., 2015). A recent 2011 report indicates that the negative effects of globalization, unhealthy diet, and limited physical activity present challenges for public health, especially in low and middle-income countries (WHO, 2011). Monitoring these

inequalities and risk factors can help inform local government and prevention researchers to develop effective intervention programs (Hosseinpoor et al., 2012).

There is a large gap in the current research focusing on childhood obesity in LMICs older than age five (Jaacks et al., 2015). A 2011 review on “Global prevalence of overweight and obesity” included 23 studies on obesity in preschool children and only one study out of the 23 was from an LMIC (Vietnam) (Quelly, & Lieberman, 2011). Additionally, many studies have focused on obesity among children and adults in LMICs (Black, Victora, Walker, Bhutta, Christian, De Onis, & Uauy, 2013; Patel, Narayan, & Cunningham, 2015; Swinburn, Sacks, Hall, McPherson, Finegood, Moodie, & Gortmaker, 2011). However, it is imperative to separate the two because the influencing factors and treatment are completely different when dealing with adults versus children. Older children and adolescents are an important group to target because overweight and obesity becomes more prevalent towards adolescence and later (Poskitt, 2014). Furthermore, focusing on this age group is imperative in order to modify current health behaviors that may lead to obesity and other non-communicable diseases.

Current research has reported on the growing prevalence rates of obesity in children. There has been a substantial increase in prevalence rates of childhood obesity globally from 1980 to 2013 (Ng, Fleming, Robinson, Thomson, Graetz, Margono, & Abraham, 2014). In developed countries, rates have increased from 22.9% to 24.7% in boys and 21.7% to 23.66% in girls (Ng et al., 2014). In addition, prevalence rates have increased in developing countries from 8.1% to 12.9% in boys and 8.4% to 13.4% in girls (Ng et al., 2014). Although prevalence rates are increasing globally, a majority of overweight and obese children are currently living in low-income countries (De Onis, Blössner, & Borghi, 2010). A recent study from China indicates growing rates of overweight in girls ages 11-18 years old from 3.5% in 1991 to 9.3% in 2011

(Gordon-Larsen, Wang, & Popkin, 2014). Another study from Mexico reports an increase in overweight among girls ages 12-19 from 11.1% in 1988 to 35.8% in 2012 (Barquera, Campos, & Rivera, 2013). Additionally, a 2012 study indicated that prevalence rates of childhood obesity are still on the rise with rates at 41.8% in Mexico, 22.1% in Brazil, 22% in India and 19.3% in Argentina (Gupta, Goel, Shah, & Misra, 2012). This evidence demonstrates that there is a need to focus our efforts on childhood overweight and obesity in LMICs.

## 2.3 DEFINING CHILDHOOD OVERWEIGHT AND OBESITY

The World Health Organization, United States Centers for Disease Control and Prevention, and International Obesity Task Force all have definitions of overweight and obesity in children and adolescents. Current research uses the WHO, CDC and IOTF criteria in studies dealing with childhood obesity (Dearth-Wesley et al., 2008; Lourenço, Villamor, Augusto, & Cardoso, 2012; Onywera et al., 2014; Tathiah et al., 2013). Childhood overweight and obesity are defined as “abnormal or excessive fat accumulation that presents a risk to one’s health” (WHO, 2016). The respective organizations standards for assessing overweight and obesity in children are listed in Table 4.

**Table 4.** Child Growth Standards Used To Measure Body Mass Index in Children

Organization	Child Growth Standards
World Health Organization	<p><i>(birth to age 5)</i></p> <p><b>Obese:</b> Body mass index (BMI) &gt; 3 standard deviations above the WHO growth standard median</p> <p><b>Overweight:</b> BMI &gt; 2 standard deviations above the</p> <p><i>(ages 5 to 19)</i></p> <p><b>Obese:</b> Body mass index (BMI) &gt; 2 standard deviations above the WHO growth standard median</p> <p><b>Overweight:</b> BMI &gt; 1 standard deviation above the WHO growth standard median.</p>
U.S. Centers for Disease Control and Prevention	<p><i>(ages 2 to 19):</i> BMI assessed using age- and sex-specific percentiles:</p> <p>Obese: BMI - 95th percentile</p> <p>Overweight: BMI - 85th and &lt; 95th percentile</p> <p><i>(Birth to age 2 )</i></p> <p>CDC uses a modified version of the WHO criteria.</p>
International Obesity Task Force	<p><i>(ages 2 to 18):</i> BMI assessed using age- and sex-specific percentiles:</p> <p>Corresponds to the WHO Adult BMI Standards</p> <ul style="list-style-type: none"> <li>• BMI greater than or equal to 25 is overweight</li> <li>• BMI greater than or equal to 30 is obesity.</li> </ul>

## 2.4 DEFINING THE DUAL BURDEN OF UNDER AND OVERNUTRITION

The distribution of nutritional diseases in low and middle-income countries is shifting from undernutrition to a dual burden of under and over nutrition (Tzioumis, & Adair, 2014). Globally, prevalence rates of malnutrition are decreasing while rates of over-nutrition in children are decreasing (Ihab, Jalil, Manan, Suriati, Zalilah, & Rusli, 2013; Kimani-Murage, 2013; Tzioumis, & Adair, 2014; Uauy, Garmendia, & Corvalán, 2014). The WHO estimates that rates of over-nutrition has increased to 1.2 billion while rates of undernourished population in the world have declined and is around 1.2 billion (Sattar, McConnachie, Shaper, Blauw, Buckley, de Craen, & Lennon, 2008). Research suggests that there are many factors that contribute to this double burden of malnutrition in LMICs which include socioeconomic status, globalization, poor nutritional status, anemia, and micronutrient deficiencies (Le Nguyen, Le Thi, Thuy, Huu, Do, Deurenberg, & Khouw, 2013; Subramanian, Kawachi, & Smith, 2007; Tzioumis, & Adair, 2014). Globalization, the growth of fast food outlets, and commercial products have led to increases in childhood obesity (Poskitt, 2014). Also, poor nutritional status, anemia and micronutrient deficiencies have been associated with underweight children (Tzioumis & Adair, 2014). Additionally, a current study suggests that this dual burden has been identified at the community, individual and household level collectively, but these levels have not been addressed simultaneously (Tzioumis, & Adair, 2014). A study conducted in Brazil, China, Indonesia, and Vietnam and the United States on ‘dual burden households and nutrition paradox’ indicates that over 50% of households that had an underweight person also had an overweight person (Doak, Adair, Bentley, Monteiro, & Popkin, 2005). This article further suggests that household lifestyle factors such as diet and physical activity patterns may contribute to the dual burden of malnutrition. A similar analysis in Vietnam indicates that malnutrition was more prevalent in

rural areas at 22.2% and overweight and obesity was most prevalent in urban areas at 29% (Le Nguyen et al., 2013). However, there are mixed results in the existing literature related to urban vs. rural nutritional status in children. A study from China indicated that children living in rural neighborhoods had higher rates of overweight and obesity in children (Dearth-Wesley et al., 2008). Another study from South Africa found that children living in urban environments had higher rates of childhood obesity compared to children in rural environments (Armstrong, Lambert, Sharwood, & Lambert, 2006). This evidence suggests that more research needs to be done in regards to figuring out the neighborhood context and other factors that may be contributing to these different trends.

In sum, the dual burden of malnutrition poses a threat to the overall health of children in LMICs. Since, malnutrition refers to both underweight, overweight, and stunting in developing countries, it is important to recognize the underlying factors contributing to these conditions (Uauy et al., 2014). Prevention of these nutritional diseases is a continuous process that starts in the fetal stages of development and continues throughout childhood and adolescence (Uauy et al., 2014). Public health stakeholders and government agencies must remain supportive and provide the necessary resources to tackle this important health issue.

## 2.5 DEFINING THE NUTRITION TRANSITION

The nutrition transition is defined by the multiple changes occurring in developing countries, including the movement away from traditional dietary patterns towards a more Westernized culture that is associated with overconsumption of energy-dense foods (Popkin, 2004). It is believed that this transition began in the early 1970's where changes in diets began to shift towards processed foods and sugar-sweetened beverages (Popkin, Adair, & Ng, 2012).



However, research suggests that the nutrition transition did not become recognizable in LMICs until the 1990's when there were rapid increases in non-communicable diseases (NCD's) (Popkin, Adair, & Ng, 2012). The burden of NCD's has become a global crisis with rates continuously rising (Beaglehole, Bonita, Alleyne, Horton, Li, Lincoln, & Piot, 2011). Furthermore, developing countries have the largest burden of non-communicable diseases when compared to developed countries (Bygbjerg, 2012). Currently, obesity, diabetes, hypertension, and other NCD's are widely documented in LMICs (Azizi, Ghanbarian, Momenan, Hadaegh, Mirmiran, Hedayati, & Zahedi-Asl, 2009; Beaglehole, Bonita, Horton, Adams, Alleyne, Asaria, & Cecchini, 2011; Popkin, & Slining, 2013). In low- and middle-income countries, 53.8% of all deaths are attributed to non-communicable diseases while 36.4% of deaths to communicable diseases (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006).

Evidence suggests that the nutrition transition is related to changes in patterns of agricultural, socioeconomic factors, and economic changes (Popkin, 1998). Rapid urbanization and growing populations in urban areas increased changes in unhealthy diets (Popkin, 1993). Also, diets in urban areas have increased in the consumption of foods higher in sugar and fat, more animal products, processed foods, less breastfeeding and supplementation of infant diets compared to diets in rural areas (Popkin, 1993). Additionally, a wealth of research has shown that NCD's is attributable to lifestyle and environmental factors such as limited physical activity and smoking (Miranda, Kinra, Casas, Davey Smith, & Ebrahim, 2008). Since lifestyle and environmental factors are modifiable, we understand that many NCD's are preventable.

## 2.6 FACTORS ASSOCIATED WITH CHILDHOOD OVERWEIGHT AND OBESITY

Current research has focused on the growing prevalence rates of childhood overweight and obesity in low and middle-income countries ((Lobstein, Jackson-Leach, Moodie, Hall, Gortmaker, Swinburn, & McPherson, K. 2015; Quelly & Lieberman, 2011; Swinburn et al., 2011). However, there is limited representative data on the actual factors contributing to childhood overweight and obesity in LMICs. This is due to the lack of intervention studies and statistical data available in these countries. There have been many reviews and reports on the associated factors that influence childhood obesity in LMICs. However, there are very limited documented statistically significant factors available in papers (Poskitt, 2014, Quelly & Lieberman, 2011).

Research suggests that many factors are associated contributors to childhood overweight and obesity in LMICs. Some of these factors include lack of physical activity, urbanization, fast food consumption, food advertisements, skipping breakfast, screen time/ television viewing, short sleep duration, and limited health policies (Katzmarzyk, Barreira, Broyles, Champagne, Chaput, Fogelholm, & Lambert, 2015; Poskitt, 2014, Quelly & Lieberman, 2011). It is important to recognize that the factors influencing childhood obesity may be different based on cultural and environmental influences (Poskitt, 2014). For example, two-thirds of South African adolescents report consuming fast food at a minimum of 3 times per week and had higher BMI's than adolescents who did not report consuming fast food (Feeley, Musenge, Pettifor, & Norris, 2013). In addition, a study in India indicated that parents played a major role in dietary intake and parental food choices influenced children's food choices (Riggs, Tewari, Stigler, Rodrigues, Arora, Khubchandani, & Pentz, 2013). Furthermore, additional research suggest that factors influencing obesity differ in urban vs. rural environments (Adamo, Sheel, Onywera, Waudo,

Boit, & Tremblay, 2011; Miranda et al., 2008). This paper will examine the existing literature on factors associated with childhood overweight and obesity in low and middle-income countries and will assist in efforts to improve prevention and intervention programs.

## 2.7 PREVENTION METHODS AND ROLE OF GOVERNMENT

Since childhood obesity has increased dramatically in low and middle-income countries, prevention and management should be an essential public health priority. Many low and middle-income countries are exploring policy measures related to decreasing health disparities such as obesity and other non-communicable diseases (Popkin, Adair, & Ng, 2012). However, few of these countries are fully engaged in the initiatives to prevent the growing rates of obesity (Popkin, Adair, & Ng, 2012). The government has a major influence on the future direction of obesity rates, especially in low and middle-income countries. For example, the commercial sector including fast food and beverage companies are expanding in LMICs and are influencing overweight and obesity (Poskitt, 2014). Although this sector brings economic growth to these countries, it is also impacting the health of community members in a negative way. Government officials should start with assessing the current health policies and programs that are already in place (Poskitt, 2014). In addition, effective disease surveillance must be in place to track obesity rates over time and evaluate progress over time (Alwan, MacLean, Riley, Ld'Espaignet, Mathers, Stevens, & Bettcher, 2010). Furthermore, LMICs can learn from other initiatives taking place in similar countries/environments and design interventions based on existing effective programs.

When designing interventions, it is important to promote healthy lifestyles among children across cultures and environments (Katzmarzyk et al., 2015). Since lifestyle behaviors may not be the same across all regions of the world, designing culturally appropriate programs to

address possible perceptions and myths related to health behaviors are essential (Adair, 2014). For example, in most African countries, there is a strong socio-cultural belief that being big-boned or roundness is a sign of wealth (Adamo et al., 2011). Therefore, it would be important to address myths such as this to shift beliefs related to healthy lifestyles. It is imperative that all LMICs have political commitment to support action-based initiatives towards healthy lifestyle changes and combat childhood obesity.

## CHAPTER 3

### METHODS

#### *Search strategy, inclusion and exclusion criteria*

The present review included studies that investigated childhood obesity and over-nutrition in low and middle-income countries. Low-and middle income countries as defined by the World Bank include low-income economies include (LI, gross national income US \$1,045 or less per capita ) and middle-income (gross national income US of more than \$1,045 but less than \$12,736 per capita) (World Bank, 2016). Children were defined as any person between the ages of 0 and 17 as aligned with The United Nations Convention on the Rights of the Child standard definition (United Nations, 2016). Studies that included only adult over-nutrition as an outcome were excluded. Studies were limited to those published between 2005 and 2015 to provide a recent representation of the literature.

#### *Search Terms Described Below*

<b><i>Table 5. Searching keywords</i></b>		
Child	1) Child	3) Childhood
	2) Children	4) Adolescent
Obesity	1) Obesity	3) Malnutrition
	2) Overweight	4) Over-nutrition
LMIC	1) Developing countries	
	2) Low and middle-income countries	

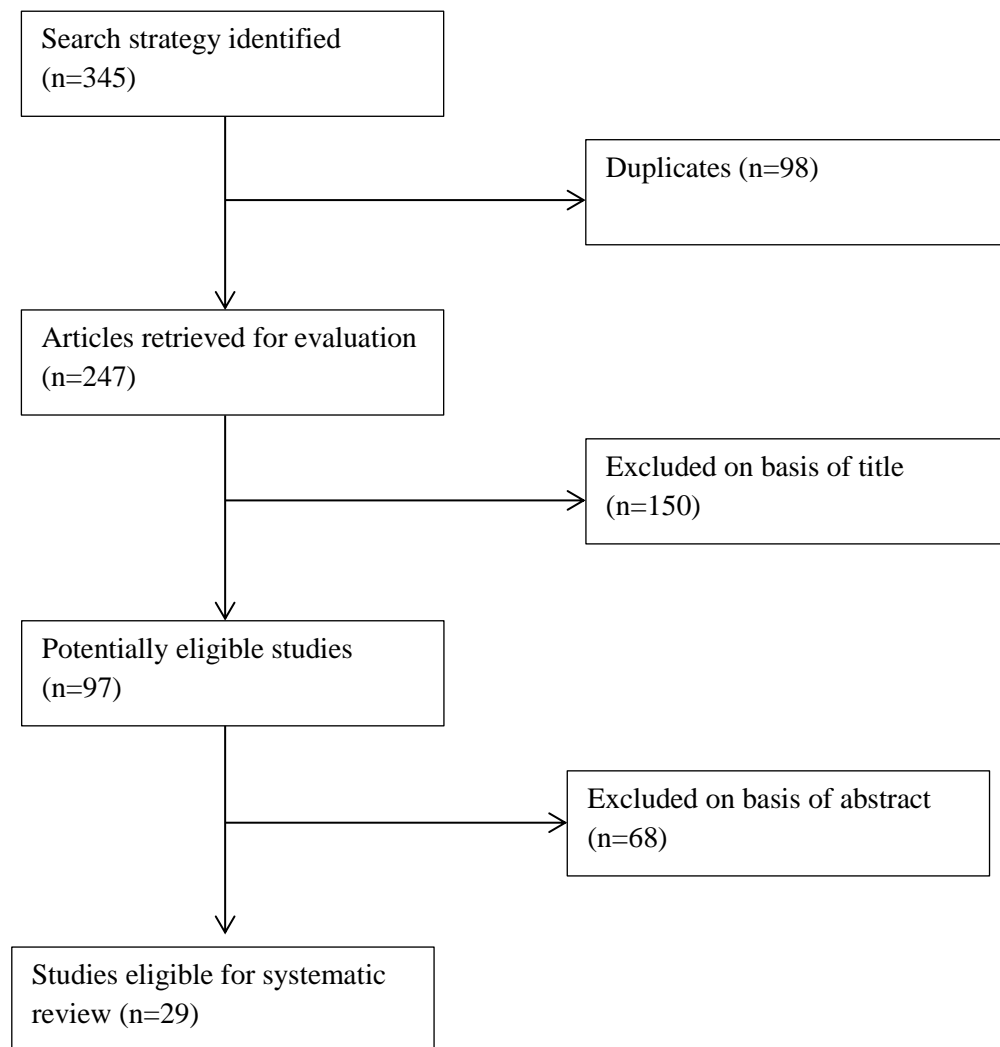
The search began in November 2015 and ended in February 2016, and the databases included were EBSCO, PubMed, Web of Science, CINAHL, and Scopus. Limitations placed on the search required that the articles be:

1. Peer reviewed
2. Written in English,
3. Include children 0-17.

All abstracts were considered for significance by one author (DR), and full papers were then examined to determine relevance.

Studies that measured outcomes other than child or adolescent overweight and obesity were excluded, however if studies measured child obesity along with other variables they were included. A number of studies examined childhood obesity in general in low and middle-income countries; these were excluded because we wanted to focus the review on specific LMICs and avoid generalized papers. Studies that examined risks and factors contributing to childhood obesity were included. This includes one qualitative analysis that offered insights about contributing factors from children's point of view as well as the other quantitative studies. Twenty-nine articles met the inclusion and exclusion criteria (see Figure 2).

**Figure 1.** Search Strategy Results



\*Databases: EBSCO, PubMed, Web of Science, Scopus, and CINAHL

## **CHAPTER 4**

### **RESULTS**

The following chapter presents results from the 29 articles included in the review. The results will highlight the factors contributing to overweight and obesity in each peer-reviewed article. In addition, it will offer suggestions for policy changes and prevention and intervention programs in LMICs.

A total of 345 articles were identified, 150 articles were excluded based on the title, and 247 were examined for evaluation with 98 duplicates across databases. In addition, 97 articles were examined for relevance and 68 articles were excluded based on the abstract. In total, 29 articles met the inclusion criteria and were included in the review. There were 18 LMICs represented in this review which is about 13% of all LMICs (see Figure 2). The methodology used in each study varied. Therefore, it is not possible to report any variations across or between groups in these low and middle-income countries. Additionally, studies varied in target age group, settings, population characteristics, demographics, and method of data collection and analysis. See (Table 6) for additional information on the specific LMICs included in this review, obesity evaluation standards used in articles and associated factors influencing obesity. Previous research shows that the development of childhood overweight and obesity involves a complex set of factors many of which interact with one another (Davison & Birch, 2001). These complex factors can be conceptualized using the Ecological Systems Theory (EST). The Ecological Systems Theory highlights the ecological niche in which a child's location in society influences their behaviors (Davison & Birch, 2001). The ecological niche for a child includes the family, school, and community/environment (Davison & Birch, 2001). This review uses a modified version of the EST as a framework to identify the factors that influence childhood overweight



and obesity in LMIC. Findings are presented by factors grouped into 6 categories: (i) sociodemographic factors, (ii) nutrition transition/globalization, (iii) family household structure, (iv) maternal health status, (v) community environment, and (vi) sedentary lifestyle (see Figure 3).

#### 4.1 SOCIODEMOGRAPHIC FACTORS

The most common risk factor for childhood overweight and obesity across all articles was high socioeconomic status (SES). Of the 29 studies that were investigated, 13 articles found a strong association between overweight and obese children and high SES (Assis et al., 2005; Carrillo-Larco et al., 2014; Discigil et al., 2009; Dearth-Wesley et al., 2008; Gómez-Arbeláez et al., 2014; Gonzalez-Casanova et al., 2014; Kimani-Murage et al., 2011; Lourenco et al., 2012; Mushtaq, Gull, Shafique, Abdullah, Shad, & Siddiqui., 2011; Mushtaq, Gull, Abdullah, Shahid, Shad, & Akram., 2011; Onywere et al., 2014; Thakre et al., 2011; Trang et al., 2012). Furthermore, a few of the studies which reported SES as a risk factor, also found that living in affluent neighborhoods with excess resources was a risk factor for childhood obesity (Mushtaq, Gull, Shafique, Abdullah, Shad, & Siddiqui., 2011; Mushtaq, Gull, Abdullah, Shahid, Shad, & Akram., 2011; Thakre et al., 2011). Contrary to this, two of the studies completed in Columbia and Vietnam found strong associations between poverty and childhood obesity (Gonzalez-Casanova et al., 2014; Trang et al., 2012). In addition, two studies from Columbia and Vietnam found that children who had access to transportation (motorcycles or cars) had higher levels of overweight and obesity than children who lacked these resources (Gómez-Arbeláez et al., 2014; Trang et al., 2012).

Although few studies investigated the association between schools and childhood obesity, 2 studies found that attending private school was associated with higher rates of overweight and

obesity (Mushtaq, Gull, Abdullah, Shahid, Shad, & Akram., 2011; Onywere et al., 2014). This aligns with the fact that having a high SES allows parents to afford private school education for their children. In addition to parents having high SES and buying power, one study found that children who were employed also had advantages when it came to affording resources. One study done in Brazil found that adolescents who were employed had higher abdominal obesity than those who were unemployed (De Moraes et al., 2013). This association was explained by the large amounts of processed and energy-dense foods adolescents consumed before and during work (De Moraes et al., 2013).

#### 4.2 NUTRITION TRANSITION

The Nutrition Transition is explained by the shift towards a more Westernized diet and changes in eating patterns including high consumption of energy-dense foods, sugar-sweetened beverages, and fast foods (Popkin, Adair, & Ng, 2012). Many low and middle-income countries are experiencing the nutrition transition which has led to increases in preventable non-communicable diseases such as heart disease, obesity, and diabetes (Muthuri et al., 2014). Ten out of the twenty-nine studies included in this review referenced the nutrition transition as one of the risk factors for childhood overweight and obesity (Adamo et al., 2011; Agha-Alinejad et al., 2015; Assis et al., 2005; Carrillo-Larco et al., 2014; Dancause et al., 2015; Dearth Weslet et al., 2008; Esquivel et al., 2010; Gómez-Arbeláez et al. 2014; Lourenco et al., 2012; Tathiah et al., 2013; Trang et al., 2012).

Furthermore, one study from rural South Africa found that rural areas were experiencing profound changes in food patterns including more fast foods, which was associated with the 9% overweight and 3.8% obesity rates in children (Tathiah, 2013). Another study from Pakistan found that living in urban areas with access to more stores serving fast food and other processed

foods was a risk factor for childhood obesity (Mushtaq, Gull, Abdullah, Shahid, Shad, & Akram., 2011). A study done in China found that the nutrition transition which caused dietary shifts especially in high-income households, was the primary reason for childhood overweight (Dearth-Wesley et al., 2008). This study found that in 1991, 7.9% of children were overweight and in 2004 16.5% were overweight (Dearth-Wesley et al., 2008). Although only ten articles noted the nutrition transition as a main risk factor, all 29 articles talked briefly about the effect of the nutrition transition on childhood obesity in LMICs.

#### 4.3 FAMILY HOUSEHOLD STRUCTURE

Three studies examined the relationship between family-based household factors and childhood obesity (Gonzalez-Casanova et al., 2014; Kimanui-Murage et al., 2011; Mushtaq, Gull, Abdullah, Shahid, Shad, & Akram., 2011). However, there were a total of 6 out of 29 articles that mentioned household factors being associated with obesity (Fatemeh et al., 2012; Gonzalez-Casanova et al., 2014; Katzmarzyk et al., 2015; Kimanui-Murage et al., 2011; Mushtaq, Gull, Abdullah, Shahid, Shad, & Akram., 2011; Thakre et al., 2011). One study from Pakistan found that children who have two parents with full-time jobs have higher rates of overweight and obesity than children with one working parent. Also, children with two working parents had obesity rates at 22.5% compared to 15.5% obesity in children with only an employed father (Mushtaq, Gull, Abdullah, Shahid, Shad, & Akram., 2011). This was explained by the parents' busy lifestyles, which can influence children to care for themselves, skip breakfast or rely on fast foods for meals. This same study found that children with 3 or fewer siblings had higher rates of overweight compared to children with more than three siblings, reporting 31.9% and 14.6% respectively. Furthermore, Mushtaq, Gull, Abdullah, Shahid, Shad, & Akram. (2011),

also indicated that parental education was a contributing factor to childhood obesity. Children with parents who completed a college degree or higher were two times as likely to be overweight than other children.

Another study from Columbia found that living with extended family members was associated with higher rates of obesity (Gonzalez-Casanova et al., 2014). This was explained by extended family members influencing the eating and exercise behaviors of children, which may be different from their main caregiver (Gonzalez-Casanova et al., 2014). In addition, Gonzalez-Casanova et al. (2014), found more female to be overweight than males. This outcome was explained by the social norms in Columbia that encourage increased body fat in girls and more physical activity in boys. Additionally, a study from South Africa noted that household factors were the main reason for obesity in children because parents influence food choices, and exercise choices (Kimanui-Murage et al., 2011). Moreover, a similar study from India found that parents serving unhealthy meals due to their limited time at home, was a risk factor for obesity (Riggs et al., 2015).

Sleep duration was found to be a risk factor for obesity in two studies (Katzmarzyk et al., 2015; Thakre et al., 2011). Both studies found that short sleep duration was a significant behavioral correlate of obesity (Katzmarzyk et al., 2015; Thakre et al., 2011). This was explained by household factors such as parents working and unable to monitor sleep patterns. There is a need to educate parents on these important factors and encourage more monitoring of health behaviors including duration of sleep.

#### 4.4 MATERNAL HEALTH STATUS

Early life factors especially those related to maternal health have been associated with childhood overweight and obesity (Adair et al., 2013; Dancause et al., 2011; Li et al., 2012; Lourenco et al., 2015). Three studies from Brazil, China and a five country birth cohort study in Brazil, Guatemala, India, South Africa and the Philippines found that maternal obesity was associated with childhood overweight and obesity (Adair et al., 2013; Li et al., 2012; Lourenco et al., 2015). In addition, Li et al. (2012), found an association between babies that were born large for gestational age (LGA) were three times as likely to be overweight than smaller babies. Li et al. (2012) also found that children who had a family history of obesity-related diseases had higher rates of obesity than other children. Lastly, overweight and obesity prevalence rates were 14.5% and 3.3% respectively among children ages 9-15 in China (Li et al., 2012).

Furthermore, Dancause et al. (2011) reported that children with low birth weight (LBW) and stunted children were at higher risk of overweight and obesity than normal weight children. This was explained by the societal pressures that are placed on parents including encouraging rapid weight gain in children who are LBW and stunted. This misconception needs to be clarified to parents of LBW children and steady, healthy weight gain in early life should be encouraged instead. Interventions should focus on educating pregnant mothers on the risks of under and over-nutrition, especially since there has been evidence that under-nutrition, stunting, and over-nutrition are all risk factors of childhood obesity

#### 4.5 COMMUNITY ENVIRONMENT

Very few studies investigated the environment and its effects on overweight and obesity in children. However, two studies reported on environmental characteristics and its associations

with childhood obesity (Mushtaq, Gull, Abdullah, Shahid, Shad, & Akram., 2011; Trang et al., 2012). Trang et al. (2012) reported low walkability in the environment as a main risk factor for childhood obesity. This outcome was explained by the decreased prevalence of active commuting in Vietnam throughout the years. In addition, Trang et al. (2012) reported that living in wealthy environments was a risk factor for obesity in children. This was explained by the fact that children living in wealthy neighborhoods were less likely to commute around the neighborhood, due to their parents having the luxury to drive them to and from school and other activities. A similar study from Pakistan also reported that living in urban areas with high SES as a risk factor for childhood overweight and obesity (Mushtaq, Gull, Abdullah, Shahid, Shad, & Akram., 2011). Contrary to this, Trang et al. (2012) found that children living in impoverished neighborhoods were more likely to actively commute and had lower obesity rates than wealthy children (Trang et al., 2012).

#### 4.6 SEDENTARY LIFESTYLES

Twelve studies reported sedentary lifestyle or low levels of physical activity in children to be an associated risk factor for childhood obesity (Adamo et al., 2011; Agha-Alinejad et al., 2015; Discigil et al., 2009; Esquivel et al., 2010; Heidari et al., 2014; Katzmarzyk et al., 2015; Kimani-Murage et al., 2011; Mandal, A., & Mandal, G 2012; Mushtaq, Gull, Abdullah, Shahid, Shad, & Akram., 2011; Onywera et al., 2014; Ramzan et al., 2008; Tathiah et al., 2013). One study from Kenya compared physical activity in children from urban and rural areas and reported that urban children had lower levels of physical activity than rural children (Adamo et al., 2011). In addition, the prevalence rates of obesity in rural children were 0% compared to 6.8% in boys and 16.7% girls from urban areas. A study from India reported low levels of physical activity to

be associated with childhood obesity (Mandal, A., & Mandal, G 2012). This study also reported low levels of health literacy in children in the study. This suggests that health educators need to target young children by teaching and encouraging frequent physical activity as suggested by the World Health Organization. Furthermore, a study from Iran reported that normal weight girls performed better on fitness tests than overweight and obese girls (Agha-Alinejad et al., 2015). This outcome proposes that obesity also inhibits your ability to engage in physical activity.

In addition to low levels of physical activity being a risk for childhood obesity in LMICs, studies also reported that these low levels of physical activity are due to long duration of screen time (Katzmarzyk et al., 2015; Ramzan et al., 2008; Thakre et al., 2011). Screen time is defined by television viewing, playing video games, or using a computer/tablet device (Katzmarzyk et al., 2015). A study from India by Thakre et al. (2011) reported higher prevalence rates of obesity among children living in urban areas. Due to the high traffic in urban areas, children can only play indoor games or watch television. This cultural limitation suggests that these children do not get the recommended amount of physical activity compared to their peers living in rural environments who are not restricted to indoor activities. There is an urgent need to educate this community on the benefits of outdoor playtime and physical activity in order to prevent childhood obesity.

#### 4.7 DESIGNING CULTURALLY APPROPRIATE INTERVENTIONS

Based on the results, each country included in this review had differences in risk factors contributing to childhood obesity. Therefore, it is important to note these differences when designing interventions. For example, living in poverty and having high socioeconomic status were risk factors for childhood obesity in Columbia. This shows that there are social and

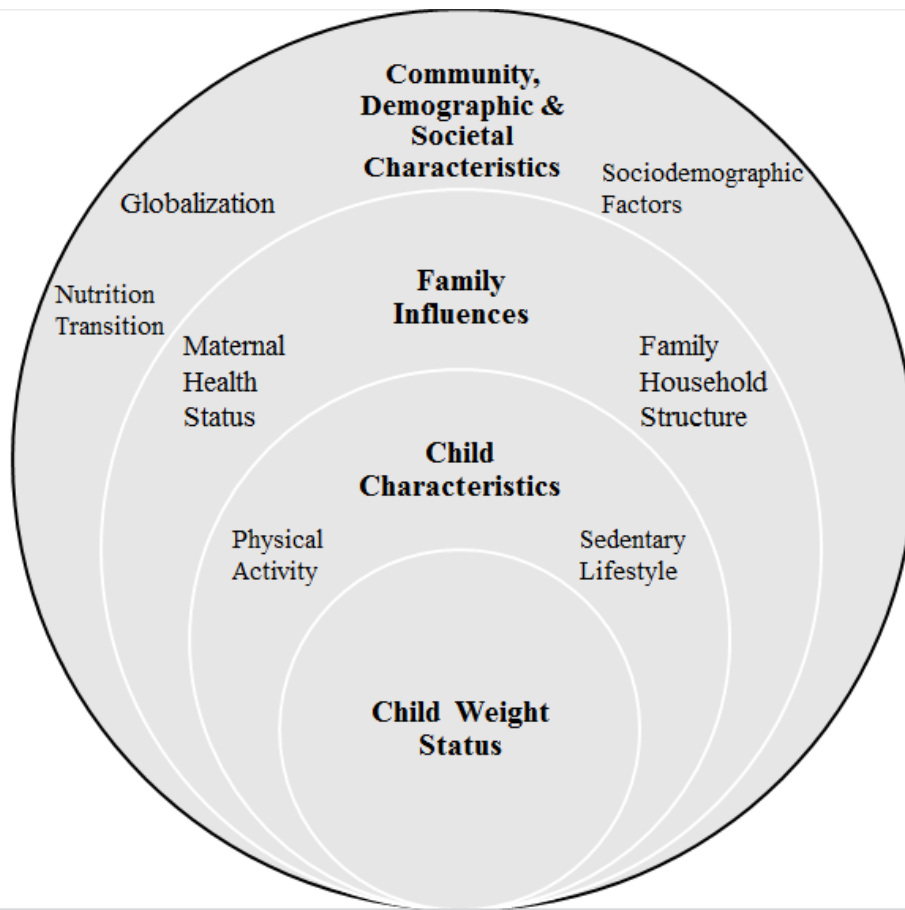
contextual differences in low income vs. high-income families and both include risk factors for childhood obesity. In addition, living in high-income affluent neighborhoods was a risk factor for childhood obesity in Turkey, India, and China. Lastly, living in urban Pakistan was a risk factor for childhood obesity however living in rural South Africa was also a risk factor. Figure 4 explains effects of childhood obesity and shows that some factors showed a positive and negative effect depending on the country represented.



**Figure 2.** Low and Middle-Income Countries Included in Review (ArcGIS 10.3, 2016)



**Figure 3.** Ecological Model of Predictors of Childhood Overweight and Obesity in LMICs



**Figure 3** Ecological model of predictors of childhood overweight and obesity in LMIC. Modified from (Davison & Birch, 2001).

**Figure 4.** Positive and Negative Influences of Childhood Overweight and Obesity in LMICs

Sociodemographic Factors	Globalization	Family Household Structure	Maternal Health Status	Community Environment	Food marketing	Sedentary Lifestyle
<ul style="list-style-type: none"> <li>• Low SES -</li> <li>• High SES(-,+)</li> <li>• Affordability of processed foods -</li> <li>• Transport -</li> <li>• Entertainment (affordability of TV's and video games)-</li> </ul>	<ul style="list-style-type: none"> <li>• Changes in food production -</li> <li>• Economic Growth -</li> <li>• Urbanization (-,+)</li> <li>• Increase in fast-food -</li> <li>• Nutrition Transition -</li> </ul>	<ul style="list-style-type: none"> <li>• Parental roles in food choices -</li> <li>• Work life balance -</li> <li>• Skipping Breakfast -</li> <li>• Extended Family Members -</li> </ul>	<ul style="list-style-type: none"> <li>• Maternal Obesity-</li> <li>• Unhealthy Diet -</li> <li>• Low Birth Weight (children forced to gain weight rapidly) -</li> </ul>	<ul style="list-style-type: none"> <li>• Rural (-,+)</li> <li>• Urban (-,+)</li> <li>• Walkability +</li> </ul>	<ul style="list-style-type: none"> <li>• Food Advertisement Exposure -</li> <li>• Commercial/Processed Food Products -</li> </ul>	<ul style="list-style-type: none"> <li>• Watching TV -</li> <li>• Playing Video Games -</li> <li>• Low Rates of Physical Activity-</li> </ul>

**Table 6.** Factors Influencing Childhood Overweight and Obesity in Low and Middle-Income Countries

<b>Author (year published)</b>	<b>Country (region)</b>	<b>Age (s)/ sample size</b>	<b>Factors Associated with Overweight and Obesity</b>	<b>Obesity Evaluation Standard Used</b>
Ref 4. Onywera et al., (2014)	Kenya	9-11 y.o. (n=563)	Sedentary lifestyle High-income Attending private schools Urbanization	WHO
Ref 31. Adamo et al., (2011).	Kenya	9-13 y.o. (n=179)	Nutritional Transition Low levels of physical activity	CDC
Ref 7. Tathiah et al., (2013)	South Africa	9-12 y.o. (n=936)	Changes in food patterns Nutritional transition Inactivity	WHO
Ref 34. Kimani-Murage et al., (2011).	South Africa	10-20 y.o. (n=1,848)	Unhealthy Diet Low levels of physical activity High Socioeconomic status Household factors	CDC
Ref 45. Salman et al., (2010)	Sudan	6-12 y.o. (n=304)	Hypertension	IOTF
Ref 17. Lourenço et al. (2012)	Brazil	0-10 y.o. (n=255)	Nutritional Transition High Socioeconomic status Maternal obesity Child birth weight	WHO
Ref 50. Assis et al., (2005)	Brazil	7-10y.o. (n=2,936)	Nutrition Transition High Socioeconomic status	IOTF

**Table 6.** (Cont.)

<b>Author (year published)</b>	<b>Country (region)</b>	<b>Age (s)/ sample size</b>	<b>Factors Associated with Overweight and Obesity</b>	<b>Obesity Evaluation Standard Used</b>
Ref 20. Gómez-Arbeláez et al. (2014)	Columbia	8-14 y.o. (n=668)	Availability of transport (car or motorcycle) High Socioeconomic status Nutritional Transition	CDC
Ref 47. Esquivel et al., (2010)	Cuba	<19 y.o. (n=51,177)	Nutrition Transition Socioeconomic development Urbanization Sedentary lifestyle	CDC
Ref 48. Discigil et al., (2009)	Turkey	6-16 y.o. (n=1,348)	High Socioeconomic status	CDC
Ref 22. Kelishadi et al. (2012).	Iran	2-18 y.o. (n=457)	Limited Physical activity Over consumption of carbohydrates	CDC
Ref 24. Agha-Alinejad et al. (2015).	Iran	9-11 y.o. (n=183)	Nutritional Transition Urbanization Poor fitness performance Low levels of physical activity	IOTF
Ref 11. De Moraes et al., (2013)	Brazil	14-18 y.o. (n=991)	High consumption of soda and sweets Abdominal Obesity Unhealthy Diet	WHO
Ref 19. Gonzalez-Casanova et al., (2014)	Columbia	5-18 y.o. 2005 (n=9,229) 2010 (n=21,520)	High Socioeconomic status Poverty Living with extended family member	WHO
Ref 42. Thakre et al., (2011).	India	5-16 y.o. (n=1,524)	High Socioeconomic status Living in high-income neighborhood Consumption of “junk food” Short duration of sleep	CDC

**Table 6. (Cont.)**

<b>Author (year published)</b>	<b>Country (region)</b>	<b>Age (s)/ sample size</b>	<b>Factors Associated with Overweight and Obesity</b>	<b>Obesity Evaluation Standard Used</b>
Ref 40. Fatemeh et al., (2012).	Iran	2-5 y.o. (n=500)	Mothers occupation Fathers low levels of education	CDC
Ref 38. Heidari et al., (2014).	Iran	12-14 y.o. (n=12,946)	Lack of physical activity	CDC
Ref 43. Mushtaq et al., (2011).	Pakistan	5-12 y.o. (n=1,860)	Living in high-income neighborhood Higher parental education Both parents having jobs Having 3 or less siblings	WHO
Ref 46. Mushtaq et al., (2011)	Pakistan	5-12 y.o. (n=1,860)	Urban Neighborhoods High Socioeconomic status Living in affluent neighborhoods Attending private school	WHO
Ref 49. Ramzan et al., (2008)	Pakistan	6-11 y.o. (n=1,338)	Long duration of viewing television and computers Sedentary lifestyle Over-eating energy-dense foods	CDC
Ref 39. Mandal, A., & Mandal, G (2012).	India	12-18 y.o. (n=571)	Low health literacy Unhealthy eating habits Low levels of physical activity	CDC
Ref 6. Riggs et al., (2013)	India	9-11 y.o. (n=183)	Long Duration of Screen time Unhealthy Diet Parents serving unhealthy meals Parents lack time after work to prep healthy meals	N/A

**Table 6. (Cont.)**

<b>Author (year published)</b>	<b>Country (region)</b>	<b>Age (s)/ sample size</b>	<b>Factors Associated with Overweight and Obesity</b>	<b>Obesity Evaluation Standard Used</b>
Ref 41. Adair et al., (2013).	China	9-15 y.o. (n=7,194)	Family history of obesity (ORD) Pre-term large gestational age (LGA)	WHO
Ref 9. Dearth-Wesley et al., (2008)	China	6-18 y.o. (n=1566)	High income Dietary Shifts (from traditional foods to processed foods)	WHO
Ref 21. Trang et al. (2012).	Vietnam	11-16 y.o. (n=759)	Environment (low walkability) Poverty/ low Socioeconomic status Urbanization Transportation Shifts (motor vehicles)	IOTF
Ref 44. Dancause et al., (2012).	Vanuatu	6-17 y.o. (n=513)	Low birth weight Stunting Nutrition Transition Urbanization	WHO
Ref 30. Katzmarzyk et al., (2015).	Brazil, China, Columbia, India, Kenya, and South Africa	9-11 y.o. (n=6,025)	Low levels of physical activity Short Sleep Duration Long Duration of Screen Time	WHO
Ref 36. Carrillo-Larco et al., (2014)	Ethiopia, India, Peru, Vietnam		Parental Education High Socioeconomic status	IOTF
Ref 35. Adair et al., (2013).	Brazil, Guatemala, India, and Philippines	0-31 y.o. 5 birth cohorts (n=8,362)	Low Birthweight Rapid weight gain after age 2	IOTF

## **CHAPTER 5**

### **DISCUSSION AND CONCLUSION**

Early identification of risk factors related to childhood obesity is paramount. Findings from this review suggests that the key factors associated with childhood overweight and obesity in LMICs include sociodemographic factors, the nutrition transition, family household structure, maternal health status, environment, and sedentary lifestyle. The independent effects of these factors are unclear since many of these underlying factors co-occurred in the same studies. In all the relationships, it is uncertain how these various factors interact with one another. Due to the nature of the studies we cannot infer causality. It is important that future studies address the individual and interactive factors that are associated with childhood overweight and obesity in LMICs in order to provide appropriate intervention strategies.

The factors associated with childhood overweight and obesity in LMICs identified in this review are similar to those found in previous reports (Black et al., 2013; Lobstein et al., 2015; Poskitt, 2014). Additionally, these results are similar to those reported from high-income countries such as The United States, United Kingdom, Canada and France (Biro & Wien, 2010; Galloway, Young, & Egeland, 2010; Swinburn et al., 2011). This is not surprising as this review discussed the idea that LMICs are experiencing the nutrition transition and the shift from traditional foods to a westernized diet containing processed and energy-dense foods. Therefore, we would expect to see similar trends with respect to childhood overweight and obesity as we see in high-income countries.



## 5.1 POLICY IMPLICATIONS

The results of this study can be helpful in designing strategies and prevention programs in low and middle-income countries. It is important to gain government support in order to move forward with the prevention of childhood obesity in LMICs. All sectors including health, nutrition, education, and finance ministries play an important role in combating this critical health issue (Poskitt, 2014). It is important that healthcare providers educate patients on healthy eating and physical activity to prevent various diseases. Schools and day cares are also a key stakeholder and should be influencing healthy eating patterns amongst children. In addition, parents need to provide positive role modeling and support when it comes to healthy food and exercise choices.

Furthermore, nutrition policies in LMICs may need to be revised. Governments in LMICs may not be tempted to eliminate certain industries such as fast food and beverage companies which help with the economic growth of these countries (Poskitt, 2014). However, without a healthy generation of youth to contribute to the growing economies, the economy will not be sustained. So which is more important, managing and preventing childhood obesity which contributes to the development of other non-communicable diseases or restricting certain “unhealthy” industries to advertise and influence the eating patterns of the children? Although the answer may seem simple to some, it is much more complex for LMICs due to the lack of financial resources, government support and advocacy. Additionally, it is not only important to implement health policies, but evaluating these policies is much more important. LMICs should work together to design health policies for children especially those that are similar in terms of culture, economic resources, and lifestyle.

## 5.2 STUDY LIMITATIONS

This review has several limitations. Most importantly, the countries included in the review do not represent the entire list of low and middle-income countries. According to the World Bank, there are 135 countries which are considered an LMIC based on income level. However, only 18 countries were represented in this review, which is only 13% of LMICs. Due to the lack of published studies from LMICs, these results cannot be generalized to the entire group of LMICs. There was a huge selection of published reports on prevalence rates and implications for prevention (Adair, 2014; Lobstein et al., 2015; Sunguya, Ong, Dhakal, Mlunde, Shibanuma, Yasuoka, & Jimba, 2014). Yet, there were very few studies that assessed the underlying factors that influence childhood overweight and obesity and therefore were excluded from this review. Additionally, 5 out of the 29 studies included a sample of children up to age 18. Although, the review criteria included children ages 0-17, we felt it was important to include these few studies since this is not a huge age difference. These studies sampled younger children up to age 18 and therefore, they were necessary to include.

## 5.3 CONCLUSION

Besides concerns related to the limited number of published articles, this review serves as an explanation of the underlying factors associated with obesity in LMICs. Future studies should investigate the underlying factors influencing childhood overweight and obesity in various LMICs. The current research is severely limited with respect to this topic in LMICs. Studies that seek to offer prevention strategies should pay close attention to sociocultural and environmental influences of obesity. It is imperative that interventions are designed uniquely for each country as we concluded that risk factors vary with respect to each country. Furthermore, these

interventions should be tailored to the communities especially since many of the LMICs have high rates of obesity in rural and urban communities. It is clear that rural and urban children have different challenges and risk factors with respect to obesity, therefore designing culturally appropriate interventions are important (Penny, Creed-Kanashiro, Robert, Narro, Caulfield, & Black, 2005). By improving the understanding of the risk factors related to childhood overweight and obesity in LMIC, researchers will be able to tackle the root of the problem and work on preventative efforts. As of now, solutions related to childhood obesity in LMICs do not look promising due to the fact that many of these LMICs do not have strategic plans or policies in place to tackle this health issue. However, if public health stakeholders, policy makers and communities work together to create preventative initiatives, much can be done to tackle this preventable disease.

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