CHILDHOOD OBESITY IN LATIN AMERICA AND MEXICO: AN EVALUATION OF PAN AMERICAN HEALTH ORGANIZATION POLICIES, CAREGIVER'S TIME PREFERENCES, AND ASSOCIATION WITH MEDICAL CONDITIONS, HEALTHCARE UTILIZATION AND HEALTH STATUS

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TITLE: Childhood obesity in Latin America and Mexico: An evaluation of Pan American Health Organization policies, caregiver's time preferences, and association with medical conditions, healthcare utilization and health status.

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Lay abstract

In Latin America, almost one out of four children are overweight or had obesity. To inform health policies aimed at reducing childhood obesity in Latin America and Mexico, this doctoral thesis has three main objectives: 1) to gain a deeper understanding of policies and interventions implemented in Latin America to reduce childhood and adolescent obesity; 2) to understand how parental decision-making impact children obesity status in Mexico; and 3) to measure the association between children body mass index status and medical conditions, general heath and healthcare resource utilization in Mexico.

Abstract

Due to the increased consumption of high-energy processed foods and sugar-sweetened beverages combined with increased sedentary behavior and increasing screentime, the percentage of children and adolescents with overweight or having obesity in Latin America increased from 25% in 2007 to more than 34% in 2021. To inform the development of future health policies, this dissertation consists of three original research studies that examined childhood obesity in Latin America and Mexico. In the first study, a scoping review was conducted to determine to which extent policies included in the 2014 5-year Pan America Health Organization (PAHO) Plan of Action for the Prevention of Obesity in Children and Adolescents, had been implemented and evaluated in 19 Latin America countries. Results indicated that PAHO recommended policies have been implemented to various degrees in Latin America and more research is required to understand the impact of these policies. Using data from the 2012 Mexican Families and Life Survey (MxFLS), the second study explored the time preferences of children' caregivers as a factor related to childhood overweight or obesity in Mexico. Results showed that children caregivers' time preferences were associated with children's BMI status and as such, children caregivers' time preferences should be considered when developing policies to reduce childhood obesity. The last study used the same survey data to document the association between children's BMI status, medical conditions, health status, and healthcare resource utilization. While the findings showed few associations, several limitations were associated with the survey design and data, and more research is required to understand the burden of obesity in children in Mexico. Overall, these

three papers highlight the need for continuous efforts, evaluations, and policies to prevent and address childhood obesity in Mexico and Latin America.

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BMI:	Body Mass Index
CI:	Confidence Interval
Gologit:	generalized ordinal models
IQR:	Interquartile
MxFLS:	Mexican Family Life Survey
MXN:	Mexican pesos
OR:	Odds Ratio
PAHO:	Pan American Health Organization
SD:	Standard deviation
SES:	Socioeconomic Status
WCRF:	World Cancer Research Fund
WHO:	World Health Organization

Declaration of Academic Achievement

This dissertation presents three original research studies (Chapters 2-4), an introductory chapter (Chapter 1) and a concluding chapter (Chapter 5). Chapter 2 has been published in Obesity Science & Practice. Chapter 3 has been accepted in PLOS ONE. I, Mariana Molina Jaimes, am the lead author of each co-authored chapter. I conceived of all research questions with input at various stages from committee members and colleagues, completed all data work and analysis, and wrote the manuscripts. Chapter 2-4 are co-authored with Jean-Eric Tarride. Laura N. Anderson, and G. Emmanuel Guindon.

Chapter 1. Introduction

This first Chapter introduces the complete dissertation work, which includes three original research chapters (Chapters 2-4). The introduction provides an overview of the childhood obesity epidemic, including associated factors and proposed policies to prevent it, focusing on the Latin American region. Secondly, it explains the aims, rationale, and approaches for each of the individual studies in this thesis. Finally, the Chapter concludes by summarizing the contributions addressed by the dissertation.

The epidemic of overweight and obesity in children and youth

Worldwide, the number of individuals who are living with overweight or obesity has tripled since the 1980s, from nearly 200 million to 650 million in 2016 (1–3). Almost one out of three individuals of any age are currently living with overweight or obesity (2). By 2030, around 40% of the world's population is expected to be living with overweight, and 20% with obesity (4). The increase in the prevalence of obesity also affects children and adolescents. For example, the prevalence of overweight and obesity among children under the age of five increased from 4% (32 million) in 1990 to 7% (41 million) in 2016 (3), while it increased from 4% (60 million) in 1975 to 18% (340 million) in 2016 (3,5) for older children and adolescents. While the prevalence of obesity in children in the U.S. and Canada was stable or slightly decreased in the decade before the pandemic, (6), the prevalence of obesity in children has increased in Latin America (2) due to changes in lifestyle and built environment (7). It is currently estimated that 24% of children and adolescents in the region are either overweight or have obesity in Latin America (8). In Mexico, more than one-third of children and adolescents were overweight or had obesity in 2018 (compared to 28% in

2000) (9,10). Mexico is among the countries with the highest rates of childhood obesity worldwide (11,12).

The increasing prevalence of overweight and obesity in children is not only concerning due to the large number of people affected and the short-term consequences during childhood, such as hypertension, type II diabetes, metabolic syndrome, or pulmonary disorders (13–16), but also due to the long-term consequences for adult disease risk (17–20). This increase in health problems has put immense strain on healthcare systems worldwide, making overweight and obesity a major public health concern (21–23). While overweight and obesity are the result of imbalances between dietary intake and energy expenditure (3,24), a combination of several factors such as genetics, socio-economic status, built environment, personal preferences, policy, and structural factors, and others influence overweight and obesity (25). Therefore, obesity is considered a multifactorial and complex disease (24,26).

Associated factors

As mentioned above, high rates of childhood overweight and obesity are attributed to several factors, including unhealthy diets, sedentary lifestyles, and genetic predisposition. For instance, in Latin America, consuming high-energy processed foods and sugar-sweetened beverages is common, while the consumption of fruits, vegetables, and whole grains is relatively low (7). Additionally, increased physical inactivity (due to sedentary behavior and screentime) and dependence on motorized transportation are also contributors to the epidemic of obesity. Barry Popkin describes this phenomenon as the "nutrition transition," resulting from various cultural and economic factors (24).

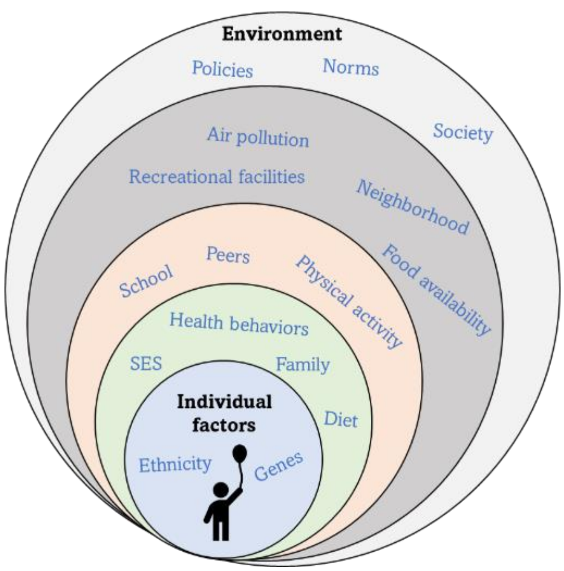
Mimicking processes like the demographic transition (shifting from high fertility and high mortality to low fertility and mortality) and the epidemiolocal transition (from high rates for infectious diseases to high chronic non-transmissible diseases); the nutritional transition refers to the process of moving from a lifestyle based on diets higher on fiber and vegetables, as well as high physical activities, to another less healthy with more saturated fats, sugar, refined foods, and higher sedentarism. Changes in food processing, marketing, availability, and the reduction of recreational areas to unwind and exercise have led to an imbalance in energy consumption and expenditure, resulting in the observed growth of the prevalence of overweight and obesity (24).

Thus, obesity (and especially childhood obesity) is indeed a complex disease (see Figure 1), determined by interconnected factors (27), including individual dietary decisions, physical activity, family dynamics and eating habits, built environment and culture, and, to a lesser degree, genetic and metabolic factors (27,28). These factors can be classified as either endogenous (depending only on an individual's decisions) or external (beyond an individual's control). Most external factors can be grouped as "obesogenic environment,"; a term that describes "the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations" (29). This encompasses all social, physical, and built environments.

Therefore, to tackle the high rates of overweight and obesity in children, it is essential to consider all layers of factors. Interventions and policies must aim to address individuals' decisions (personal-based approaches), social factors (targeting families, social networks, and community engagement), improving parental working and living conditions, and promoting healthy macro policies (30–33). This is because preventing or treating obesity requires multidimensional strategies focusing on individual, familial, institutional, and environmental levels of influence (34).

Thus, when planning and designing policies for childhood obesity, factors such as family decisions, parental obesity status, and parental time preferences are key (30,32,35–37). However, factors regarding parents and their decisions are often ignored when designing policies. For example, there is broad evidence about time preferences and discount rates (i.e., how individuals value benefits and costs in the present and future) and how this can shape adult decisions. It has been studied that individuals with a preference for short-term or immediate rewards have a higher probability of unhealthy habits or addictions (38–41) than individuals with lower discount rates (i.e., willing to wait for long-term [higher] rewards). Few studies have explored how parental time preferences are associated with childhood obesity. The relevance of this information lies in the fact that parents or caregivers are the main decision-makers and role models for eating habits, physical activity, and other social behaviors (37).

Figure 1. Influencing factors of childhood obesity.



Adapted from Kansra et al. (2021) (42) and Boonpleng et al. (2013) (43)

Health and economic consequences associated with obesity in children and youth.

Obesity is both a disease and a risk factor for subsequent conditions. It is associated with multiple factors and has numerous health and economic consequences (44). In children, overweight and obesity have a double concern. First, it has been demonstrated that children living with obesity are at greater risk of many adverse health outcomes in childhood, but it is also a concern that they will be at greater risk of more complex health issues during adulthood (21–23). In the short term, children living with overweight, or obesity are more likely to suffer respiratory diseases (15), mental illness (45), digestive disorders (46), and musculoskeletal difficulties (47). While in the long run, it is important to consider the increased risk of cardiometabolic diseases and cancer in adulthood, as well as premature mortality (20,48).

Comorbidities associated with overweight and obesity during childhood could be linked to a rise in healthcare utilization (21–23). For example, a network meta-analysis found that obesity was associated with increased emergency room and outpatient visits compared to normal-weight children (rate ratio: 1.34, 95% confidence interval (1.07, 1.68)) (21). Similarly, another meta-analysis estimated that a lifetime direct healthcare cost for overweight and obesity in children was USD 162,000 per child (49). However, these estimations have been made in high-income countries, and little has been explored in the Latin America region. Exploring the burden on the healthcare system is significant, especially from a policy perspective, as projections show increasing healthcare expenditures due to the rising obesity rates.

Health policies to prevent obesity in children and youth.

In response to the increasing prevalence of childhood and adolescent overweight and obesity in Latin America, several countries from Latin America have implemented various policies to prevent childhood obesity (7,50,51). Over the last ten years, both the World Health Organization (WHO) and the (more regional) Pan American Health Organization (PAHO) have developed and proposed different frameworks to address the rising problem of obesity in children and adolescents (51). The first priority is to design comprehensive public policies: from food production to consumption, including improving agriculture and food supply, school education, nutrition labeling, and unhealthy food taxes. It is also important to design and promote food guidelines to inform families of accurate nutrition and help guide healthy food choices. Finally, research should be supported to better understand the roots of obesity and the dynamics between obesity and the nutritional transition by promoting physical activity and modifying built environments to reduce sedentarism.

As a result of these efforts, 19 countries in Latin America signed in 2014 PAHO’s Plan of Action to prevent childhood obesity. This 5-year plan included five lines of actions centered on primary healthcare and breastfeeding promotion, school nutrition, fiscal and marketing, multisectoral, and surveillance (51). However, there has not been any formal tracking of the proposed policies' development, implementation, or evaluation, which is relevant to inform other countries about the barriers, challenges, results, and success of the PAHO policies implemented in 2014.

Thesis contributions

This sandwich thesis comprises three main papers that use different approaches to gain a deeper understanding of policies and interventions aimed at preventing childhood and adolescent obesity in Latin America and Mexico. The research incorporates elements such as time preferences to understand parental decision-making regarding their children's lifestyles and to measure the burden of childhood and adolescent obesity in the country, considering medical conditions and healthcare utilization.

First, Chapter Two provides an overview of policies and interventions implemented in the Latin America region. In this Chapter, a scoping review was conducted to assess the extent to which the ten policies included in PAHO's five-year Plan of Action for the Prevention of Obesity in Children and Adolescents have been implemented and evaluated across the 19 signing countries in Latin America. Although resources such as the Global Atlas on Childhood Obesity and the World Cancer Research Fund (WCRF) tracker exist, they have certain limitations, which make them of limited interest to informing policymakers. For instance, the Global Atlas lacks specific policy details (i.e., targeted population, policy characteristics) and does not indicate whether policies have been evaluated. Additionally, the WCRF tracker only includes policies from the NOURISHING and MOVING frameworks (52) and, as such, excludes many of PAHO's recommendations, such as surveillance and multifactorial interventions. To better inform future policy design and implementation, the primary objectives of this work were to determine the extent to which PAHO recommendations have been implemented and evaluated in Latin America. This paper provides a broad but detailed description of the policies and interventions implemented, the details of the interventions, and an analysis of whether these policies/interventions have been evaluated to measure their success.

Using data on children from the Mexican Family Life Survey, a nationally representative survey of Mexico, the second and third papers used descriptive and regression analyses to answer two important research questions. Recognizing the relevance that parents or children's caregivers are the main decision-makers and role models for lifestyle decisions, Chapter Three explores the caregiver's time preferences as a component related to childhood overweight or obesity. Only one study in the United States found that parents with a preference for the present (higher discount rates) were more likely to have children with obesity than parents with a preference for the future. Chapter Three addressed a gap in the literature, aiming to determine the association between parents' or caregivers' time preferences and overweight and obesity in their children in Mexico. To our knowledge, this is only the second study examining the link between caregivers' time preferences and childhood overweight and obesity, and it is the first such study carried out in Latin America. Additionally, this research explores differences between caregivers' time preferences and children's BMI status, considering both age groups and the sex of the children, and uses a nationally representative survey for the Mexican population.

Lastly, Chapter Four seeks to document and inform policymakers about the burden of overweight and obesity among children in Mexico. Its objectives are to describe the population of children in Mexico according to BMI categories and to analyze the associations between children's BMI status, medical conditions, health status, and healthcare resource utilization. Although such associations have been documented in other countries, no study has been conducted in Mexico. Furthermore, this work examines parental weight perception, an important factor to consider when designing policies to prevent childhood obesity, as parents may underestimate their child's weight and disregard health concerns.

References

1. Danaei G, Finucane MM, Lin JK, et al. National, regional, and global trends in systolic blood pressure since 1980: systematic analysis of health examination surveys and epidemiological studies with 786 country-years and 5·4 million participants. The Lancet. 2011;377(9765):568-577. doi:10.1016/S0140-6736(10)62036-3
2. Ng M, Fleming T, Robinson M, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. The Lancet. 2014;384(9945):766-781. doi:10.1016/S0140-6736(14)60460-8
3. WHO. Obesity and Overweight: Key Facts.; 2020. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
4. Finkelstein EA, Khavjou OA, Thompson H, et al. Obesity and Severe Obesity Forecasts Through 2030. Am J Prev Med. 2012;42(6):563-570. doi:10.1016/j.amepre.2011.10.026
5. United Nations. Economic and Social Affairs. Population Statistics. https://www.un.org/en/desa
6. Harvard S of public health. Child Obesity: Too Many Kids Are Too Heavy, Too Young.; 2022. https://www.hsph.harvard.edu/obesity-prevention-source/obesity-trends-original/global-obesity-trends-in-children/#:~:text=Over%20the%20past%20three%20decades,children%20is%20overweight%20or%20obese.
7. Popkin BM, Reardon T. Obesity and the food system transformation in Latin America: Obesity and food system transformation. Obes Rev. 2018;19(8):1028-1064. doi:10.1111/obr.12694
8. Rivera JÁ, de Cossío TG, Pedraza LS, Aburto TC, Sánchez TG, Martorell R. Childhood and adolescent overweight and obesity in Latin America: a systematic review. Lancet Diabetes Endocrinol. 2014;2(4):321-332. doi:10.1016/S2213-8587(13)70173-6
9. Oropeza Abúndez C, ed. Encuesta nacional de salud y nutrición 2018-19: resultados nacionales. Primera edición. Instituto Nacional de Salud Pública; 2020.
10. Olaiz G, Rivera-Dommarco J, Shamah-Levy T. Encuesta Nacional de Salud y Nutrición 2006. Published online 2006. https://ensanut.insp.mx/encuestas/ensanut2006/doctos/informes/ensanut2006.pdf
11. Shamah-Levy T, Cuevas-Nasu L, Gaona-Pineda EB, Valenzuela-Bravo DG, Méndez Gómez-Humarán I, Ávila-Arcos MA. Childhood obesity in Mexico: Influencing factors and prevention strategies. Front Public Health. 2022;10:949893. doi:10.3389/fpubh.2022.949893
12. OECD. The Heavy Burden of Obesity: The Economics of Prevention. OECD; 2019. doi:10.1787/67450d67-en
13. Jankowska A, Brzeziński M, Romanowicz-Sołtyszewska A, Szlagatys-Sidorkiewicz A. Metabolic Syndrome in Obese Children—Clinical Prevalence and Risk Factors. Int J Environ Res Public Health. 2021;18(3):1060. doi:10.3390/ijerph18031060
14. Abbasi A, Juszczyk D, van Jaarsveld CHM, Gulliford MC. Body Mass Index and Incident Type 1 and Type 2 Diabetes in Children and Young Adults: A Retrospective Cohort Study. J Endocr Soc. 2017;1(5):524-537. doi:10.1210/js.2017-00044

15. di Palmo E, Filice E, Cavallo A, et al. Childhood Obesity and Respiratory Diseases: Which Link? Children. 2021;8(3):177. doi:10.3390/children8030177
16. Xanthopoulos M, Tapia IE. Obesity and common respiratory diseases in children. Paediatr Respir Rev. 2017;23:68-71. doi:10.1016/j.prrv.2016.10.002
17. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis: Adult obesity from childhood obesity. Obes Rev. 2016;17(2):95-107. doi:10.1111/obr.12334
18. Biro FM, Wien M. Childhood obesity and adult morbidities. Am J Clin Nutr. 2010;91(5):S1499-S1505. doi:10.3945/ajcn.2010.28701B
19. Fang X, Zuo J, Zhou J, et al. Childhood obesity leads to adult type 2 diabetes and coronary artery diseases: A 2-sample mendelian randomization study. Medicine (Baltimore). 2019;98(32):e16825. doi:10.1097/MD.0000000000016825
20. Drozdz D, Alvarez-Pitti J, Wójcik M, et al. Obesity and Cardiometabolic Risk Factors: From Childhood to Adulthood. Nutrients. 2021;13(11):4176. doi:10.3390/nu13114176
21. Hasan T, Ainscough TS, West J, Fraser LK. Healthcare utilisation in overweight and obese children: a systematic review and meta-analysis. BMJ Open. 2020;10(10):e035676. doi:10.1136/bmjopen-2019-035676
22. Tarride JE, Burke N, Bischof M, et al. A review of health utilities across conditions common in paediatric and adult populations. Health Qual Life Outcomes. 2010;8(1):12. doi:10.1186/1477-7525-8-12
23. Musich S, MacLeod S, Bhattarai GR, et al. The Impact of Obesity on Health Care Utilization and Expenditures in a Medicare Supplement Population. Gerontol Geriatr Med. 2016;2:233372141562200. doi:10.1177/2333721415622004
24. Popkin BM. The Nutrition Transition: An Overview of World Patterns of Change. Nutr Rev. 2004;62:S140-S143. doi:10.1111/j.1753-4887.2004.tb00084.x
25. Government office for science. Tackling Obesities: Future Choices - Project Report. 2nd ed.; 2007. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/287937/07-1184x-tackling-obesities-future-choices-report.pdf
26. Blüher M. Obesity: global epidemiology and pathogenesis. Nat Rev Endocrinol. 2019;15(5):288-298. doi:10.1038/s41574-019-0176-8
27. Lin X, Li H. Obesity: Epidemiology, Pathophysiology, and Therapeutics. Front Endocrinol. 2021;12:706978. doi:10.3389/fendo.2021.706978
28. Hruby A, Hu FB. The Epidemiology of Obesity: A Big Picture. PharmacoEconomics. 2015;33(7):673-689. doi:10.1007/s40273-014-0243-x
29. Swinburn B, Egger G, Raza F. Dissecting Obesogenic Environments: The Development and Application of a Framework for Identifying and Prioritizing Environmental Interventions for Obesity. Prev Med. 1999;29(6):564. doi:10.1006/pmed.1999.0585
30. Kumanyika SK, Parker L, Sim LJ, Institute of Medicine (U.S.), Institute of Medicine (U.S.), eds. Bridging the Evidence Gap in Obesity Prevention: A Framework to Inform Decision Making. National Academies Press; 2010.
31. World Health Organization. Population-Based Approaches to Childhood Obesity Prevention. World Health Organization; 2012. Accessed May 1, 2023. https://apps.who.int/iris/handle/10665/80149

32. Ash T, Agaronov A, Young T, Aftosmes-Tobio A, Davison KK. Family-based childhood obesity prevention interventions: a systematic review and quantitative content analysis. Int J Behav Nutr Phys Act. 2017;14(1):113. doi:10.1186/s12966-017-0571-2
33. Wilfley DE, Hayes JF, Balantekin KN, Van Buren DJ, Epstein LH. Behavioral interventions for obesity in children and adults: Evidence base, novel approaches, and translation into practice. Am Psychol. 2018;73(8):981-993. doi:10.1037/amp0000293
34. Lipek T, Igel U, Gausche R, Kiess W, Grande G. Obesogenic environments: environmental approaches to obesity prevention. J Pediatr Endocrinol Metab. 2015;28(5-6). doi:10.1515/jpem-2015-0127
35. Stoklosa M, Shuval K, Drope J, et al. The intergenerational transmission of obesity: The role of time preferences and self-control. Econ Hum Biol. 2018;28:92-106. doi:10.1016/j.ehb.2017.12.004
36. Classen TJ, Thompson O. Genes and the intergenerational transmission of BMI and obesity. Econ Hum Biol. 2016;23:121-133. doi:10.1016/j.ehb.2016.08.001
37. Clark HR, Goyder E, Bissell P, Blank L, Peters J. How do parents' child-feeding behaviours influence child weight? Implications for childhood obesity policy. J Public Health. 2007;29(2):132-141. doi:10.1093/pubmed/fdm012
38. Hunter RF, Tang J, Hutchinson G, Chilton S, Holmes D, Kee F. Association between time preference, present-bias and physical activity: implications for designing behavior change interventions. BMC Public Health. 2018;18(1):1388. doi:10.1186/s12889-018-6305-9
39. Hoch SJ, Loewenstein GF. Time-Inconsistent Preferences and Consumer Self-Control. J Consum Res. 1991;17(4):492. doi:10.1086/208573
40. Zhang L, Rashad I. OBESITY AND TIME PREFERENCE: THE HEALTH CONSEQUENCES OF DISCOUNTING THE FUTURE. J Biosoc Sci. 2008;40(1):97-113. doi:10.1017/S0021932007002039
41. Takeuchi K. Non-parametric test of time consistency: Present bias and future bias. Games Econ Behav. 2011;71(2):456-478. doi:10.1016/j.geb.2010.05.005
42. Kansra AR, Lakkunarajah S, Jay MS. Childhood and Adolescent Obesity: A Review. Front Pediatr. 2021;8:581461. doi:10.3389/fped.2020.581461
43. Boonpleng W, Park CG, Gallo AM, Corte C, McCreary L, Bergren MD. Ecological Influences of Early Childhood Obesity: A Multilevel Analysis. West J Nurs Res. 2013;35(6):742-759. doi:10.1177/0193945913480275
44. Daniel S. The Consequences of Childhood Overweight and Obesity. Future Child. 2006;16. http://www.jstor.org/stable/3556550
45. Rankin J, Matthews L, Cobley S, et al. Psychological consequences of childhood obesity: psychiatric comorbidity and prevention. Adolesc Health Med Ther. 2016;Volume 7:125-146. doi:10.2147/AHMT.S101631
46. Phatak UP, Pashankar DS. Obesity and Gastrointestinal Disorders in Children. J Pediatr Gastroenterol Nutr. 2015;60(4):441-445. doi:10.1097/MPG.0000000000000670
47. Krul M, Van Der Wouden JC, Schellevis FG, Van Suijlekom-Smit LWA, Koes BW. Musculoskeletal Problems in Overweight and Obese Children. Ann Fam Med. 2009;7(4):352-356. doi:10.1370/afm.1005

48. Nielsen J, Hulman A, Narayan KMV, Cunningham SA. Body Mass Index Trajectories From Childhood to Adulthood and Age at Onset of Overweight and Obesity: The Influence of Parents' Weight Status. Am J Epidemiol. 2022;191(11):1877-1885. doi:10.1093/aje/kwac124
49. Onyimadu O, Violato M, Astbury NM, Jebb SA, Petrou S. Health Economic Aspects of Childhood Excess Weight: A Structured Review. Children. 2022;9(4):461. doi:10.3390/children9040461
50. Kline L, Jones-Smith J, Jaime Miranda J, et al. A research agenda to guide progress on childhood obesity prevention in Latin America: Child obesity research guide Latin Am. Obes Rev. 2017;18:19-27. doi:10.1111/obr.12572
51. PAHO. Plan of Action for the Prevention of Obesity in Children and Adolescents. WHO; 2014.
52. Flodmark CE, Marcus C, Britton M. Interventions to prevent obesity in children and adolescents: a systematic literature review. Int J Obes. 2006;30(4):579-589. doi:10.1038/sj.ijo.0803290

Chapter 2. A review of implementation and evaluation of Pan American Health Organization's policies to prevent childhood obesity in Latin America

Declaration.

This paper has been published in Obesity Science & Practice.

I was responsible for conceptualizing the research question, study design, and methods, through consultations with Dr. Jean-Eric Tarride. I was responsible for all the data cleaning and analysis. Dr. Laura N. Anderson and Dr. G. Emmanuel Guindon each provided feedback on the methods, the drafts and approved the final version.

Original research paper

Title: A review of implementation and evaluation of Pan American Health Organization's policies to prevent childhood obesity in Latin America

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Abstract

Rationale: To inform future policies, the study objectives were to determine to what extent the policies included in the five-year Plan of Action for the Prevention of Obesity in Children and Adolescents -proposed by Pan American Health Organization (PAHO) and signed by 19 Latin America countries in 2014- have been implemented and evaluated.

Methods: A scoping review of the Governmental websites for Latin American countries and a literature review was conducted to identify whether policies have been implemented and evaluated. Key information was abstracted.

Results: Our review identified 115 PAHO policies/interventions implemented (43% implemented after signing the proposed plan in 2014). Nearly all (18/19) countries implemented food guidelines or school feeding programs, but fiscal and marketing policies were less commonly implemented (6/19). We identified 44 evaluations of PAHO policies of which 23% were qualitative and 77% quantitative. The results of these evaluations were in general positive (e.g., decrease in sugar-sweetened beverages consumption following tax implementation) but no studies evaluated the outcome of reduced obesity.

Conclusions: PAHO recommended policies have been implemented to various degrees in Latin America since 2014 and more research is required to understand the impact of these policies on child and adolescent obesity.

KEYWORDS

Childhood obesity, Latin America, PAHO

Introduction

Worldwide estimates suggest that 158 million children 5-19 years of age were living with obesity in 2020 and it is anticipated that this will almost double to 254 million) (1). Over the last decades the Latin America region (representing almost 9% of the global population) has seen a large increase in the number of children living with obesity due to higher levels of urbanization, limited access to space for physical activities (2–4), and increased access (higher availability and lower prices) to ultra-processed food with lower nutrients, but excessive calories (3,5). As a result, the percentage of children and adolescents overweight or with obesity in Latin America increased from 25% in 2007 (6) to 38% in 2016 (7). To address this growing epidemic, several countries in Latin America had implemented policies over the last decades to prevent obesity among children and adolescents (8) (e.g., Baby Friendly hospitals in the 1990s (9)).

In parallel, the Pan American Health Organization (PAHO) developed a five-Year Plan of Action for the Prevention of Obesity in Children and Adolescents to unify efforts in Latin America and launch a regional public health initiative in Latin America. PAHO's Plan of Action, which was signed in October 2014 by all 19 countries of Latin America (10), was centered around five main areas called lines of actions (e.g., primary healthcare and breastfeeding promotion, school nutrition, fiscal and marketing, multisectoral, and surveillance) resulting in 11 objectives (10). Supp Table 1 presents the detailed lines of action and objectives of the PAHO Plan of Action. However, the extent to which these 2014 PAHO recommendations have been implemented in Latin America or were evaluated has not been studied yet as a whole. While the 2019 Global Atlas on Childhood Obesity (1) gathered information of 196 countries about the prevalence, risk factors, and the existence of governmental policies to tackle childhood obesity, the Atlas did not contain detailed information about the type of policies that were implemented or whether these policies were evaluated. While the World Cancer Research Fund International (WCRF) created in 2020 a database to track worldwide policies related to diet, weight, and physical activity as per the NOURSHING and MOVING frameworks (11), the WCRTF data do not include other policies included in PAHO recommendations (e.g., surveillance, and multifactorial social programs). Other authors have reviewed interventions to prevent childhood obesity around the world (11), in Latin America (Mexico, Chile, Colombia, and Brazil) (12) or the impact of taxes for sugar-sweetened beverages (SSB) (13) but the studies included in these reviews preceded the implementation of PAHO recommendations in 2014 (11,12) or their scope was too narrow (focus in only one policy) (13). In addition, a 2014 workshop (14) on the prevention of childhood overweight and obesity in Latin America highlighted the need to develop a cohesive research agenda (12), to build research capacity (15) and to carefully evaluate (2) interventions to prevent childhood obesity in Latin America. As such the impact of the extent in Latin American countries of policies/interventions identified in the PAHO strategic plan has not been formally evaluated. To inform future policies, the objectives of this study were to determine to which extent the PAHO recommendations have been implemented and evaluated in Latin America.

Methods

Overview

To answer the study objectives, a scoping review was conducted to identify PAHO policies implemented in Latin America at the country level and publicly funded. Scoping review designs are particularly appropriate to answer a broad question and when the type of documents and material used to determine the existence of policies and interventions are generally not published in indexed journals (16). The results of this scoping review were reported following the Preferred Report Item for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines (17).

Selection of PAHO interventions

Table 1 presents the detailed objectives associated with each of the PAHO five lines of actions and the policy interventions to be considered in our evaluation. Compared to the overall 11 objectives given in the PAHO strategic plan (Supp Table 1), the two policies related to "engaging other government institutions" and "improving access to urban recreational spaces" were excluded from the assessment due to the difficulty in identifying and measuring those two policies in public documents. Overall, we included in our evaluation 10 policies recommended by PAHO (Table 1).

Table 1. Summary of PAHO's lines of actions and proposed policies/interventions

PAHO's lines of actions	Objectives	Policy/interventions considered
1. Primary health care and promotion of breastfeeding and healthy eating	1. Promotion of healthy eating based on national food-based dietary guidelines […]	National Food-Based Guideliness
	2. To reinforce efforts to implement the Global Strategy for Infant and Young Child Feeding […]	Baby Friendly Hospital Initiative
2. Improvement of school nutrition and physical activity environments	1. National school feeding programs as well as the sale of foods and beverages in schools […]	National school feeding programs
		Food sales regulation at schools
	2. Promote and strengthen school and early learning policies and programs that increase physical activity	Programs for physical activity at school[¥]
3. Fiscal policies and regulation of food marketing and labelling	1. Reduce children and adolescents' consumption of sugar-sweetened beverages […]	Taxes for sugar-sweetened beverages
	2. Regulations to protect children and adolescents from the impact of marketing […]	Marketing regulation of unhealthy food and beverages
	3. Implement norms for front-of-package labeling […]	Food labeling for packaged food and beverages
4. Other multisectoral actions	3. Increase the availability of and accessibility to nutritious foods	National programs of food subsidies and money transferences
5. Surveillance, research, and evaluation	1. To strengthen country information systems […]	Development and implementation of national surveys/census of nutritional and anthropometric status

[¥] Extracurricular mandatory physical education

Scoping review

A search strategy was developed to identify for each of the 19 Latin America countries any policies/interventions proposed by PAHO to combat obesity in children and adolescent and implemented at the country level. The search was conducted in Spanish, Portuguese and English and did not include timeframe limit. Two searches were conducted. First, governmental websites of each of the 19 countries (e.g., Ministry of Health) were searched to identify any reference to the implementation of each policy and intervention recommended by PAHO, through governmental press releases or other official documents. The websites of WHO, PAHO and the World Cancer Research Fund International were also searched. Policies implemented at the local levels or privately funded were excluded. Following the results of this first search, a second systematic search was performed in PubMed, LILACS and EconLit to identify any publications reporting on the evaluation of PAHO policies identified during the first search of government websites. In addition to relevant subject headings (e.g., pediatric* OR childhood obesity), broad terms such as "(impact evaluation OR process evaluation OR evaluation*) AND ([country]) AND ([specific policy/intervention]) were used. For example, the combination "(impact evaluation OR process evaluation) OR evaluation*) AND (Mexico OR Mexican) AND (Sugar-sweetened beverage tax OR SSB tax)" was used to identify papers evaluating policies related to the quantitative and qualitative evaluation of the implementation of SSB taxes in Mexico. In addition, the search was also conducted with Google Scholar search engine to identify additional literature. Documents found through the literature identified using Goggle Scholar were cross-referenced with the published literature to minimize the risk of missing any relevant studies. References of all retrieved documents or publications were also reviewed. The searches were conducted from February to April 2020.

Data abstraction process and analysis

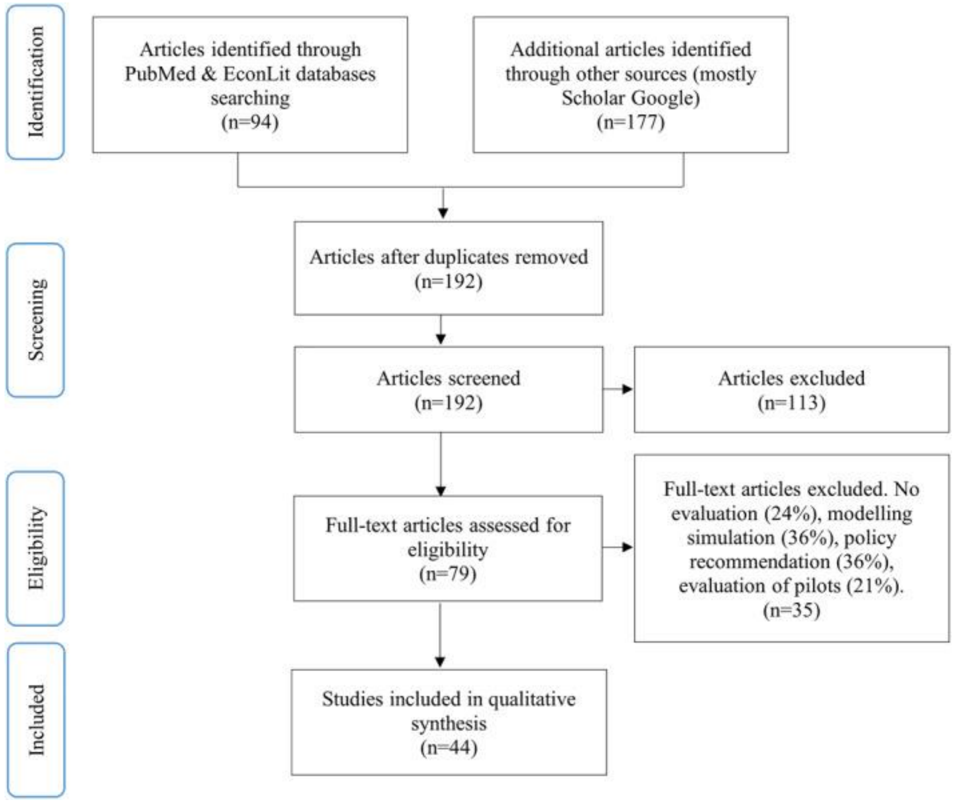
For each of the 19 Latin American countries, a standardized data abstraction form was used to capture the following information for each policy recommended by PAHO: implementation status (yes or no), year of implementation and whether it was before or after 2014 PAHO recommendations, as well as the characteristics of the implemented policies/interventions. For example, for a policy related to the implementation of national food-based dietary guidelines, we described the key characteristics of these guidelines (e.g., recommendations regarding daily amount of calories, water consumption or physical activity), how the information was summarized (e.g., image of a plate of food) and whether the recommendations were customized by subgroups (e.g., age). For our second objective, we documented whether an intervention had been evaluated in Latin America and abstracted key information on these evaluations (impact or process evaluation, objectives, study design, intervention and comparator groups, outcomes, results, and authors' conclusion). Due to differences in methods and outcomes, meta-analyses techniques were not conducted. The data extraction process was conducted by one author (MM) and reviewed by another (JET).

Results

Scoping review results

Through our search of government websites, we identified 115 PAHO policies/interventions implemented in Latin America. We also retrieved 44 publications through published literature which evaluated one of the PAHO interventions. Figure 1 presents the selection process.

Figure 1. Study identification, screening, and eligibility, guided by PRISMA-ScR



Implementation of PAHO Policies in Latin America

Overall results

Out of a maximum of 10 policies/interventions that could have been implemented, the number of PAHO interventions implemented in each country ranged from two (Nicaragua and Cuba) to ten (Ecuador and Mexico). As shown in Table 2, 18 out of 19 countries of Latin America implemented national food-based dietary guidelines and national school feeding programs. The majority of the countries also implemented policies to increase the availability and accessibility to nutritious food (14 countries), to create country information systems to better monitor obesity trends (14 countries), to regulate the sale of foods and beverages in schools (13 countries) or to implement extracurricular physical activities (10 countries). Less commonly implemented were fiscal and marketing policies related to taxes (six countries), marketing regulation (six countries) and food labeling (six countries). While interventions related to primary healthcare and breastfeeding promotion (line of action 1) were mostly implemented before the 2014 PAHO recommendations (e.g., 61% of national food based dietary guidelines), other lines of actions (e.g. policies related to the sale of foods and beverage) were mostly implemented in recent years. Table 2 presents the detailed results for each of the 10 policy recommendations.

Table 2. Results for policy/intervention implemented by country and line of action.

Country	Primary health care and breastfeeding promotion		School nutrition and physical activity			Fiscal and marketing policies			Multisectoral	Surveillance and data availability	Total policies/ interventions implemented	% policies/interventions applied after 2014°
	Food guideline	Baby-friendly hospital	School feeding	Sales regulation at school	Physical activity	Taxes	Marketing regulation	Food labeling	Food availability and accessibility	Information systems		
Argentina	2019	1991	2010	2010	2019	--	--	--	2003	2004	7	29%
Belize	2012	--	2017	--	--	--	--	--	2012	--	3	33%
Bolivia	2014	1991	2015	--	--	--	2016	2016	2006	2018	7	71%
Brazil	2015	--	2009	2015	1998	--	2014	--	2003	2013	7	43%
Chile	2013	1991	1964	2015	2010	2014	2016	2016	--	2003	9	44%
Colombia	2015	---	2013	2019	--	--	--	--	--	2005	4	50%
Costa Rica	2011	--	2017	2012	--	--	--	--	--	1996	4	25%
Cuba	2009	1990	--	--	2013	--	--	--	--	--	3	0%
Ecuador	2017	1991	1989	2014	2014	2016	2013	2013	2003	2011	10	40%
El Salvador	2009	---	2009	2017	--	2010	--	--	2009	--	5	20%
Guatemala	2012	1991	2010	2017	2014	--	--	--	2016	1987	7	43%
Honduras	2013	--	2017	2016	--	--	--	--	--	2019	4	75%
Mexico	2010	1993	2001	2014*	2002	2014	2014	2020	2014	2000	10	50%
Nicaragua	--	1991	2007	--	--	--	--	--	2007	--	3	0%
Panama	2013	--	2019	2017	2008	2019	--	--	2006	2019	7	57%
Paraguay	2013	1991	2014	--	2015	--	--	--	2005	2011	6	33%
Peru	2019	--	2012	2019	2018	2018	2013	2019	2005	2006	9	56%
Uruguay	2016	1991	1997	2014	--	--	--	2018	2006	2013	7	43%
Venezuela	1991	--	1969	--	--	--	--	--	2003	--	3	0%
Total countries implemented	18	10	18	13	10	6	6	6	14	14	115	48%
% Countries implemented after 2014°	39%	0%	33%	85%	50%	83%	67%	83%	14%	21%		

*This was preceded by *Programa de acción en el contexto* escolar in 2010 which was implemented only in public elementary schools.
° 2014 as reference for the initial PAHO's recommendations

Results by Line of Action

The following summarizes the policies implemented in the Latin America by PAHO five lines of action, starting with the 1st Line of Action centered around food guidelines and baby friendly hospitals. Detailed information by country can be found in Supp Table 2-20.

Line of Action 1. Primary health care and promotion of breastfeeding and healthy eating (i.e., food guidelines and baby-friendly hospital)

Except Nicaragua, all Latin American countries have implemented national food-based dietary guidelines and almost two third (62%) of countries implemented the food guidelines before the 2014 PAHO recommendations. The vast majority of the food guidelines recommended the use of physical activity (83%), drinking water daily (72%) and avoiding SSB consumption (67%). Almost all national dietary guidelines (except Mexico) included key messages to support the recommendations. Baby friendly hospitals designed to promote breastfeeding (i.e., second policy of PAHO Line of Action 1) were implemented in 10 countries in the 1990s.

Line of Action 2. School nutrition and physical activity environments (i.e., school feeding programs, sales regulation at school and physical activity programs)

Eighteen (94%) of the 19 Latin American countries have implemented school feeding programs which stipulated that school should provide at least one complete meal a day (83%) or a complementary snack (17%). Two third of the countries offered school feeding programs to all school-aged children (66%) while the remaining school feeding programs (33%) were restricted to vulnerable children only. Almost two-third of the school feeding programs (61%) were implemented before the 2014 PAHO Strategic Plan. The second policy of PAHO Line of Action 2 is related to the regulation of the sale of unhealthy foods and beverages in schools which policies were implemented in 68% of the 19 Latin American countries. and this, mostly after 2014 (83%). The type of healthy food that should be sold in school according to the country-specific food guidelines (23%), warning labels for unhealthy foods (23%), banned advertising and marketing of unhealthy products inside the schools (23%) or the requirement that school must provide free drinking water (15%) were the most common types of policies implemented in Latin America to regulate the sale of foods and beverages in school. Finally, 10 Latin American countries (52%) have implemented national programs of physical activity at school. Only two countries (20%) provided information on the characteristics of these programs (i.e., lectures not longer than 40 minutes with a ten-minute break for physical movements; 15 minutes of physical activity at start and end of the school day).

Line of Action 3. Fiscal policies, regulation of food marketing and labelling

Compared to the previous PAHO Line of Action 1 and 2, policies related to Line of Action 3 were less commonly implemented in Latin America and the implementations of the policies was most recent. For example, less than one third (32%) of Latin American countries have established fiscal policies to reduce children and adolescents' consumption of SSBs and five countries implemented these policies after 2014. When these policies were implemented, two-third of the countries used ad valorem taxes (e.g., 10% of retail price) or specified cut-offs for beverages to be taxed. The remaining countries used either a fixed amount of tax per quantity (e.g., 0.25USD per liter) or a general tax on all beverages with sugar added regardless of the amount of sugar. Similarly, only six Latin American countries (32%) implemented PAHO policy to protect children and adolescents from the impact of marketing of SSB, high-dense energy food and fast food, the second policy of

Line of Action 3. Specifically, three countries banned the marketing of these products in television movies and sports events while three countries regulated advertising content and exposure hours (e.g., junk food and SSB advertisement is banned between 14:30 and 19:30 hours on public television in Mexico). Finally, eight countries (42% of all countries) implemented norms for front-of-package labelling, the third policy of PAHO Line of Action 3. Hexagons (50%) and traffic lights (25%) were commonly included on the packaging of food products to indicate "excess" of calories, sugar, sodium, saturated fat, and trans fats). In addition, four countries (50%) banned characters and cartoons from food packaging.

Line of Action 4. Other multisectoral actions

Fourteen countries (74% of all countries) have implemented interventions to increase the availability and access to nutritious food, of which twelve countries (86%) implemented these policies before the 2014 PAHO Strategic Plan. Most of the countries (86%) targeted vulnerable populations living below the poverty line and a similar number of countries used subsidies or money transfers to promote healthy food consumption. Five countries (36%) conditioned the monetary transfer to educational and health responsibilities, and three (21%) also provided financial aid for agriculture production (either to sell farmer products or self-consumption). Finally, four countries (29%) provided food supplements to families.

Line of Action 5. Surveillance, research, and evaluation

The last line of action is related to the development and implementation of information systems to allow for the analysis of trends and determinants of obesity to better inform policy decision-makers. Most of the countries (74%) have implemented specific health surveillance systems for research and evaluation and in general, these systems were existing before 2014 (79%). Six countries (43%) performed one-time surveys, one country (7%) has an ongoing cohort of children (started in 2013), and two (14%) are specific for mother-child health.

3.3. Evaluation of PAHO Policies implemented in Latin America

We identified 44 peer-reviewed publications which evaluated PAHO interventions implemented in Latin America (Table 3). Ten studies were qualitative studies and 31 were quantitative studies. School nutrition programs and fiscal and marketing policies were the most frequently evaluated policies.

Table 3. Results for policy/intervention evaluated by country and line of action.

		Qualitative studies	Quantitative studies	Number of studies	Total countries evaluated	As % of countries that implemented
Primary health care and breastfeeding promotion	Food guideline	Brazil (2017), Uruguay (2017)	None	2	2	11%
	Baby-friendly hospital	None	None	0	0	0%
School nutrition	School feeding	Bolivia (2017)	Argentina (2013), Brazil (2018, 2019), Chile (2013), Colombia (2009, 2015), Ecuador (2004) & Mexico (2017)	9	7	39%
	Sales regulation at school	Mexico (2019)	Chile (2019) & Mexico (2017)	3	2	15%
	Physical activity at schools	Mexico (2018)	None	1	1	10%
Fiscal and marketing policies	Taxes	Mexico (2018)	Chile (2018a, 2018b, 2020) & Mexico (2015, 2016a, 2016b, 2016c~, 2017a, 2017b, 2017c, 2017d, 2017e~ 2018a, 2018b, 2019[a], 2019b~)	17	2	33%
	Marketing regulation	None	Peru (2018), Chile (2020a, 2020b)	3	2	33%
	Food labeling	Ecuador (2017a, 2017b) & Chile (2019)	Chile (2020) & Ecuador (2019)	5	2	33%
Multisectoral	Food availability and accessibility	Argentina (2016)	Brazil (2011) & Ecuador (2019)	3	3	21%

~ non-basic energy-dense food tax

Qualitative Studies

In general, the qualitative studies were evaluating barriers and facilitators to the uptake of food-based dietary guidelines, best practices to implement school nutrition and physical activity programs or population awareness of fiscal policies. Most studies relied on focus groups while a few studies were qualitative evaluations of best practices (18–25). Results of these studies supported the implementation of these programs although a few barriers to the implementation of these policies were identified (e.g., healthy food was not always palatable or was perceived as difficult to cook, governmental policies were often perceived as insufficient to combat obesity issues, and there was a lack of knowledge and understanding about anti-obesity policies). Supp Table 21 presents the details of 10 qualitative studies evaluating PAHO policies implemented in seven countries.

Quantitative studies

Thirty-one PAHO related policies implemented in seven countries were evaluated using quantitative methods. Most of these studies were published over the last five years. The following provides an overview of these studies by line of action. No quantitative studies were found evaluating the impact of national food-based guidelines or baby friendly hospital initiatives (Line of action 1) or the development of obesity-related national surveys/census (Line of Action 5).

Line of action 2: Eight publications reported the evaluation of national school feeding programs implemented in six countries. A variety of methods (e.g. difference-in-difference, Interrupted Time Series, repeated cross-sectional' studies Ordinary Least Square) using two to 10 years of data were used to measure the impact of these programs in terms of academic performance or school attendance (26–29), children's nutrition (30,31) or adherence of children to the school feeding program (32,33). Results indicated that these programs had little impact on academic performance of children nutrition. Supp Table 22 presents the details of these eight evaluations of national school feeding. In addition, two studies evaluating the impact of regulating sales of foods and beverage in schools in Chile and Mexico found that less unhealthy food was sold at schools (from 90.4% to 15% of total sales in Chile) after the implementation of such programs (34). The results also indicated that the consumption of homemade food was increased (from 31.9% to 48% children brought food from home) although homemade food was found to lack in general macronutrients (35) (Supp Table 23).

Line of action 3: The impact of implementing taxes for SSB in Mexico (36–45) or Chile (46–48) were evaluated in 13 studies using before and after approaches (62%) or Interrupted Time Serie (38%) applied to one to three years of monthly, quarterly, or annual data. Most studies explored changes in household purchases (38%) or changes in prices of sugared beverages (38%). All studies indicated that the consumption and purchases of SSB decreased after prices increases of SSB ranged from 8% in Mexico (39) to between 2% (48) and 22% in Chile (46). In addition, several studies reported that the implementation of a sugar tax had no impact on employment, industries' sales, or inflation rates. Three quasi-experimental studies were performed in Mexico evaluating changes in taxed food purchases, after 8% tax implementation (49–51). Similar to the SSB documents, all studies revealed a reduction in taxed food purchase; between 5.1%-5.3% in the first year, and 7.4% for the second. Supp Table 24 provides the details. The impact of marketing regulations on the content of sugar sweetened products in Peru and Chile were evaluated in three studies (24,52,53). Results indicated that junk food advertisement decreased (35% of preschoolers and 52% adolescents reported watching none or a lower amount of advertisement for junk food in Chile after regulation (53) while the promotion of healthy diets and physical activity increased following the implementation of marketing regulations (Supp Table 25). The impact of food labeling showed mixed results with one study showed a decrease in the sales of SSB in Chile (54) while no changes were observed in Ecuador (55) (Supp Table 26).

Line of action 4: Two studies evaluating the impact of increased access to nutritious food reported the consumption of healthy food increased in Brazil following a program to subsidized food products such as cereals, beans, and meat. A similar program was found to reduce malnutrition and health related problems in Ecuador (56,57).

Discussion

Our study documents for the first time to which extent 10 national policies recommended by PAHO to reduce obesity in children and adolescents were implemented in the 19 countries of Latin America. While the 19 countries signed in 2014 on the Plan of Action for the Prevention of Obesity in Children and Adolescents proposed by PAHO, only Mexico and Ecuador have implemented all policies/interventions included in this plan. Some of these interventions (e.g., National Food-Based Dietary Guidelines or School Feeding Programs) were already implemented in many countries before 2014 while others (e.g., fiscal policies) were mostly implemented after the signing of the PAHO document. Compared to policies related to the implementation of national food-based dietary guidelines or school feeding programs which were implemented in almost all the countries, fiscal and marketing policies were only implemented in six of 19 Latin America countries. Even though PAHO did not provide specific guidelines, our analyses showed that most of the policies shared similar characteristics. For example, almost all dietary guidelines included symbols to summarize recommendations and there were only two types of food labels and two types of taxes. In addition to describe the PAHO policies implemented in Latin America, our study contributes to the development of an inventory of interventions for the prevention of obesity in children and adolescents. As such our work complements the inventory of interventions related to diet and physician activity which can be found in the WCRF database by identifying other types of policies used to prevent obesity in children and adolescent such as the implementation of surveys monitoring population health, and multisectoral interventions.

Another important contribution of our study is to have reviewed 44 evaluations of the policies recommended by PAHO. More than three-quarter of the studies were quantitative studies using pre-post study design. Most the studies were performed for Mexican policies/interventions, especially for fiscal strategies (39%), more than half were quantitative (77%) and used a few years of either monthly, quarterly, and annual data to evaluate the impact of the policies using a pre-post design. Evaluations of the effect of taxes on SSBs showed a reduction on SSB purchases as well as a reduction in non-basic high dense energy food. a reduction on advertisement exposure and junk food consumption was also found following the implementation of f advertising regulations and food labeling. On the other hand, the results of the evaluations of national school feeding programs showed mixed results. The results of the qualitative studies showed overall support for programs aimed at decreasing obesity among children and adolescents although several barriers to the implementation of such programs were identified (e.g., preference for unhealthy food, lack of knowledge of policy being implemented).

It is difficult to compare the results of our study to the existing literature about implementation or evaluation of interventions/policies against childhood obesity due to our focus on Latin America.

However, our results are consistent with two recent studies. Following a review of 24 controlled studies, Flodmark (2006) reported that obesity could be prevented through programs that combine promotion of healthy eating and physical activities. While the results of the evaluation of PAHO policies or interventions implemented in Latin America support these results, none of the studies that we identified used comparative data or focus on changes of prevalence of overweight or obesity (11). Teng (2019) performed a systematic review and meta-analyses of 15 studies evaluation the impact of taxes for SSBs on purchases and calorie intake. The results indicated that implementing a tax of 10% decreased beverage purchases and calory intake by 10% as well (13). Due to the larger scope of our study compared to Teng (2019) our search identified four additional studies (one for Chile and three for Mexico) which evaluated the impact of taxation on employment and industries' sales (41,44,47). Yet, since most of the studies included in Teng (2019) were also identified in our review, the results of Teng are also consistent with our study. While these results support the implementation of the PAHO policies in Latin America, our results suggest the need for additional longitudinal comparative studies using longer follow-up and anthropometric measures to better understand the value of national policies aimed at decrease obesity in children and adolescents. This argument was also discussed by Parra et al. (2017) who noted that while research on childhood obesity in Latin America is improving (especially after 2014), research has not been complex and was concentrated in a few countries only (15). Even so, a comprehensive analysis of a particular policy may be complicated due to the fact that other policies and interventions may have been implemented in parallel (37) and it may be important to evaluate national strategies as well as their individual components. This however implies that public and open surveillance systems are in place (12). Facilitators (e.g., consideration of socio-cultural features and increasing awareness) and barriers (e.g., preferences for palatable unhealthy food, and superficial knowledge of programs) identified in our review could also help when designing national policies.

When interpreting the results of our review, some limitations should be noted. First, information about the implementation of the PAHO policies in Latin America was gathered from governmental websites or official press releases. In doing so we assumed that any PAHO interventions implemented in a country will be traceable through Government electronic documents, which may not be always true. However, to minimize the risk of missing PAHO policies implemented in Latin America, we cross referenced the country searches with the PAHO, WHO and the WCRFI websites. In some cases, the documents retrieved did not provide detailed information on the specifics of the intervention (e.g., type of food banned for sales regulation). Although we took a more systematic approach when evaluating the peer-reviewed literature, there is always a risk to miss one or several studies even if we checked all the references of the publications retrieved by our search. We only documented whether a policy was implemented, not if it remained into effect. Another limitation of this study is related to it scope as we only searched and reviewed policies and interventions implemented nationally and publicly funded as PAHO recommendations were meant to be implemented by governments at the country level. As such, we did not include any evaluations of local or regional initiatives or privately funded. Finally, when reviewing policies/intervention evaluations in Latin America, we did not perform any type of quality assessment of the studies. Rather, we provided a general description of these studies. Although we documented whether a policy was implemented before or after 2014 PAHO Strategic Plan, we were not able to determine to which extent the 2014 PAHO Strategic Plan had a direct impact in policy development and implementation after 2014. The reason is that it may take a few years time to develop and implement a policy. It is clear that if a policy was implemented before 2014 then the 2014 PAHO strategic Plan has nothing to do with it. However, if the policy was implemented after 2014, it is impossible to know if this was the direct result of the PAHO Strategic Plan or not. It may be the case that the 2014 PAHO Strategic Plan has helped accelerating the process from the agenda to implementation.

Despite these limitations, our study represents the first attempt to provide an inventory and categorise policy interventions implemented in Latin America for the prevention of obesity in children and adolescents. Future research should validate and complement this inventory by using other methods and sources of data such as surveying academic institutions. Overall, our scoping review suggests that many of the policies recommended by PAHO 2014 strategy have been put into effect in Latin America, but much needs to be done. This includes ensuring that funding is available for the continuation of these policies when implemented. For example, many school feeding programs implemented in Latin America had to cease or scale down their activities once the monetary aid from international organizations ended (58). A similar situation happened with the Baby-Friendly Hospital Initiative which was cancelled in some countries due to the costs associated with renewing the hospital certifications (9). It is also well know that the food industry has lobbied against the implementation of fiscal, regulatory, and marketing policies related to unhealthy food and beverages (2,59,60) and therefore ensuring political buying from governments is key for the successful implementation of such policies. All these arguments open the door to further analysis. Deep policy analysis could be performed to understand political forces and pathways that have determined whether a policy is implemented or not. For example, previous studies in the region concluded that, when analyzing some policy case studies, evidence-based advocacy created strong opposition against industry while supporting policy development (2). Besides, exploring the duration of policies and interventions is relevant to analyze determinants of success, beyond the main implementation. In addition, there is a need for reliable datasets and well-designed observational studies to accurately evaluate interventions in the Latin American region (8,12). Research is a key element in the combat against childhood obesity in Latin America and elsewhere, specially to inform further development and implementation of policies and interventions with a more robust and long-term surveillance (2,8,12,15).

We found that PAHO recommended policies have been implemented to various degrees in Latin America and more research is required to understand the impact of these policies on child and adolescent obesity.

References

1. Lobstein T, Brinsden H. Global Atlas on Childhood Obesity.; 2019:212. https://www.worldobesity.org/nlsegmentation/global-atlas-on-childhood-obesity
2. Pérez-Escamilla R, Lutter CK, Rabadan-Diehl C, et al. Prevention of childhood obesity and food policies in Latin America: from research to practice: Obesity research to practice in Latin America. Obes Rev. 2017;18:28-38. doi:10.1111/obr.12574
3. Popkin BM, Reardon T. Obesity and the food system transformation in Latin America: Obesity and food system transformation. Obes Rev. 2018;19(8):1028-1064. doi:10.1111/obr.12694
4. Corvalán C, Garmendia ML, Jones-Smith J, et al. Nutrition status of children in Latin America: Nutrition status of the Latin American Region. Obes Rev. 2017;18:7-18. doi:10.1111/obr.12571
5. Colchero MA, Guerrero-López CM, Molina M, Unar-Munguía M. Affordability of Food and Beverages in Mexico between 1994 and 2016. Nutrients. 2019;11(1):78. doi:10.3390/nu11010078
6. Rivera JÁ, de Cossío TG, Pedraza LS, Aburto TC, Sánchez TG, Martorell R. Childhood and adolescent overweight and obesity in Latin America: a systematic review. Lancet Diabetes Endocrinol. 2014;2(4):321-332. doi:10.1016/S2213-8587(13)70173-6
7. OECD, The World Bank. Health at a Glance: Latin America and the Caribbean 2020. OECD; 2020. doi:10.1787/6089164f-en
8. Caballero B, Vorkoper S, Anand N, Rivera JA. Preventing childhood obesity in Latin America: an agenda for regional research and strategic partnerships: Childhood obesity in Latin America. Obes Rev. 2017;18:3-6. doi:10.1111/obr.12573
9. PAHO. The Baby Friendly Hospital Initiative in Latin America and the Caribbean: Current Status, Challenges, and Opportunities. Accessed August 20, 2020. https://iris.paho.org/bitstream/handle/10665.2/18830/9789275118771_eng.pdf?sequence=1&isAllowed=y
10. PAHO. Plan of Action for the Prevention of Obesity in Children and Adolescents. WHO; 2014.
11. Flodmark CE, Marcus C, Britton M. Interventions to prevent obesity in children and adolescents: a systematic literature review. Int J Obes. 2006;30(4):579-589. doi:10.1038/sj.ijo.0803290
12. Kline L, Jones-Smith J, Jaime Miranda J, et al. A research agenda to guide progress on childhood obesity prevention in Latin America: Child obesity research guide Latin Am. Obes Rev. 2017;18:19-27. doi:10.1111/obr.12572
13. Teng AM, Jones AC, Mizdrak A, Signal L, Genç M, Wilson N. Impact of sugar-sweetened beverage taxes on purchases and dietary intake: Systematic review and meta-analysis. Obes Rev. 2019;20(9):1187-1204. doi:10.1111/obr.12868
14. NIH Fogarty International Center. Preventing Childhood Overweight and Obesity in Latin America: Linking Evidence to Policy and Practice.; 2018. https://www.fic.nih.gov/About/center-global-health-studies/Pages/preventing-childhood-obesity-latin-america.aspx

15. Parra DC, Vorkoper S, Kohl HW, et al. Research capacity for childhood obesity prevention in Latin America: an area for growth: Childhood obesity prevention. Obes Rev. 2017;18:39-46. doi:10.1111/obr.12579
16. Sucharew H. Methods for Research Evidence Synthesis: The Scoping Review Approach. J Hosp Med. 2019;14(7):416. doi:10.12788/jhm.3248
17. Tricco AC, Lillie E, Zarin W, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018;169(7):467. doi:10.7326/M18-0850
18. Oliveira MS da S, Silva-Amparo L. Food-based dietary guidelines: a comparative analysis between the Dietary Guidelines for the Brazilian Population 2006 and 2014. Public Health Nutr. 2018;21(1):210-217. doi:10.1017/S1368980017000428
19. Machín L, Aschemann-Witzel J, Patiño A, et al. Barriers and Facilitators to Implementing the Uruguayan Dietary Guidelines in Everyday Life: A Citizen Perspective. Health Educ Behav. 2018;45(4):511-523. doi:10.1177/1090198117744243
20. Valdivia G. "Evaluación final externa programa conjunto" sistema agraalimentario sostenible para el mejoramiento nutricional infantil.; 2017.
21. Théodore FL, Moreno-Saracho JE, Bonvecchio A, et al. Lessons learned and insights from the implementation of a food and physical activity policy to prevent obesity in Mexican schools: An analysis of nationally representative survey results. Byrne M, ed. PLOS ONE. 2018;13(6):e0198585. doi:10.1371/journal.pone.0198585
22. Ortega-Avila AG, Papadaki A, Jago R. Exploring perceptions of the Mexican sugar-sweetened beverage tax among adolescents in north-west Mexico: a qualitative study. Public Health Nutr. 2018;21(03):618-626. doi:10.1017/S1368980017002695
23. Freire WB, Waters WF, Rivas-Mariño G, Nguyen T, Rivas P. A qualitative study of consumer perceptions and use of traffic light food labelling in Ecuador. Public Health Nutr. 2017;20(5):805-813. doi:10.1017/S1368980016002457
24. Correa T, Fierro C, Reyes M, Dillman Carpentier FR, Taillie LS, Corvalan C. "Responses to the Chilean law of food labeling and advertising: exploring knowledge, perceptions and behaviors of mothers of young children." Int J Behav Nutr Phys Act. 2019;16(1):21. doi:10.1186/s12966-019-0781-x
25. Abeyá Gilardon EO. Una evaluación crítica de los programas alimentarios en Argentina. Salud Colect. 2016;12(4):589. doi:10.18294/sc.2016.935
26. Adrogue C, Orlicki ME. Do In-School Feeding Programs Have an Impact on Academic Performance and Dropouts? The Case of Public Schools in Argentina. Educ Policy Anal Arch. 2013;21:50. doi:10.14507/epaa.v21n50.2013
27. McEwan PJ. The impact of Chile's school feeding program on education outcomes. Econ Educ Rev. 2013;32:122-139. doi:10.1016/j.econedurev.2012.08.006
28. Pérez Carrillo S. Educación y nutrición. Un análisis del programa de alimentación escolar en Bogotá. Published online 2015. http://repositorio.uniandes.edu.co/xmlui/handle/1992/2807
29. Cadena Minotta L. Evaluación de impacto programa de alimentación escolar. FLACSO sede Ecuador; 2004. https://repositorio.flacsoandes.edu.ec/handle/10469/460

30. Arsenault LN, Xu K, Taveras EM, Hacker KA. Parents' Obesity-Related Behavior and Confidence to Support Behavioral Change in Their Obese Child: Data From the STAR Study. Acad Pediatr. 2014;14(5):456-462. doi:10.1016/j.acap.2014.03.001
31. Shamah-Levy T, Cuevas-Nasu L, Gómez-Acosta LM, et al. Efecto del programa de servicios SaludArte en los componentes de alimentación y nutrición en escolares de la Ciudad de México. Salud Pública México. 2017;59(6, nov-dic):621. doi:10.21149/8116
32. Rocha NP, Filgueiras MDS, Albuquerque FM de, et al. Analysis of the national school feeding program in the municipality of Viçosa, state of Minas Gerais. Rev Saúde Pública. 2018;52:16. doi:10.11606/S1518-8787.2018052007090
33. Ferreira DM, Barbosa RMS, Finizola NC, et al. Perception of the operating agents about the Brazilian National School Feeding Program. Rev Saúde Pública. 2019;53:34. doi:10.11606/S1518-8787.2019053000597
34. Massri C, Sutherland S, Källestål C, Peña S. Impact of the Food-Labeling and Advertising Law Banning Competitive Food and Beverages in Chilean Public Schools, 2014–2016. Am J Public Health. 2019;109(9):1249-1254. doi:10.2105/AJPH.2019.305159
35. López-Olmedo N, Jiménez-Aguilar A, Morales-Ruan M del C, Hernández-Ávila M, Shamah-Levy T, Rivera-Dommarco JA. Consumption of foods and beverages in elementary schools: Results of the implementation of the general guidelines for foods and beverages sales in elementary schools in Mexico, stages II and III. Eval Program Plann. 2018;66:1-6. doi:10.1016/j.evalprogplan.2017.08.009
36. Ng SW, Rivera JA, Popkin BM, Colchero MA. Did high sugar-sweetened beverage purchasers respond differently to the excise tax on sugar-sweetened beverages in Mexico? Public Health Nutr. 2019;22(4):750-756. doi:10.1017/S136898001800321X
37. Colchero MA, Popkin BM, Rivera JA, Ng SW. Beverage purchases from stores in Mexico under the excise tax on sugar sweetened beverages: observational study. BMJ. Published online January 6, 2016:h6704. doi:10.1136/bmj.h6704
38. Colchero MA, Salgado JC, Unar-Munguía M, Molina M, Ng S, Rivera-Dommarco JA. Changes in Prices After an Excise Tax to Sweetened Sugar Beverages Was Implemented in Mexico: Evidence from Urban Areas. Nugent RA, ed. PLOS ONE. 2015;10(12):e0144408. doi:10.1371/journal.pone.0144408
39. Colchero MA, Rivera-Dommarco J, Popkin BM, Ng SW. In Mexico, Evidence Of Sustained Consumer Response Two Years After Implementing A Sugar-Sweetened Beverage Tax. Health Aff (Millwood). 2017;36(3):564-571. doi:10.1377/hlthaff.2016.1231
40. Colchero MA, Guerrero-López CM, Molina M, Rivera JA. Beverages Sales in Mexico before and after Implementation of a Sugar Sweetened Beverage Tax. Guerrero-Romero F, ed. PLOS ONE. 2016;11(9):e0163463. doi:10.1371/journal.pone.0163463
41. Guerrero-López CM, Molina M, Colchero MA. Employment changes associated with the introduction of taxes on sugar-sweetened beverages and nonessential energy-dense food in Mexico. Prev Med. 2017;105:S43-S49. doi:10.1016/j.ypmed.2017.09.001
42. Colchero MA, Molina M, Guerrero-López CM. After Mexico Implemented a Tax, Purchases of Sugar-Sweetened Beverages Decreased and Water Increased: Difference by Place of Residence, Household Composition, and Income Level. J Nutr. 2017;147(8):1552-1557. doi:10.3945/jn.117.251892

43. Álvarez-Sánchez C, Contento I, Jiménez-Aguilar A, et al. Does the Mexican sugar-sweetened beverage tax have a signaling effect? ENSANUT 2016. Huerta-Quintanilla R, ed. PLOS ONE. 2018;13(8):e0199337. doi:10.1371/journal.pone.0199337
44. Mendoza-Velázquez A, Aguirre Sedeño D. Impuesto especial a alimentos y bebidas y su impacto en la inflación en México: dinámica, persistencia y cambio de régimen. Rev Panam Salud Pública. 2019;43:1. doi:10.26633/RPSP.2019.88
45. Colchero MA, Zavala JA, Batis C, Shamah-Levy T, Rivera-Dommarco JA. Cambios en los precios de bebidas y alimentos con impuesto en áreas rurales y semirrurales de México. Salud Pública México. 2017;59. doi:10.21149/7994
46. Nakamura R, Mirelman AJ, Cuadrado C, Silva-Illanes N, Dunstan J, Suhrcke M. Evaluating the 2014 sugar-sweetened beverage tax in Chile: An observational study in urban areas. Langenberg C, ed. PLOS Med. 2018;15(7):e1002596. doi:10.1371/journal.pmed.1002596
47. Cuadrado C, Dunstan J, Silva-Illanes N, Mirelman AJ, Nakamura R, Suhrcke M. Effects of a sugar-sweetened beverage tax on prices and affordability of soft drinks in Chile: A time series analysis. Soc Sci Med. 2020;245:112708. doi:10.1016/j.socscimed.2019.112708
48. Caro JC, Corvalán C, Reyes M, Silva A, Popkin B, Taillie LS. Chile's 2014 sugar-sweetened beverage tax and changes in prices and purchases of sugar-sweetened beverages: An observational study in an urban environment. Langenberg C, ed. PLOS Med. 2018;15(7):e1002597. doi:10.1371/journal.pmed.1002597
49. Batis C, Rivera JA, Popkin BM, Taillie LS. First-Year Evaluation of Mexico's Tax on Nonessential Energy-Dense Foods: An Observational Study. Wareham NJ, ed. PLOS Med. 2016;13(7):e1002057. doi:10.1371/journal.pmed.1002057
50. Hernández-F M, Batis C, Rivera JA, Colchero MA. Reduction in purchases of energy-dense nutrient-poor foods in Mexico associated with the introduction of a tax in 2014. Prev Med. 2019;118:16-22. doi:10.1016/j.ypmed.2018.09.019
51. Taillie LS, Rivera JA, Popkin BM, Batis C. Do high vs. low purchasers respond differently to a nonessential energy-dense food tax? Two-year evaluation of Mexico's 8% nonessential food tax. Prev Med. 2017;105:S37-S42. doi:10.1016/j.ypmed.2017.07.009
52. Busse P, Bernabé-Ortiz A. Self-regulation of the Peruvian food industry: health message cues in the context of food and beverage advertisements. Public Health. 2018;159:1-3. doi:10.1016/j.puhe.2018.03.003
53. Dillman Carpentier FR, Correa T, Reyes M, Taillie LS. Evaluating the impact of Chile's marketing regulation of unhealthy foods and beverages: pre-school and adolescent children's changes in exposure to food advertising on television. Public Health Nutr. 2020;23(4):747-755. doi:10.1017/S1368980019003355
54. Taillie LS, Reyes M, Colchero MA, Popkin B, Corvalán C. An evaluation of Chile's Law of Food Labeling and Advertising on sugar-sweetened beverage purchases from 2015 to 2017: A before-and-after study. Basu S, ed. PLOS Med. 2020;17(2):e1003015. doi:10.1371/journal.pmed.1003015
55. Sandoval LA, Carpio CE, Sanchez-Plata M. The effect of 'Traffic-Light' nutritional labelling in carbonated soft drink purchases in Ecuador. Cummings M, ed. PLOS ONE. 2019;14(10):e0222866. doi:10.1371/journal.pone.0222866

56. de Bem Lignani J, Sichieri R, Burlandy L, Salles-Costa R. Changes in food consumption among the Programa Bolsa Família participant families in Brazil. Public Health Nutr. 2011;14(5):785-792. doi:10.1017/S136898001000279X
57. Moncayo AL, Granizo G, Grijalva MJ, Rasella D. Strong effect of Ecuador's conditional cash transfer program on childhood mortality from poverty-related diseases: a nationwide analysis. BMC Public Health. 2019;19(1):1132. doi:10.1186/s12889-019-7457-y
58. World Food Program. Strengthening National Safety Nets. School Feeding: WFP's Evaolving Role in Latin America and the Caribbean.; 2016. Accessed August 20, 2020. https://cdn.wfp.org/wfp.org/publications/Strenghtening%20National%20Safety%20Nets_School%20Feeding_WFP%20Evolving%20Role%20in%20LAC_Eng%20compressed.pdf?_ga=2.65453678.1956288782.1597944017-1152642750.1597944017
59. Bergallo P, Castagnari V, Fernández A, Mejía R. Regulatory initiatives to reduce sugar-sweetened beverages (SSBs) in Latin America. Romer D, ed. PLOS ONE. 2018;13(10):e0205694. doi:10.1371/journal.pone.0205694
60. Tselengidis A, Östergren PO. Lobbying against sugar taxation in the European Union: Analysing the lobbying arguments and tactics of stakeholders in the food and drink industries. Scand J Public Health. 2019;47(5):565-575. doi:10.1177/1403494818787102

Chapter 3. Association between children's caregivers time preferences and childhood overweight and obesity in Mexico

Declaration.

This paper has been accepted in PLOS ONE.

I was responsible for conceptualizing the research question, study design, data cleaning, and statistical analysis, through consultations with Dr. Jean-Eric Tarride. I was responsible for all the analysis. Dr. Laura N. Anderson and Dr. G. Emmanuel Guindon each provided feedback on the methods, the drafts and approved the final version.

Original research paper

Title: Association between children's caregivers time preferences and childhood overweight and obesity in Mexico

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Abstract

Background: Parents or children's primary caregivers are a key influence on child weight as both decision makers and role models for eating patterns, physical activity, and other social behaviors. It is unknown whether caregivers' time preferences are associated with overweight or obesity in children. The primary objective was to estimate the association between parents' or caregivers' time preferences and children having overweight or obesity in Mexico.

Methods: A cross-sectional study was conducted using a representative survey of the Mexican population. A multinomial logistic model was used to examine the association between parents' or caregivers' time preferences (patience and time consistency) and child overweight or obesity, adjusting for potential confounders.

Results: The study included 9,102 children (mean age 10, 43% female) and 5,842 caregivers (mean age 37; 95% female). Intertemporal preference was strongly associated with increased odds of overweight or obesity in children. A medium patient caregiver had higher odds of having overweight (adjusted OR: 1.73; 95% CI: 1.19, 2.52). Similarly, having a caregiver with a present (OR: 2.52; 95% CI: 1.72, 3.70) or future bias (OR: 1.48; 95% CI: 1.11, 1.98) was associated with higher odds of obesity.

Conclusion: Caregivers' time preferences were associated with having overweight and obesity in children and should be considered when developing policies to reduce children's obesity status.

Introduction

Due to its high prevalence, associated morbidity, and associated costs, obesity is a major public health issue. It is well understood that obesity is a multifactorial problem, combining biological, environmental, social, behavioral, and economic elements (1,2) as well as lifestyle decisions (3–5). While policy decisions and environmental factors influence healthy or unhealthy choices, individuals' time preferences also shape decisions (3). The term 'time preferences' (also sometimes referred as time discounting) describes 'the extent to which individuals value benefits and costs that arise in the future differently (usually less) than if they arise today' (6). In related terms, individuals discount future rewards as they are perceived as less valuable than the same reward now (7,8). Individuals with a higher discount rate tend to prefer short-term gratifications, while individuals with a low discount rate favor long-term and possibly larger rewards (7,9,10). These time preferences (e.g., an inclination for the present or the future) have been recognized to play an important role in understanding individuals' health habits or eating behavior and obesity risk (10–13). Consuming highly palatable unhealthy food provides immediate pleasure but has negative consequences in the long-term, whereas healthy eating or exercise has distant benefits but an immediate cost. For example, people could value more the immediate pleasure from eating over future healthy aging. This could explain why some individuals would prefer smaller immediate rewards over larger rewards available after a delay (14).

The results of a recent systematic review of 41 studies exploring the relationship between unhealthy diets, obesity, and time discounting found that high-time discount rates (i.e., individuals valuing the present more than the future) were significant risk factors for unhealthy diets (3). However, most studies assessed in this systematic review focused primarily on adults, and very few explored the impact of parents' time preferences on childhood obesity. This is important because parents or caregivers are a key influence on child weight as decision-makers and role models for eating patterns, physical activity, and other social behaviors (15,16). The parental transmission of obesity has been explored as a direct effect through genetics and household environment, but also as an indirect influence given by the spread of unhealthy behaviors from parents to children (17–19). Recently one study exploring the intergenerational effects of parents' time preferences and children's obesity status reported that parents with a preference for the present instead of the future had a higher likelihood of having children with obesity after adjusting for several covariates (17). However, this study was conducted in the U.S., and the generalizability of results to other settings or countries is limited. For example, in Mexico, the prevalence of obesity in children is among the highest in the world (20), and the impact of time preferences is unknown. To fill a gap in the literature and to inform future health policies, our primary objective was to determine the association between parents' or caregivers' time preferences and overweight and obesity in their children in Mexico. Secondary objectives were to determine the association between caregiver's time preferences and children's overweight or obesity by child age and sex and to identify other factors independently associated with children obesity status.

Methods

Study Design and Data source

A cross-sectional study was conducted using the Mexican Family Life Survey (MxFLS). The MxFLS, a representative survey of the Mexican population at the national, urban, rural, and regional levels (21) is a face-to-face in-home survey that collects extensive information at the household and individual levels, including anthropometric measures of all household members and intertemporal preferences of adults, which is conducted every six years. Specifically, it obtained information about intertemporal preferences, obesity status of parents or caregivers and children, and information about other individual and household characteristics and lifestyle habits. Data from the 2012 MxFLS was used in these analyses as the data from the 2018 survey was not released at time of writing.

Study population

The analysis included children between 2-17 years old and adults (≥18 years and older) taking care of at least one of the included children. The MxFLS captures who is the main caregiver for the children, which is either a parent or another family member (e.g., grandparent, uncles/aunts). If this information was not provided, or if the main reported caregiver did not live in the same house as the children (i.e., if the children's caregiver is an employee), the information from one of the parents living in the household was used. Hereafter, we use the term "caregivers" as relating to both parents or other family members helping with childcare. Participants with complete information on time preferences and other covariables described below were included.

Dependent variable

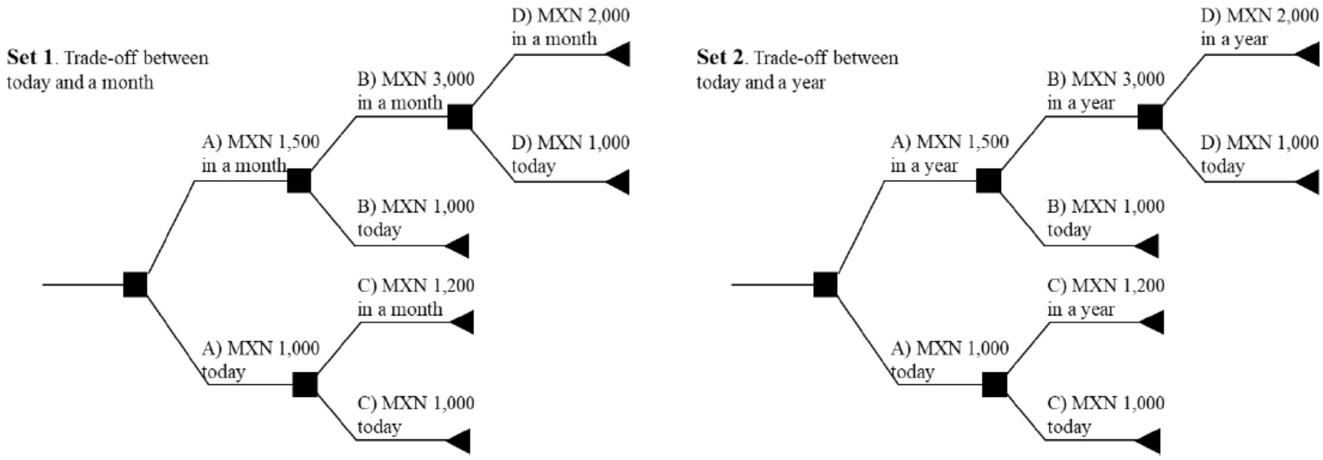
The primary dependent variable was based on children's body mass index (BMI, [kg/m^2]). Both height and weight were measured by trained personnel, using standardized instruments, at home when carrying out the survey (21). Child overweight and obesity were defined using the World Health Organization (WHO) BMI cut-points (22). Child BMI z-scores were calculated based on age and sex using the recommended WHO growth standards for children aged 2 to 4 years and the WHO reference data for children aged 5-17. Children were divided into three categories: normal weight (for ages two to five, BMI z-scores <2; and older than five, z-scores <1), overweight (for ages two and five, 2≤ BMI z-score <3; and older than five, 1≤ BMI z-score <2), and obesity (for age two to five, BMI z-score ≥3; and older than five, BMI z-score ≥2) (22). Few children were underweight; thus, this group was combined with the normal weight children for this study.

Independent variables

The primary independent variables were the caregivers' time preferences which were defined by two concepts: patience and time consistency. Patience refers to the extent an individual is willing to wait to receive a higher reward in the future, compared to a smaller immediate reward. Consistent with previous studies (3,12,23), patience was expressed in terms of patient, medium patient and impatient. Time-consistency refers to how individuals modify their willingness to wait when the time frame changes. Aligned with the literature, time-consistency was expressed in term of time consistent, present bias and future bias (5,17).

Figure 1 presents the trade-offs and rewards used to construct measures of time preference used in the MxFLS. Adult participants were asked two sets of questions. In the first set of questions, adults were asked to choose between 1,000 Mexican pesos (MXN) (approximately $50) today or MXN 1,500 (approximately USD) in a month; if they chose MXN 1,500 in a month over 1,000 today, they were asked if they would choose MXN 3,000 in a month or MXN 1,000 today (option B in Figure 1). If the answer was MXN 3,000, participants were asked whether they preferred MXN 2,000 in a month or MXN 1,000 today (option C in Figure 1). On the other hand, if participants chose MXN 1,000 today instead of MXN 1,500 in a month, participants were asked to choose between MXN 1,200 in a month or MXN 1,000 today (option D in Figure 1) and the survey ended. In addition to asking to choose a reward now or in a month, the second set of questions asked participants to decide between today and in a year similarly. These two questions were used to estimate parameters of patience (represented by δ) and time consistency (β).

Figure 1. Survey's trade-off to measure time preferences.



Therefore, using the survey information on the preference section and following previous literature on time preferences, as well as previously published thresholds to determine patience and time-consistency parameters (3,10,17), the first set of questions of the survey (select an hypothetical amount to receive today versus a possible larger sum in a month) was employed to calculate patience (i.e., δ) as:

$$\delta = \frac{\$1{,}000}{\textit{minimum amount of money willing to accept in a month over } \$1{,}000 \textit{ today}}$$

Consistent with previous works (3,10,17), this information was used to categorize the children's caregivers as patient if the children's caregiver was willing to accept MXN 1,200 in a month instead of MXN 1,000 today (δ=0.83=$1000/1,200) and impatient when they preferred $1,000 today than $3,000 in a month (δ=0.33; $1,000/$3,000). Those caregivers preferring to accept MXN 1,500 (δ=0.67) or $2,000 in a month (δ=0.50) instead of MXN 1,000 today were considered medium patient. Children's caregivers who always chose to receive MXN 1,000 today (δ=1) regardless of the hypothetical amount in a month were considered impatient, assuming there was no quantity higher enough to make them willing to defer their reward.

Similarly, we calculated the parameter for time consistency based on the responses from both sets of questions:

$$\beta = \frac{minimum\ amount\ of\ money\ willing\ to\ accept\ in\ a\ month\ over\ \$1{,}000\ today}{minimum\ amount\ of\ money\ willing\ to\ accept\ in\ one\ year\ over\ \$1{,}000\ today}$$

Children's caregivers were classified as present biased if the amount of money they chose in a shorter-term was higher than in the future ($\beta>1$, i.e., MXN 3,000 in a month and MXN 2,000 in a year), future biased if long term amount was higher ($\beta<1$, i.e., MXN 1,500 in a month and MXN 2,000 in a year), or time consistent if they chose the same amount in both 1-month and 1-year periods ($\beta=1$). The methods used to derive the thresholds for δ and β used in this study were consistent with previous works (3,10,17).

Children were described in terms of age groups (i.e., 2-7, 8-12, and 13 years and older), sex, weekly hours spent in front of a screen for other proposes than schoolwork, and weekly hours allocated to physical activity. Caregivers were also described in terms of age groups (i.e., 18-39, 40 years or older), sex, education (i.e., less than high school, high school and more), marital status (single or married) and BMI categories (i.e., normal weight: BMI<25 kg/m2, overweight: 25≤BMI<30 kg/m2, and obesity BMI≥30 kg/m2). The households in which the children lived were described in terms of socioeconomic status (SES) stratified as low, medium, and high constructed through principal component analysis with a combination of household assets and income data (24), and household location identified as rural/urban status.

Statistical analysis

Mean, standard deviations (SDs) and percentages for continuous and discrete variables, respectively, were first used to describe the populations. The children and the adult populations were stratified by BMI categories to identify any differences in baseline characteristics. To further describe the data, caregivers' time preferences, patience and time consistency were presented by parents' BMI categories, education, household SES, and location. Multiple pairwise comparisons (Tukey's test) for continuous variables (25) and an adaptation of the Tukey's test for discrete variables (26) were used to test for any differences between BMI categories.

To evaluate the association between caregivers' time preferences and children's overweight and obesity status, we used multivariable multinomial logistic regressions and reported odds ratios (OR) and 95% confidence intervals (CI) using a two-step strategy. First, to provide a baseline association between caregiver's time preferences and children's obesity, we adjusted for children's age groups and sex and caregiver's age group, sex, marital status and education and household SES. In a second step, we ran another model in which we added caregiver's BMI and weekly number of hours children spent in front of a screen or in physical activity. Correlation and collinearity between covariates used in the model were tested using Pearson correlations and Variance Inflation Factors (VIF), respectively. To deal with potential measurement error associated with caregivers' BMI, we also ran a model in which caregivers' BMI was analyzed as a continuous polynomial variable. Since the association between parental time preferences and children obesity status may also depend on children's sex and age, separate stratified models were conducted by these two variables.

While multinomial logistic models are commonly used to analyze BMI categories (27,28), a sensitivity analysis was conducted by analyzing the data using a logistic regression model with normal weight as the comparison group as it was done in the U.S. study on parental time preferences (17) as well as a generalized ordinal models (gologit). Gologit models are different from multinomial logistic models as they modify the comparison group allowing comparisons to all categories greater than the current to all those less than or equal to the current one (i.e., normal weight versus overweight and obesity; normal weight and overweight versus obesity). These models have been recently used to model ordinal data in the areas of multidrug resistance (29), tobacco or opioid consumption (30,31), and depression or pain control (32,33).

Sampling weights were used for all descriptive and models' estimations per the MxFLS survey instructions (21). In addition, when calculating the 95% CIs associated with the ORs, the standard errors were clustered at the household level as some children have the same caregiver and share the same household. All analyses were conducted using Stata SE 16.1.

Results

Study population

From the original sample of 12,089 children with information about their caregiver, 1,833 did not have complete anthropometric information, 240 missed the time allocation variable, 342 did not have information about household characteristics, and 572 did not have information about the caregiver's time preferences. Appendix 1 presents this information. The analysis included 9,102 children between two and 17 years of age, representing more than 13 million Mexican children and adolescents when the survey results were extrapolated to the Mexican population.

The mean age of the children was almost 10 (SD=5), 49% were female, and children spent almost 14 hours (SD=15) per week in front of a screen and 13 (SD=13) hours per week of physical activity. The distribution of BMI categories indicated that 70% of the children had normal weight, 18%

were classified as overweight, and 12% had obesity. Older children and males were statistically significantly more likely to have overweight or obesity relative to younger children and female. Similarly, children with overweight or obesity spent statistically significantly less time physically active and more time on a screen than children with normal weight. Table 1 provides the details.

Table 2. Descriptive statistics for Mexican children between 2-17 years of age and by BMI category

	Total	**Normal weight**	**Overweight**	**Obesity**
Sample size, %	9,102	6,418, 70%	1,567 -18%	1,117 -12%
[weighted population]	[13,752,356]	[9,235,645]	[2,565,012]	[1,951,699]
Age (years) [a, b]				
Mean (Std. Dev)	9.58 (4.7)	8.97 (4.8)	10.98 (4.6)	10.62 (4.3)
By group (%)				
2-7 [a, b]	37	44	21	18
8-12 [a, b, c]	32	29	40	47
13-17 [a, c]	31	27	39	35
Sex				
Female (%) [b, c]	49	49	53	40
Physical activity				
(Hours per week) [a, b]				
Mean (Std. Dev)	13.94 (14.8)	14.76 (11.6)	12.44 (11.6)	11.90 (11)
Screen time				
(Hours per week) [a, b]				
Mean (Std. Dev)	12.74 (12.8)	12.01 (16.9)	14.34 (13.8)	14.23 (13.7)

The survey design was considered for all estimations. a, b, c, d indicates statistical significance (i.e., P< 0.05) for the following comparisons: a: normal weight vs. overweight, b: normal weight vs. obesity, c: overweight vs. obesity. Source: authors construction with information from Mexican Family Survey Life (21)

The baseline characteristics of the children's caregivers (i.e., n=5,842 representing more than 9.5 million Mexican caregivers) are presented in Table 2 for the overall population and stratified by children's BMI status. Approximately 94% of the caregivers were the children's parents while the remaining 6% were family members. The mean age of the caregivers was 37 (SD=11) years, 95% were female, 81% had a lower education than high school and 87% were married. Based on caregiver BMI, 38% were classified as overweight and 37% had obesity. Almost two-thirds (61%)

of the caregivers were living in an urban setting, and more than half in a medium SES household (56%). The stratified analyses revealed several differences in the caregivers' characteristics by children's BMI category. For example, caregivers of normal weight children were younger (68%) than children with overweight (64%) or obesity (59%) ($p<0.01$ for all comparisons between BMI categories). Children with overweight (45%) or obesity (58%) were also more likely to have caregivers with obesity compared to children with normal weight (31%; $p<0.01$ for all comparisons). Caregivers living in high SES neighborhoods or urban settings were also more likely to have children with obesity. Table 2 presents the details.

Table 2. Descriptive statistics for Mexican caregivers and per by BMI category of children

Caregiver characteristics		Children's BMI status		
	Total	Normal weight	Overweight	Obesity
Sample size caregivers [weighted population]	5,842 [9,585,138]	4,439, 76% [7,284,705]	876, 15% [1,437,771]	526, 9% [862,662]
Caregiver Characteristics				
Age (years) [a, b]				
Mean (Std. Dev)	37.29 (10.8)	36.20 (10.2)	38.43 (9.2)	38.24 (9.3)
18-39 (%) [a, b]	66	68	64	59
Sex (%)				
Female	95	95	97	96
Schooling (%)				
Less than high school [b]	81	82	78	79
Marital status (%)				
Married	87	85	90	90
BMI category (%)				
Normal weight [a, b, c]	25	31	17	13
Overweight [b, c]	38	38	38	29
Obesity [a, b, c]	37	31	45	58
Household characteristics				
Socioeconomic status (%)				
Low [a, b]	16	17	14	9
Medium	56	56	57	55
High [a, b]	29	27	29	36
Location (%)				
Urban [a, b]	61	59	66	66

The survey design was considered for all estimations. a, b, c, d indicates statistical significance (i.e., P< 0.05) for the following comparisons: a: normal weight vs. overweight, b: normal weight vs. obesity, c: overweight vs. obesity. Source: authors construction with information from Mexican Family Survey Life (21)

Caregiver's time preferences

Table 3 presents the children caregivers' time preferences for the overall population and when the caregivers were stratified by their BMI categories, household characteristics, and children's physical activity and screen time. Overall, 67% of the caregivers' population was impatient (i.e., prefer to have an immediate reward than a larger one in the future) and 14% were patient, the remaining 19% being medium patient. Between 6% (1-month assessment) and 7% (1 year) of caregivers chose the upper value of MXN 3,000 over MXN 1,000 today (Appendix A1). More than half of the caregivers (58%) were time consistent (i.e., choices did not change when considering future regards in a month or one year) and 31% had a future bias. Approximately 82% of impatient caregivers were also time consistent (Appendix A2). The stratified analyses indicated differences in caregivers' time preferences based on their characteristics. For example, patient caregivers were more likely to live in high SES neighborhoods (i.e., 43% versus 25%; $p<.005$) or urban areas (68% versus 60%, $p<0.05$) than impatient caregivers. Caregivers with a future bias were statistically significantly more likely to live in high SES neighborhood (39%) or in urban areas (68%) than caregivers who were time consistent (25% for high SES and 60% for urban area) or had a present bias (32% for high SES and 55% for urban area). Other statistically significant differences were also seen in caregivers' BMI categories or children's time spent doing physical activities or on a screen (Table 3).

Table 3. Caregiver time preferences by BMI categories, household characteristics, physical activity and screen time

Caregiver variables	Patience			Time consistency		
	Patient	Medium patient	Impatient	Time consistent	Present bias	Future Bias
All	14	19	67	58	11	31
Caregiver BMI categories (%)						
Normal weight	26	23	26	24	31	24
Overweight [d]	39	43	36	37	39	39
Obesity [d]	35	34	38	39	30	37
Household characteristics						
Socioeconomic status (%)						
Low [h]	14	10	19	19	17	10
Medium [e, f, g]	53	53	56	56	51	51
High [e, f, g, h]	43	37	25	25	32	39
Location						
Urban [h, i,]	68	67	60	60	55	68
Children's time allocation						
Physical activity (%)						
Mean (std dev) [e]	14.97 (16.0)	13.63 (16.4)	14.90 (15.9)	14.11 (16.1)	16.78 (15.2)	14.83 (15.4)
Screen time (%)						
Mean (std dev) [e]	15.27 (11.6)	13.88 (11.5)	12.46 (12.6)	12.34 (11.6)	13.35 (11.9)	14.50 (11.5)

Survey design is considered for all estimations. f-m indicates statistical significance (i.e., P< 0.05); d: patient vs. medium patient, e: patient vs. impatient, f: medium patient vs. impatient, g: time consistent vs. present bias, h: time consistent vs. future bias, i: present bias vs. future bias. Source: authors construction with information from (21)

Association between caregivers' time preferences and children's BMI status

The results of the multivariable multinomial logistic regressions are provided in Table 4 for the overall population of children and according to the two models (Model 1 without caregiver's BMI and children time spent on TV or physical activity, and Model 2 including all variables). There was no evidence of correlation or multicollinearity between the covariates (all correlations below 0.35 and an overall VIF=1.12). Having a caregiver who was classified as impatient, compared to patient, was not significantly associated with increased odds of childhood overweight or obesity. According to Model 1, having a medium patient caregiver, compared to patient, was significantly associated with increased odds of overweight in children (OR 1.47; 95% CI: 1.01, 2.14). In terms of time consistency, caregivers with a present (OR: 2.26; 95% CI: 1.36, 3.73) or future (OR: 1.45; 95% CI: 1.06, 1.99) bias, compared to caregivers who were time consistent in their choices, were also more likely to have children with obesity. As shown in Table 4, the overall time preference results did not change when the caregiver's BMI and children's time spent on T.V. or physical activity were included, although the magnitude of the ORs changed slightly. For example, for the association between having a medium patient caregiver and overweight the OR changed from 1.47 (95% CI: 1.01, 2.14) to 1.74 (95% CI: 1.19, 2.53). For a present biased caregiver, the OR changed from 2.26 (95% CI: 1.36, 3.73) to 2.52 (95% CI: 1.74, 3.66). However, the caregiver's BMI and time spent on TV or physical activity were independently associated with children's obesity.

Table 4. Multinomial logistic model for children obesity status, caregiver's patience level, and time-consistency. Overall and stepwise analysis.

	Without caregiver BMI, Physical activity, screen time		All children. Complete model	
Odds Ratio (Normal weight as reference)	Overweight	Obesity	Overweight	Obesity
Caregiver's patience (reference: patient)				
Medium patience	1.47* [1.01 - 2.14]	0.98 [0.62 - 1.53]	1.74** [1.19 - 2.53]	1 [0.54 - 1.83]
Impatient	1.12 [0.83 - 1.52]	1.40+ [0.95 - 1.93]	1.21 [0.80 - 1.81]	1.30+ [0.97 - 1.73]
Caregiver's time consistency (Reference: Time consistent)				
Present bias	1.04 [0.79 - 1.37]	2.26** [1.36 - 3.73]	1.11 [0.73 - 1.69]	2.52** [1.74 - 3.66]
Future bias	1.13 [0.87 - 1.47]	1.45* [1.06 - 1.99]	1.23 [0.85 - 1.77]	1.48** [1.11 - 1.97]
Caregiver's BMI (Reference: Normal weight)				
Overweight			2.06** [1.50 - 2.85]	1.70** [1.38 - 2.10]
Obesity			2.71** [2.09 - 3.52]	4.03** [2.88 - 5.63]
Caregiver's age group (reference 18-39)				
40 and older	0.87 [0.69 - 1.10]	1.16 [0.95 - 1.41]	0.79 [0.56 - 1.12]	0.98 [0.79 - 1.22]
Caregiver's sex				

(Reference: female)				
Male	1.09	0.98	1.14	0.98
	[0.56 - 2.11]	[0.57 - 1.68]	[0.57 - 2.28]	[0.58 - 1.67]
Caregiver’s marital status				
(Reference: Married)				
Single	0.64*	0.62	0.59+	0.46
	[0.43 - 0.95]	[0.30 - 1.28]	[0.34 - 1.04]	[0.16 - 1.27]
Caregiver’s schooling level				
(Reference: Less than high school)				
High School & more	1.31	1.21**	1.31	1.15**
	[0.93 - 1.84]	[1.09 - 1.34]	[0.88 - 1.94]	[1.06 - 1.26]
Household socioeconomic status				
(reference: Low)				
Medium	1.08	1.74**		
	[0.74 - 1.57]	[1.24 - 2.43]	0.81+	1.2
High	1.11	2.33**	[0.64 - 1.04]	[0.88 - 1.65]
	[0.81 - 1.53]	[1.73 - 3.14]	0.87	1.75*
Household location: Urban/rural			[0.59 - 1.30]	[1.15 - 2.65]
(Reference: Rural)				
Urban	1.35**	1.35**	1.44**	1.27*
	[1.20 - 1.53]	[1.20 - 1.53]	[1.28 - 1.63]	[1.05 - 1.54]
Child’s age group (reference: 2-7)				
08-12	3.29**	4.19**	3.04**	3.78**
	[2.33 - 4.65]	[3.32 - 5.30]	[2.17 - 4.26]	[3.00 - 4.77]
13-17	3.28**	3.00**	2.69**	2.87**
	[2.75 - 3.91]	[1.95 - 4.59]	[1.96 - 3.69]	[2.00 - 4.10]
Child’s sex (reference: Female)				
Male	0.87	1.44*	1.05	1.65**
	[0.60 - 1.26]	[1.01 - 2.05]	[0.88 - 1.26]	[1.20 - 2.26]
Child’s physical activity (hours per week)			0.98**	0.98**
			[0.98 - 0.99]	[0.98 - 0.99]
Child’s Screen time (hours per week)			1.02**	1.02**
			[1.01 - 1.02]	[1.01 - 1.03]
Constant	0.08**	0.02**	0.05**	0.01**
	[0.06 - 0.12]	[0.01 - 0.03]	[0.03 - 0.08]	[0.01 - 0.02]
Observations	9,102		9,102	
Expanded to	*[13,752,356]*		*[13,752,356]*	

Considering the low number of male caregivers (N=386) and the fact that the caregiver's sex was not associated with children's obesity (Table 4), we excluded the caregiver's sex in our stratified analyses. However, we included the caregiver's BMI and children's time spent watching T.V. or doing physical activity. Also shown in Table 5, our stratified analyses suggested that the association between time preferences and children obesity status may have been modified by sex or age. Our estimates, however, were not precisely estimated (the confidence intervals were wide and overlapped across almost all comparisons). For example, having a caregiver impatient increased the odds of having obesity in children 13-17 years of age by 2.48 (95% CI: 1.60, 3.84) compared to 1.11 (95% CI: 0.68, 1.82) in children 8-12 years of age. Similarly, having a caregiver with a future bias increased the odds of having obesity in male children (OR: 2.11; 95% CI: 1.21, 3.69) while it decreased the odds to having obesity in female children (OR: 0.96; 95% CI: 0.72, 1.29).

Table 5. Multinomial logistic model for children obesity status, caregiver's patience level, and time-consistency. Stratified analysis by children's sex and age

	2-7 years old		8-12 years old		13-17 years old		Female		Male	
Odds Ratio (Normal weight as reference)	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity
Caregiver's patience (reference: patient)										
Medium patience	1.12	1.37	2.82*	0.73	0.76	1.07	1.67	1.2	1.81*	0.83
	[0.63 - 1.97]	[0.85 - 2.20]	[1.62 - 4.92]	[0.24 - 2.23]	[0.52 - 1.12]	[0.45 - 2.58]	[0.86 - 3.21]	[0.81 - 1.78]	[1.05 - 3.13]	[0.38 - 1.79]
Impatient	0.78	1.09	1.83*	1.11	0.66	2.48*	1.11	1.06	1.28	1.40*
	[0.48 - 1.25]	[0.49 - 2.44]	[1.12 - 2.99]	[0.68 - 1.82]	[0.32 - 1.35]	[1.60 - 3.84]	[0.55 - 2.24]	[0.68 - 1.66]	[0.85 - 1.94]	[1.15 - 1.71]
Caregiver's time consistency (Reference: Time consistent)										
Present bias	0.79	1.66	1.84*	1.73	0.77	8.27*	1.4	2.89*	0.89	2.44*
	[0.34 - 1.84]	[0.77 - 3.58]	[1.05 - 3.23]	[0.83 - 3.60]	[0.16 - 3.68]	[4.95 - 13.83]	[0.92 - 2.12]	[1.46 - 5.72]	[0.56 - 1.41]	[1.10 - 5.41]
Future bias	1.07	1.05	1.89*	1.65*	0.84	3.15*	1.32	0.96	1.2	2.11*
	[0.52 - 2.19]	[0.59 - 1.87]	[1.59 - 2.24]	[1.22 - 2.22]	[0.35 - 2.02]	[2.26 - 4.38]	[0.82 - 2.14]	[0.72 - 1.29]	[0.79 - 1.82]	[1.21 - 3.69]
Caregiver's BMI (Reference: Normal weight)										
Overweight	2.52*	1.41	1.78*	1.60	2.03*	1.93*	2.39*	2.72*	1.96*	1.46*
	[1.42 - 4.50]	[0.74 - 2.68]	[1.31 - 2.42]	[0.95 - 2.69]	[1.43 - 2.87]	[1.32 - 2.82]	[1.35 - 4.24]	[1.39 - 5.34]	[1.55 - 2.49]	[1.13 - 1.90]
Obesity	2.85*	4.22*	2.89*	3.46*	2.55*	5.54*	2.89*	8.68*	2.74*	2.89*
	[1.73 - 4.68]	[1.77 - 10.08]	[2.10 - 3.98]	[2.25 - 5.34]	[1.83 - 3.54]	[3.01 - 10.18]	[1.85 - 4.53]	[4.64 - 16.23]	[1.69 - 4.43]	[1.92 - 4.36]
Caregiver's age group (reference 18-39)										
40 and older	1.17	1.39	0.68*	0.99	0.86	0.71*	0.83	1.23	0.81	0.88
	[0.79 - 1.74]	[0.79 - 2.45]	[0.48 - 0.97]	[0.66 - 1.47]	[0.65 - 1.13]	[0.52 - 0.96]	[0.63 - 1.09]	[0.98 - 1.53]	[0.51 - 1.29]	[0.63 - 1.21]
Caregiver's marital status (Reference: Married)										
Single	1.07	0.39	0.58	0.41	0.33*	0.61	0.56*	0.32*	0.6	0.56
	[0.49 - 2.38]	[0.14 - 1.06]	[0.27 - 1.24]	[0.12 - 1.34]	[0.14 - 0.78]	[0.21 - 1.82]	[0.32 - 0.99]	[0.11 - 0.95]	[0.21 - 1.67]	[0.18 - 1.73]
Caregiver's schooling level (Reference: Less than high school)										

High School & more	1.09	0.92	2.06*	1.82*	0.82	0.56	0.9	0.88	1.77	1.45*
	[0.69 - 1.72]	[0.47 - 1.80]	[1.01 - 4.20]	[1.40 - 2.36]	[0.45 - 1.52]	[0.25 - 1.25]	[0.68 - 1.19]	[0.48 - 1.61]	[0.93 - 3.39]	[1.00 - 2.10]
Household socioeconomic status (reference: Low)										
Medium	0.98	0.88	0.57*	0.95	1.39	4.81*	0.73	0.72	0.83	1.48*
	[0.54 - 1.79]	[0.52 - 1.48]	[0.38 - 0.84]	[0.55 - 1.66]	[0.72 - 2.67]	[2.62 - 8.84]	[0.46 - 1.16]	[0.41 - 1.30]	[0.64 - 1.08]	[1.12 - 1.97]
High	0.98	1.88*	0.65	1.14	1.31	7.58*	1.09	1.51	0.67	1.78*
	[0.47 - 2.07]	[1.31 - 2.72]	[0.34 - 1.24]	[0.54 - 2.41]	[0.45 - 3.81]	[4.12 - 13.93]	[0.64 - 1.85]	[0.72 - 3.16]	[0.44 - 1.02]	[1.20 - 2.65]
Household location: Urban/rural (Reference: Rural)										
Urban	1.66*	1.46*	1.31*	1.27	1.46*	0.81	1.37*	1.31	1.55*	1.28*
	[1.11 - 2.48]	[1.04 - 2.05]	[1.13 - 1.52]	[1.00 - 1.62]	[1.08 - 1.97]	[0.61 - 1.07]	[1.15 - 1.63]	[0.91 - 1.87]	[1.34 - 1.80]	[1.02 - 1.61]
Child's age group (reference: 2-7)										
08-12							3.81*	3.23*	2.51*	4.21*
							[2.34 - 6.19]	[2.62 - 3.98]	[1.80 - 3.49]	[3.06 - 5.80]
13-17							3.41*	2.81*	2.16*	2.78*
							[2.21 - 5.28]	[1.86 - 4.24]	[1.55 - 3.01]	[1.38 - 5.62]
Child's sex (reference: Female)										
Male	1.60*	1.79*	0.89	1.73*	0.94	1.29				
	[1.08 - 2.37]	[1.33 - 2.42]	[0.65 - 1.21]	[1.20 - 2.50]	[0.57 - 1.53]	[0.68 - 2.43]				
Child's physical activity (hours per week)	0.98*	0.99*	0.99	0.98*	0.96	0.96*	0.98*	0.97*	0.99*	0.99*
	[0.97 - 1.00]	[0.98 - 1.00]	[0.97 - 1.00]	[0.97 - 1.00]	[0.91 - 1.01]	[0.95 - 0.97]	[0.96 - 0.99]	[0.96 - 0.98]	[0.98 - 1.00]	[0.98 - 1.00]
Child's Screen time (hours per week)	1.02*	1.02	1	1.01	1.04*	1.04*	1.03*	1.04*	1.01	1
	[1.00 - 1.04]	[0.99 - 1.05]	[0.99 - 1.02]	[0.99 - 1.04]	[1.03 - 1.05]	[1.02 - 1.05]	[1.01 - 1.04]	[1.03 - 1.05]	[1.00 - 1.02]	[0.98 - 1.02]
Constant	0.04*	0.01*	0.14*	0.08*	0.19*	0.01*	0.04*	0.01*	0.05*	0.02*
	[0.02 - 0.07]	[0.00 - 0.05]	[0.09 - 0.23]	[0.05 - 0.15]	[0.06 - 0.61]	[0.00 - 0.01]	[0.01 - 0.11]	[0.00 - 0.03]	[0.03 - 0.09]	[0.01 - 0.03]
Observations	3,496		2,699		2,907		4,476		4,626	
Expanded to	*[4,844,922]*		*[4,350,232]*		*[4,022,960]*		*[6,486,408]*		*[6,912,935]*	

*Notes: ciEform in brackets. * p<0.05. Survey design considered for estimations. Standard Errors are adjusted at the household level. ~For purposes other than schoolwork.*

Other associations with children BMI status

As shown in Table 4, several other variables were also significantly associated with children BMI categories in the main analyses or the stratified analyses by children's age groups and sex. Having a caregiver with overweight (except for children 8-12 years of age with obesity) or with obesity increased the odds of overweight or obesity in children compared to have a caregiver with normal weight in all analyses (i.e., females with overweight OR: 2.39; 95% CI: 1.35, 4.24 and males with overweight OR:1.96; 95% CI: 1.55, 2.49). Except for female children with obesity, living in rural areas also increased significantly the odds of overweight or obesity in children. Several other variables were associated with children's BMI status, but the association depended on the populations being studied rather than being seen across all analyses.

Sensitivity analyses

The results of gologit model and the logistic model were mostly aligned with the multinomial logistic regression model regarding the association between time preferences and caregiver's obesity status and children BMI status (see Table 5). For example, the multinomial model displayed an OR of 2.52 (95% CI:1.72, 3.70) for a present bias caregiver and a child with overweight, and the generalized ordinal model showed a coefficient of 2.42 (95% CI: 1.85, 3.17) and 1.64 (95% CI: 1.21, 2.23) in the logistic model. Differences were found in the association with an urban setting losing significance in the gologit model and in some magnitude of coefficients (but with overlapping CIs), i.e., having a caregiver with obesity with an OR of 4.03 (95% CI:2.90, 5.59) in the multinomial model, and 3.27 (95% CI:2.59, 4.13) and 3.23 (95% CI: 2.56, 4.07) in the generalized ordinal model, and the logistic model, respectively. The association of the other independent variables with children BMI status for the overall population or the stratified analyses was also consistent with the results from the multinomial logistic model (see supplemental material).

Our sensitivity analyses to deal with potential measurement error with caregivers' BMI showed that modeling caregivers' BMI as a continuous polynomial variable did not change the results (see supplemental material- Table SP1.5). Furthermore, only first-degree BMI was significant (for children obesity OR: 1.24, 95% CI: 1.07, 1.43).

Discussion

To the best of our knowledge, this is only the second study evaluating the association between caregivers’ time preferences and overweight and obesity in children and the first study conducted in Latin America or exploring the association of caregivers' time preferences and children's BMI status by children age groups and sex. Based on the results of a survey representative of the Mexican population, our findings indicated that more than two-thirds of children’s caregivers were impatient, while approximately 60% were time consistent in their choices. Patient and time-consistent adults have been shown to make healthier choices (3,10,17,34) than impatient or time-inconsistent adults.

The results of our analysis suggest that children caregivers’ time preferences were associated with children's BMI status, in particular present or future-biased time preferences were associated with increased odds of child overweight or obesity. Present-biased caregivers prefer to receive a larger reward in the short term than a higher reward in the future , which could lead to unhealthy behaviors for themselves and their children (17,35), including availability of unhealthy food at home, and the lack of promotion of the physical activity. While the relationship between future-biased caregivers and children's obesity status is less intuitive, few studies have investigated the effects of future bias on healthy decisions (17,36). Some experiments have shown that the individuals' willingness to get a larger reward in the future evolves over time (13,36,37), which could explain some of the results as a future biased individual at time t may become a present bias individual at time t+1. It is also possible that caregivers value having a bigger child and child overweight, or obesity may not be perceived as a concern. Future research should examine the reasons for a potential association between future biased time preference and obesity.

Caregiver time preferences also showed increasing odds with children's age which can be explained by imitation of unhealthy parental behavior –same diet and exercise routines (38,39). It should also be noted that in Mexico, sales of junk food are forbidden in elementary schools or nearby while daily physical activity is only mandatory in elementary schools (40). Compared to younger children attending elementary schools, Mexican children of middle school age are exposed to a more obesogenic environment (unhealthy food choices; lack of mandatory physician activity), which could also explain the age pattern seen in our study. Similarly, the obesity status of the caregivers was associated with the children's BMI status, which may be explained by straightforward genetics, the imitation of food patterns by children, higher availability of high-dense energy food at home, or lower promotion for physical activity (41–44). Living in an urban area was also associated with children's BMI status (45,46).

When comparing our results with the previous literature, BMI categories' prevalence for children and their caregivers was consistent with official reports in Mexico for 2012 (47). Similarly, our household characteristics (educational and SES status, rural status) were also aligned with nationally representative Mexican data (48). It is difficult to compare our results with the only published study on parental time preferences and children's BMI status due to important cultural and economic differences between the U.S. and Mexico. While the U.S. study found an association between patience and children's obesity status (17), our results did not support this association. This difference could be explained because we found a higher proportion of impatient adults in Mexico than in the U.S. (66% in our study versus 27% in the U.S. (17)). Differences between countries in adults' time preferences have been previously reported, showing a lower patience level in highly religious countries, middle-income, and with higher agricultural dependence (49). Also, women were reported to be more impatient than men (49), which were the main caregivers in this study. Our results on the association of caregivers' BMI status and children's BMI were also consistent with several other studies (44,50–53) conducted in Mexico or elsewhere. One Mexican study reported a strong association between the nutritional status of parents and obesity in children, which may be explained by a combination of genetics, eating patterns, and environment (i.e., sharing a household) (52).

Even though our findings are novel, this study has some limitations. First, the study is a cross-sectional analysis; therefore, causality could not be established. Second, caregiver time preferences were based on intertemporal monetary trade-offs rather than using direct food or dietary decisions. However, this method using intertemporal monetary trade-offs has been broadly used for determining time preferences related to eating, smoking, and other health behaviors (3,54–56). Third, diet or intensity of physical activity was not considered in our analyses as this information was not documented in the MxFLS. Fourth, there is a potential loss of information by using some categorical variables instead of continuous variables (i.e., BMI, caregiver age, SES). However, we explored models in which caregivers' BMI was analyzed as a continuous variable, which did not change the main results. We kept caregivers' BMI as a categorical variable in our models. Fifth, the analyses were limited by the data captured in the survey. For example, although we had information on socioeconomic status of the caregivers, we did not have access to income/spending balance or household debt variables which could be related to time preferences. However, studies that have explored the association between household (or personal) debt and obesity have not found an association between these variables (57–59). Finally, while in theory caregivers could have chosen an infinite value compared to MXN $1,000 today instead of the upper value of MXN $3,000 used in the survey, the impact of a potential ceiling effect should be minimal as less than 6% (30-day assessment) and 7% (one-year assessment) chose the upper value of MXN $3,000. Despite the limitations, this study provides relevant evidence about the association between caregiver time preferences and children's BMI status in Mexico, and this study has several strengths. First, a national representative sample of the Mexican population was used, so our results should be useful to inform future policies in Mexico. Secondly, several approaches were used for our regression analyses, and the results consistency strengthened the study findings. Finally, the study used not only parents but children's caregivers who are often the person making decisions when parents are not available.

Worldwide there is increasing research and policymaking promoting healthy lifestyles to reduce the burden of obesity and overweight in children and adolescents (60,61). Designing effective policies is crucial to understand how to support individuals to make healthy choices, especially when policies target children. Several studies have shown the importance of incorporating time preferences when designing policies to change health behaviors such as smoking, physical activity, food consumption, and health investment (11,62–64). However, very few studies have evaluated the impact of intergenerational time preferences. Our study found that caregiver time preferences were associated with children's BMI status. However, the association depended on the children's BMI status (e.g., overweight or obesity), providing new insights which could be used to develop future policies in Mexico or elsewhere. For example, given that more than two-third of caregivers in Mexico were impatient (i.e., 67% as shown in this study), policies aimed at reducing children obesity should tailor communications by framing short-term instead of long-term outcomes (64) or creating short-term financial incentive-based interventions (5,12,63) An example of such a policy is the ‘PROGRESA’ program in Mexico which provides monetary incentives in exchange of school attendance and routine GP visits for children (65). These policies should also consider other important factors such as children’s caregiver BMI status or geography (i.e., urban settings), which were also strongly associated with children's BMI status.

References

1. Popkin BM. The Nutrition Transition: An Overview of World Patterns of Change. Nutr Rev. 2004;62:S140-S143. doi:10.1111/j.1753-4887.2004.tb00084.x
2. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. Obes Rev. 2004;5(s1):4-85. doi:10.1111/j.1467-789X.2004.00133.x
3. Barlow P, Reeves A, McKee M, Galea G, Stuckler D. Unhealthy diets, obesity and time discounting: a systematic literature review and network analysis: Time discounting, diets and obesity. Obes Rev. 2016;17(9):810-819. doi:10.1111/obr.12431
4. Hruby A, Hu FB. The Epidemiology of Obesity: A Big Picture. PharmacoEconomics. 2015;33(7):673-689. doi:10.1007/s40273-014-0243-x
5. Loewenstein G, Asch DA, Friedman JY, Melichar LA, Volpp KG. Can behavioural economics make us healthier? BMJ. 2012;344(may23 1):e3482-e3482. doi:10.1136/bmj.e3482
6. Hurley JE. Health Economics. 1. ed. McGraw-Hill Ryerson; 2010.
7. Frederick S, Loewenstein G, O'donoghue T. Time Discounting and Time Preference: A Critical Review. J Econ Lit. 2002;40(2):351-401. doi:10.1257/jel.40.2.351
8. Kawakami N, Watanabe K, Nishi D, Takagi D, Hashimoto H, Tanaka SC. Time preference and personal value: a population-based cross-sectional study in Japan. BMC Psychol. 2020;8(1):85. doi:10.1186/s40359-020-00458-6
9. Laibson D. Golden Eggs and Hyperbolic Discounting. Q J Econ. 1997;112(2):443-478. doi:10.1162/003355397555253
10. Hoch SJ, Loewenstein GF. Time-Inconsistent Preferences and Consumer Self-Control. J Consum Res. 1991;17(4):492. doi:10.1086/208573
11. Hunter RF, Tang J, Hutchinson G, Chilton S, Holmes D, Kee F. Association between time preference, present-bias and physical activity: implications for designing behavior change interventions. BMC Public Health. 2018;18(1):1388. doi:10.1186/s12889-018-6305-9
12. Zhang L, Rashad I. OBESITY AND TIME PREFERENCE: THE HEALTH CONSEQUENCES OF DISCOUNTING THE FUTURE. J Biosoc Sci. 2008;40(1):97-113. doi:10.1017/S0021932007002039
13. Takeuchi K. Non-parametric test of time consistency: Present bias and future bias. Games Econ Behav. 2011;71(2):456-478. doi:10.1016/j.geb.2010.05.005
14. Loewenstein G, Brennan T, Volpp KG. Asymmetric Paternalism to Improve Health Behaviors. JAMA. 2007;298(20):2415. doi:10.1001/jama.298.20.2415
15. Gicevic S, Aftosmes-Tobio A, Manganello JA, et al. Parenting and childhood obesity research: a quantitative content analysis of published research 2009-2015: Parenting and childhood obesity research. Obes Rev. 2016;17(8):724-734. doi:10.1111/obr.12416
16. Gray LA, Hernandez Alava M, Kelly MP, Campbell MJ. Family lifestyle dynamics and childhood obesity: evidence from the millennium cohort study. BMC Public Health. 2018;18(1):500. doi:10.1186/s12889-018-5398-5
17. Stoklosa M, Shuval K, Drope J, et al. The intergenerational transmission of obesity: The role of time preferences and self-control. Econ Hum Biol. 2018;28:92-106. doi:10.1016/j.ehb.2017.12.004

18. Classen TJ, Thompson O. Genes and the intergenerational transmission of BMI and obesity. Econ Hum Biol. 2016;23:121-133. doi:10.1016/j.ehb.2016.08.001
19. Clark HR, Goyder E, Bissell P, Blank L, Peters J. How do parents' child-feeding behaviours influence child weight? Implications for childhood obesity policy. J Public Health. 2007;29(2):132-141. doi:10.1093/pubmed/fdm012
20. Shamah-Levy T, Vielma-Orozco E, Heredia-Hernández O, et al. Encuesta Nacional de Salud y Nutrición 2018-19: Resultados Nacionales.; 2020. https://ensanut.insp.mx/encuestas/ensanut2018/doctos/informes/ensanut_2018_informe_final.pdf
21. Rubalcava L, Teruel G. Encuesta Nacional sobre Niveles de Vida de los Hogares, Tercera Ronda. Published online 2013. www.ennvih-mxfls.org
22. WHO. Obesity and Overweight: Key Facts.; 2020. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
23. Davis C, Patte K, Levitan R, Reid C, Tweed S, Curtis C. From motivation to behaviour: A model of reward sensitivity, overeating, and food preferences in the risk profile for obesity. Appetite. 2007;48(1):12-19. doi:10.1016/j.appet.2006.05.016
24. Poirier MJP, Grépin KA, Grignon M. Approaches and Alternatives to the Wealth Index to Measure Socioeconomic Status Using Survey Data: A Critical Interpretive Synthesis. Soc Indic Res. 2020;148(1):1-46. doi:10.1007/s11205-019-02187-9
25. Haynes W. Tukey's Test. In: Dubitzky W, Wolkenhauer O, Cho KH, Yokota H, eds. Encyclopedia of Systems Biology. Springer New York; 2013:2303-2304. doi:10.1007/978-1-4419-9863-7_1212
26. Elliott AC, Reisch JS. Implementing a Multiple Comparison Test for Proportions in a 2 xc Crosstabulation in. In: ; 2006.
27. Lohse T, Rohrmann S, Faeh D, Hothorn T. Continuous outcome logistic regression for analyzing body mass index distributions. F1000Research. 2017;6:1933. doi:10.12688/f1000research.12934.1
28. Juvanhol LL, Lana RM, Cabrelli R, et al. Factors associated with overweight: are the conclusions influenced by choice of the regression method? BMC Public Health. 2016;16(1):642. doi:10.1186/s12889-016-3340-2
29. Agga GE, Scott HM. Use of generalized ordered logistic regression for the analysis of multidrug resistance data. Prev Vet Med. 2015;121(3-4):374-379. doi:10.1016/j.prevetmed.2015.08.015
30. Romberg AR, Miller Lo EJ, Barton AA, Xiao H, Vallone DM, Hair EC. Cigarette smoking, prescription opioid use and misuse among young adults: An exploratory analysis. Prev Med. 2019;129:105845. doi:10.1016/j.ypmed.2019.105845
31. Romberg AR, Rath JM, Miller Lo EJ, et al. Young Adults' Opioid Prescription History and Opioid Misuse Perceptions. Am J Health Behav. 2019;43(2):361-372. doi:10.5993/AJHB.43.2.12
32. Lin L yi, Sidani JE, Shensa A, et al. ASSOCIATION BETWEEN SOCIAL MEDIA USE AND DEPRESSION AMONG U.S. YOUNG ADULTS: Research Article: Social Media and Depression. Depress Anxiety. 2016;33(4):323-331. doi:10.1002/da.22466

33. Cai B, Oderda GM. The Association Between Pain and Depression and Some Determinants of Depression for the General Population of the United States. J Pain Palliat Care Pharmacother. 2012;26(3):257-265. doi:10.3109/15360288.2012.703292
34. Chen S, Li G. Time-inconsistent preferences, consumption, investment and life insurance decisions. Appl Econ Lett. 2020;27(5):392-399. doi:10.1080/13504851.2019.1617395
35. Santiago-Torres M, Adams AK, Carrel AL, LaRowe TL, Schoeller DA. Home Food Availability, Parental Dietary Intake, and Familial Eating Habits Influence the Diet Quality of Urban Hispanic Children. Child Obes. 2014;10(5):408-415. doi:10.1089/chi.2014.0051
36. Attema AE, Brouwer WBF, Claxton K. Discounting in Economic Evaluations. PharmacoEconomics. 2018;36(7):745-758. doi:10.1007/s40273-018-0672-z
37. Scholten M, Read D. Discounting by Intervals: A Generalized Model of Intertemporal Choice. Manag Sci. 2006;52(9):1424-1436. doi:10.1287/mnsc.1060.0534
38. García García E, Vázquez López MÁ, Galera Martínez R, et al. Prevalencia de sobrepeso y obesidad en niños y adolescentes de 2 a 16 años. Endocrinol Nutr. 2013;60(3):121-126. doi:10.1016/j.endonu.2012.09.014
39. Li X, Xiang ST, Dong J, et al. Association between Physical Activity and Age among Children with Overweight and Obesity: Evidence from the 2016-2017 National Survey of Children's Health. BioMed Res Int. 2020;2020:1-8. doi:10.1155/2020/9259742
40. Secretaría de Gobernación. POLÍTICAS PÚBLICAS PARA UNA EDUCACIÓN FÍSICA DE CALIDAD UNESCO/MÉXICO. Published online 2018. https://www.gob.mx/salud/documentos/politicas-publicas-para-una-educacion-fisica-de-calidad-unesco-mexico-167271
41. Pearson N, Biddle SJ, Gorely T. Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review. Public Health Nutr. 2009;12(2):267-283. doi:10.1017/S1368980008002589
42. Nepper MJ. Associations of the Home Food Environment with Eating Behaviors and Weight Status among Children and Adolescents. J Nutr Food Sci. 2015;s12. doi:10.4172/2155-9600.S12-004
43. Jago R, Davison KK, Thompson JL, Page AS, Brockman R, Fox KR. Parental Sedentary Restriction, Maternal Parenting Style, and Television Viewing Among 10-to 11-Year-Olds. PEDIATRICS. Published online August 22, 2011:peds.2010-3664. doi:10.1542/peds.2010-3664
44. Keane E, Layte R, Harrington J, Kearney PM, Perry IJ. Measured Parental Weight Status and Familial Socio-Economic Status Correlates with Childhood Overweight and Obesity at Age 9. Kazembe L, ed. PLoS ONE. 2012;7(8):e43503. doi:10.1371/journal.pone.0043503
45. Jia P, Xue H, Cheng X, Wang Y, Wang Y. Association of neighborhood built environments with childhood obesity: Evidence from a 9-year longitudinal, nationally representative survey in the US. Environ Int. 2019;128:158-164. doi:10.1016/j.envint.2019.03.067

46. Nurwanti E, Hadi H, Chang JS, et al. Rural–Urban Differences in Dietary Behavior and Obesity: Results of the Riskesdas Study in 10–18-Year-Old Indonesian Children and Adolescents. Nutrients. 2019;11(11):2813. doi:10.3390/nu11112813
47. Oropeza Abúndez C, Instituto Nacional de Salud Pública (Mexico), Mexico, eds. Encuesta Nacional de Salud y Nutrición 2012: Resultados Nacionales. Primera edición. Instituto Nacional de Salud Pública : Secretaría de Salud; 2012.
48. INEGI. Encuesta Nacional de Ingresos y Gastos de Los Hogares 2020, Nueva Serie.; 2020. https://www.inegi.org.mx/rnm/index.php/catalog/685/variable/F13/V1758?name=est_socio
49. Falk A, Becker A, Dohmen T, Enke B, Huffman D, Sunde U. Global Evidence on Economic Preferences*. Q J Econ. 2018;133(4):1645-1692. doi:10.1093/qje/qjy013
50. Wang Y, Min J, Khuri J, Li M. A Systematic Examination of the Association between Parental and Child Obesity across Countries. Adv Nutr Int Rev J. 2017;8(3):436-448. doi:10.3945/an.116.013235
51. Martínez-Villanueva J, González-Leal R, Argente J, Martos-Moreno GÁ. Parental obesity is associated with the severity of childhood obesity and its comorbidities. An Pediatría Engl Ed. 2019;90(4):224-231. doi:10.1016/j.anpede.2018.06.010
52. Klünder-Klünder M, Cruz M, Medina-Bravo P, Flores-Huerta S. Do children of parents with overweight and obesity have an increased risk of developing obesity and changes in the blood pressure? Bol Méd Hosp Infant México. 2011;68(6).
53. Fuemmeler BF, Lovelady CA, Zucker NL, Østbye T. Parental obesity moderates the relationship between childhood appetitive traits and weight: Childhood Appetitive Traits and Obesity. Obesity. 2013;21(4):815-823. doi:10.1002/oby.20144
54. Madsen KP, Kjær T, Skinner T, Willaing I. Time preferences, diabetes self-management behaviours and outcomes: a systematic review. Diabet Med. 2019;36(11):1336-1348. doi:10.1111/dme.14102
55. Peretti-Watel P, L'Haridon O, Seror V. Time preferences, socioeconomic status and smokers' behaviour, attitudes and risk awareness. Eur J Public Health. 2013;23(5):783-788. doi:10.1093/eurpub/cks189
56. Brown H, Pol M. THE ROLE OF TIME PREFERENCES IN THE INTERGENERATIONAL TRANSFER OF SMOKING. Health Econ. 2014;23(12):1493-1501. doi:10.1002/hec.2987
57. Averett SL, Smith JK. Financial hardship and obesity. Econ Hum Biol. 2014;15:201-212. doi:10.1016/j.ehb.2013.12.004
58. Keese M, Schmitz H. Broke, Ill, and Obese: Is There an Effect of Household Debt on Health?: Broke, Ill, and Obese. Rev Income Wealth. 2014;60(3):525-541. doi:10.1111/roiw.12002
59. Averett SL, Smith JK. Indebted and overweight: The link between weight and household debt. IZA DP. (6898). https://www.econstor.eu/bitstream/10419/67186/1/727546546.pdf
60. PAHO. Plan of Action for the Prevention of Obesity in Children and Adolescents.; 2014. https://iris.paho.org/bitstream/handle/10665.2/49138/obesity-plan-of-action-child_eng_2015.pdf?sequence=1&isAllowed=y

61. Molina M, Anderson LN, Guindon GE, Tarride J. A review of implementation and evaluation of Pan American Health Organization's policies to prevent childhood obesity in Latin America. Obes Sci Pract. Published online October 30, 2021:osp4.572. doi:10.1002/osp4.572
62. Zauberman G, Urminsky O. Consumer intertemporal preferences. Curr Opin Psychol. 2016;10:136-141. doi:10.1016/j.copsyc.2016.01.005
63. Koffarnus MN, Jarmolowicz DP, Mueller ET, Bickel WK. CHANGING DELAY DISCOUNTING IN THE LIGHT OF THE COMPETING NEUROBEHAVIORAL DECISION SYSTEMS THEORY: A REVIEW: CHANGING DELAY DISCOUNTING. J Exp Anal Behav. 2013;99(1):32-57. doi:10.1002/jeab.2
64. Ortendahl M, Fries JF. Framing health messages based on anomalies in time preference. Med Sci Monit Int Med J Exp Clin Res. 2005;11(8):RA253-256.
65. Campos-Alanis J. Análisis del Programa de Educación, Salud y Alimentación (Progresa) en el municipio de San Felipe del Progreso, Estado de México, 1998-2000. Papeles Poblac. 2003;9(35):181-207.

Chapter 4. The association between childhood obesity and caregiver-reported medical conditions, health status and healthcare use in Mexico

Declaration.

I was responsible for conceptualizing the research question, study design, data cleaning, and statistical analysis, through consultations with Dr. Jean-Eric Tarride. I was responsible for all the analysis. Dr. Laura N. Anderson and Dr. G. Emmanuel Guindon each provided feedback on the methods, the drafts and approved the final version.

Original research paper

Title: The association between childhood obesity and caregiver-reported medical conditions, health status and healthcare use in Mexico

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Abstract

Background: Childhood obesity is a major public health concern globally, yet the burden of childhood obesity in Mexico remains understudied. This study aimed to document the associations between children's obesity status and medical conditions, health status, and healthcare resource utilization as reported by their caregivers.

Methods: Data from the 2012 cross sectional Mexican Family Life Survey were used to examine the association between children's Body Mass Index status (normal weight, overweight, obesity) and caregiver-reported medical conditions, health status, and healthcare use in the last month among Mexican children aged 2-15 years using unadjusted and adjusted analyses. Subgroup analyses by sex and age groups were also performed.

Results: The study included 7,403 children (mean age 8 [SD 3.5], 50% female). Children's BMI status was not statistically significantly associated with caregiver-reported medical conditions, except for respiratory distress, where obesity increased the odds compared to children with normal-weight (OR: 1.66; 95% CI: 1.08, 2.83). Compared to normal weight, children living with overweight were more likely to be reported by caregivers as being in good or perfect health (OR: 1.34; 95% CI: 1.04, 1.73). There were no statistically significant associations between BMI status and physician visits or hospitalizations. Differences by sex were identified, for example, adolescents living with overweight (OR: 2.58; 95% CI: 1.96, 6.90) or obesity (OR: 3.25; 95% CI: 1.04, 10.19) were more likely to have asthma, compared to normal-weight adolescents.

Conclusion: Obesity among Mexican children was generally not associated with caregiver-reported medical conditions, health status, and healthcare resource utilization.

Introduction

Due to its rising prevalence, childhood obesity is one of the most significant global public health concerns today (1–3). Research has demonstrated that children living with obesity were more likely to have hypertension, type II diabetes, metabolic syndrome, pulmonary disorders, mental health disorders (4) during childhood than children with normal weight (5–8), and to develop more complex health issues as they transition into adulthood (9–12). Moreover, the increased incidence of obesity-related comorbidities in children could lead to higher healthcare utilization. A systematic review and meta-analysis of 33 articles published up to May 2020 revealed that children living with obesity were more frequent users of emergency rooms (rate ratios [RR]: 1.34, 95% CI: 1.07, 1.68) and outpatient visits (RR: 1.11, 95% CI: 1.02, 1.20) than children with normal weight. There were no statistically significant differences in healthcare resource utilization between children with normal weight and those living with overweight (13). Although this meta-analysis provided valuable insights into the burden of obesity in children, most of the included studies were from the United States or Europe. Only two studies were from Brazil, and their results were limited: one study examined excess weight only for hospitalized children (not considering those outside hospital settings) (14), while the second focussed on medication use (15). Consequently, the burden of obesity in children in Latin America remains poorly understood, even though overweight and obesity among children have rapidly increased in the region (16,17). In Mexico, for example, one in three children older than five were overweight or had obesity in 2018 (18).

From a policy standpoint, the burden of childhood obesity on the healthcare system is substantial, as projections indicate increasing healthcare expenditures due to the rising obesity rates in both child and adult populations (13,19,20). To better inform families, clinicians, and policymakers about the burden of obesity in children in Mexico, this paper aims to describe the population of children in Mexico according to BMI categories and to determine the association between children's BMI status and their medical conditions, health status, and healthcare resource use, as reported by their caregivers.

Methods

Study Design, Data Source, and Study Population

This cross-sectional study utilized data from the Mexican Family Life Survey (MxFLS), a representative survey of the Mexican population at national, urban, rural, and regional levels (21). In addition to the adult population, the MxFLS provides information on children aged 2-15 years as reported by the children's caregivers. The MxFLS identifies the primary caregiver for each child, typically a parent or, in some cases, another family member (e.g., grandparent, uncle/aunt). This article uses the term "caregivers" to refer to parents or other family members reporting the children's variables. The MxFLS collects extensive information during face-to-face in-home interviews at both household and individual levels, including anthropometric measurements, household characteristics, lifestyle habits, healthcare utilization, and reported health status. For these analyses, data from the 2012 MxFLS were used, as it represents the most recent publicly available data at the time of writing.

Study outcomes

The study outcomes for our population of children aged 2-15 years included: 1) the presence of medical conditions, which consisted of acute medical conditions occurring over the last month (flu, vomiting, diarrhea, fever, headache, stomach ache, respiratory infections, and respiratory distress) and chronic medical conditions diagnosed by a physician at any time (asthma and others not specified); 2) health status (perfect, good, regular, bad, and very bad); 3) physician visits in the past month (yes/no), excluding routine visits to capture only those related to medical issues and not scheduled visits such as vaccinations; and 4) hospitalization in the past year (yes/no). All outcomes were reported by the children's caregiver.

Independent variables

The primary independent variable was based on children's body mass index (BMI) z-scores. In the MxFLS survey, height and weight were measured by trained personnel at home using standardized instruments (21). Overweight and obesity were defined using the World Health Organization (WHO) BMI cut-points based on growth standards adjusted by age and sex (22). Children were divided into three categories: normal weight (for ages two to five, BMI z-scores <2; and older than five, z-scores <1), overweight (for ages two and five, 2≤ BMI z-score <3; and older than five, 1≤ BMI z-score <2), and obesity (for age two to five, BMI z-score ≥3; and older than five, BMI z-score ≥2) (22). Few children were underweight and were removed from the study (less than 2% of the total sample). Children were also described by age groups (i.e., 2-5, 6-11, and 12-15 years and older), sex, and household socioeconomic status (SES). In the MxFLS survey, SES was based on a principal component analysis from household assets and stratified as low, medium, and high SES. Caregiver's schooling level and BMI categories (i.e., normal weight: BMI<25 kg/m2, overweight: 25≤BMI<30 kg/m2, and obesity BMI≥30 kg/m2) were also included given the relevance in its association with children's health perception and seeking healthcare (23–25).

Statistical analysis

Descriptive statistics were utilized to describe the children's overall population and BMI status. Discrete variables were displayed as percentages, while continuous variables were described as means and standard deviations (SDs). A multiple imputation method was used to replace the missing values only for the caregiver's BMI variable (26,27). Unadjusted and adjusted analyses were conducted to determine the association between obesity status and the dependent variabless using children with normal weight as the comparison groups. Adjusted analyses were conducted using multivariable logistic regressions adjusted for children's age, sex, household socioeconomic status, caregiver's BMI and schooling level. For the purpose of the analyses, reported health status (perfect/good health versus regular/bad/very bad), physician visits (yes or no), and hospitalizations (yes or no) were dichotomized. Results were reported in terms of odds ratios (OR) with associated 95% confidence intervals (CIs). As the association between each dependent variable and children's obesity status may also depend on children's sex and age (28–30), separate stratified models were conducted by age and sex. Additionally, we tested the robustness of results running different models with and without weights, or without imputation. The C-statistic was estimated for each model to evaluate the goodness-of-fit of the logistic models. A C-statistic value of 0.70 or greater indicates good discrimination (31).

As per the MxFLS survey instructions, sampling weights were used for all descriptive and model estimations (21). Additionally, when calculating the 95% CIs associated with the ORs, the standard errors were clustered at the household level, as some children have the same caregiver and share the same household. All analyses were conducted using Stata SE 17.1.

Results

Study populations

The analysis examined a study population of 7,403 children aged between two and 15 years, which, when extrapolated to the Mexican population, represented over 22 million Mexican children and adolescents. The mean (SD) age of the children was eight years (SD: 3.5), and 50% were female.

According to the BMI categories, 64% of the children had normal weight, 21% were living with overweight, and 15% with obesity. Among the caregivers, 38% were living with overweight and 36% with obesity, 95% were female, and more than 90% had completed at least elementary school. Table 1 provides additional details.

Table 1. Socio-demographic characteristics in children. General and by child zBMI category

Variables	**All children**	**By Child zBMI category**		
		Normal weight	Overweight	Obesity
Sex (female)	50	51	53	42
Age (mean -SD.)	8.5 (3.5)	7.8 (3.7)	9.4 (3.2)	9.9 (2.8)
Age group (%)				
2-5 yo	26	85	12	3
6-11 yo	49	61	21	18
12-15 yo	25	53	27	20
BMI category (%)				
Normal weight	64			
Overweight	21			
Obesity	15			
Household characteristics				
SES (%)				
Low	36	40	33	25
Medium	34	34	32	33
High	31	27	36	41
Parental characteristics				
BMI category (%)				
Normal weight	29	81	12	7
Overweight	38	67	21	15
Obesity	36	56	23	21
Sex (female)	95	97	95	95
Schooling (%)				
None	8	74	16	10
Elementary	71	66	20	14
High school and higher	20	63	20	17
Sample size [Expanded sample]	**7,403 [22,785,550]**	4,738 [14,810,608]	1,555 [4,557,110]	1,110 [3,417,832]

Survey design was considered for all analysis. SES: Socioeconomic status; yo: years old: BMI: Body Mass Index; SD: Standard Deviation.

Caregiver-reported medical conditions, health status, and healthcare utilization.

Table 2 presents the descriptive data for all children and for children with normal weight. As reported by the caregivers, most children had a medical condition in the past month (60%), with the most commonly cited being the flu (39%), followed by respiratory infections (27%), headache (20%), and stomach-ache (18%). According to the children's caregivers, most children were in either good (65%) or perfect (14%) health, while approximately 20% had average health. One percent of caregivers reported that their children had bad or very bad health. Approximately 11% of the children visited a physician in the last month, and 2% were hospitalized.

Table 2. Logistic models for medical conditions, reported health status, and healthcare utilization for children with a normal weight and odds ratio by zBMI levels (reference: normal weight) (n=7,403)

			Unadjusted		Adjusted#	
Variable	All children (%)	Normal weight (%)	**OR [95% CI]** overweight vs normal weight	**OR [95% CI]** obesity vs normal weight	**OR [95% CI]** overweight vs normal weight	**OR [95% CI]** obesity vs normal weight
Any medical condition	60.3	59.8	0.97 [0.79 - 1.19]	1.06 [0.84 - 1.35]	0.97 [0.78 - 1.19]	1.06 [0.81 - 1.39]
Headache	20.1	19.7	0.98 [0.76 - 1.26]	1.09 [0.82 - 1.46]	0.95 [0.73 - 1.23]	1.09 [0.80 - 1.47]
Stomach-ache	17.7	18.0	0.98 [0.73 - 1.30]	0.83 [0.60 - 1.14]	0.99 [0.73 - 1.34]	0.86 [0.61 - 1.21]
Flu	38.8	39.3	0.96 [0.77 - 1.19]	0.94 [0.75 - 1.17]	0.99 [0.79 - 1.25]	0.98 [0.767 - 1.2]
Respiratory infection	27.4	27.1	1.06 [0.83 - 1.35]	0.92 [0.69 - 1.22]	1.18 [0.91 - 1.53]	1.13 [0.86 - 1.5]
Respiratory distress	5.5	5.1	1.04 [0.67 - 1.59]	1.41 [0.82 - 2.43]	1.15 [0.74 - 1.78]	**1.66* [1.08 - 2.83]**
Vomit	6.3	6.0	0.86 [0.55 - 1.33]	1.32 [0.80 - 2.17]	0.96 [0.58 - 1.58]	1.61 [0.87 - 2.96]
Fever	11.7	12.6	0.8 [0.57 - 1.13]	0.82 [0.56 - 1.20]	0.91 [0.64 - 1.29]	1.04 [0.67 - 1.58]
Diarrhea	3.7	3.3	0.96 [0.55 - 1.69]	1.38 [0.76 - 2.47]	1.31 [0.76 - 2.31]	1.68 [0.86 - 3.26]
Asthma	2.9	2.4	1.29 [0.75 - 2.19]	**1.67* [1.15 – 2.82]**	1.21 [0.67 - 2.14]	1.43 [0.78 - 2.61]
Other chronic diseases	2.7	2.5	1.22 [0.63 - 2.32]	1.52 [0.80 - 2.87]	0.89 [0.47 - 1.65]	1.33 [0.68 - 2.60]
Perfect or good health	79.5	78.9	**1.32* [1.02 - 1.69]**	1.07 [0.80 - 1.42]	**1.34* [1.03 - 1.72]**	0.9 [0.66 - 1.22]

Physician Visit	10.9	11.3	0.83 [0.59 - 1.16]	0.89 [0.61- 1.29]	0.92 [0.66 - 1.27]	1.15 [0.79 - 1.67]
Hospitalization	1.8	1.7	1.44 [0.75 - 2.75]	1.32 [0.65 - 2.68]	1.08 [0.51 - 2.26]	0.72 [0.28 - 1.85]

95% Confidence interval in brackets #Adjusted by sex, age, socioeconomic status, caregiver's BMI and caregiver's schooling. ** p<0.01, * p<0.05. Survey design was considered for all analysis. BMI: Body Mass Index. OR: Odds ratio. CI: Confidence Intervals

Except in a few instances, there was no statistically significant association between children's obesity status and caregiver-reported medical conditions, as shown in our unadjusted and adjusted analyses presented in Table 2. Compared to children with normal weight, children living with obesity were more likely to have asthma based on unadjusted analyses, but the association was no longer statistically significant after adjusting for covariates. After covariate adjustment, children living with obesity were more likely to experience respiratory distress in the last month compared to children with normal weight (OR: 1.66, 95% CI [1.08, 2.83]). In both the unadjusted and adjusted analyses, children's caregivers were more likely to report perfect or good health among children living with overweight compared to children with normal weight (adjusted OR: 1.34, 95% CI [1.03, 1.72]). Our analyses did not find any statistically significant associations between obesity levels and the occurrence of physician visits or hospitalizations. All C-stats reported levels between 0.65 and 0.72 (results not shown).

Stratified analyses by sex and age groups

Although few associations were found between BMI status and our outcomes in our stratified analyses, obesity among male children was found to increase the likelihood of experiencing headaches and respiratory distress compared to male children with normal weight (OR: 1.50, 95% CI [1.01, 2.23] and OR: 1.86, 95% CI [1.15, 4.05], respectively). No other statistically significant associations were found between BMI status and caregiver-reported health status and healthcare utilization of children (Table 3).

Table 3. Logistic models for medical conditions, reported health status, and healthcare utilization for children with a normal weight and odds ratio by zBMI levels (reference: normal weight) by sex (n=7,403).

	Female			Male		
	Normal weight (%)	**OR [95% CI]** overweight vs normal weight	**OR [95% CI]** obesity vs normal weight	Normal weight (%)	**OR [95% CI]** overweight vs normal weight	**OR [95% CI]** obesity vs normal weight
Any medical condition	61.9	0.86 [0.64 - 1.16]	0.82 [0.57 - 1.17]	58.2	1.06 [0.790 - 1.433]	1.29 [0.89 - 1.86]
Headache	22.4	0.81 [0.56 - 1.170	0.73 [0.47 - 1.13]	17.9	1.11 [0.762 - 1.621]	**1.50*** **[1.01 - 2.23]**
Stomach-ache	20.5	0.99 [0.65 - 1.48]	0.73 [0.45 - 1.17]	14.8	1 [0.651 - 1.528]	1.04 [0.64 - 1.68]
Flu	41.3	0.94 [0.71 - 1.26]	0.86 [0.61 - 1.21]	36.2	1.04 [0.762 - 1.426]	1.1 [0.77 - 1.55]
Respiratory infection	28.7	1.21 [0.84 - 1.74]	1 [0.66 - 1.52]	26.0	1.14 [0.814 - 1.589]	1.26 [0.85 - 1.84]
Respiratory distress	5.4	1.07 [0.56 - 2.04]	1.43 [0.78 - 2.61]	5.6	1.18 [0.622 - 2.230]	**1.86*** **[1.15 - 4.05]**
Vomit	7.3	0.91 [0.44 - 1.87]	1.73 [0.77 - 3.89]	5.1	1.08 [0.575 - 2.034]	1.51 [0.62 - 3.63]
Fever	13.0	0.98 [0.63 - 1.51]	1.38 [0.77 - 2.47]	10.4	0.82 [0.498 - 1.364]	0.74 [0.39 - 1.39]
Diarrhea	3.3	1.17 [0.48 - 2.83]	2.00 [0.91 - 4.36]	4.1	1.46 [0.706 - 3.006]	1.49 [0.56 - 3.95]
Asthma	2.3	0.81 [0.34 - 1.93]	2.38* [1.00 - 5.64]	3.6	1.48 [0.711 - 3.077]	0.97 [0.46 - 2.02]
Other chronic diseases	2.6	1 [0.46 - 2.18]	1.31 [0.45 - 3.78]	2.9	0.8 [0.284 - 2.241]	1.36 [0.60 - 3.04]
Perfect or good health	77.7	1.32 [0.93 - 1.87]	0.94 [0.59 - 1.49]	80.2	1.34 [0.917 - 1.966]	0.85 [0.55 - 1.32]
Physician visits	11.2	0.95 [0.61 - 1.45]	1.29 [0.76 - 2.18]	11.4	0.92 [0.585 - 1.440]	1.08 [0.65 - 1.79]
Hospitalizations	1.9	0.92 [0.59 - 1.44]	0.97 [0.66 - 1.76]	1.4	1.45 [0.55 - 3.80]	1.37 [0.44 - 4.18]

Logistic model adjusted by sex, age, socioeconomic status, parent's BMI and parent's schooling. 95% confidence interval in brackets. ** p<0.01, * p<0.05. Survey design was considered for all analysis. BMI: body Mass Index. OR: Odds ratio. CI: Confidence interval

In terms of our analyses by age groups, obesity among children aged six to 11 increased the odds of experiencing respiratory distress compared to normal weight children of the same age group. Children living with overweight aged 12-15 years had a higher likelihood of experiencing diarrhea (OR: 3.01, 95% CI [1.13, 8.03]) and those living with obesity had a statistically significant association with asthma (OR: 3.25, 95% CI [1.03, 10.19]) relative to children with normal weight (Table 4). With respect to caregiver-reported health status, the youngest children (aged 2-5 years) living with overweight (OR: 2.81, 95% CI [1.22, 6.48]) or obesity (OR: 3.03, 95% CI [1.12, 8.14]) were more likely to have perfect or good health compared children with to normal weight (Table 4). However, this was contrary to older children with obesity, where parents were less likely to report perfect or good health (OR: 0.56, 95% CI [0.33, 0.93]). Similar to the stratified analysis by sex, no statistically significant associations were found for hospitalizations or physician visits.

The results of our sensitivity analysis on the main analysis and the sub-group analyse indicated that the base case results did not change neither when we did not impute the missing data nor when we did not weight the sample.

Table 4. Logistic models for medical conditions, reported health status, and healthcare utilization for children with a normal weight and odds ratio by zBMI levels (reference: normal weight) by age group (n=7,403).

	2-5 years old			6-11 years old			12-15 years old		
	Normal weight (%)	**OR [95% CI]** overweight vs normal weight	**OR [95% CI]** obesity vs normal weight	Normal weight (%)	**OR [95% CI]** overweight vs normal weight	**OR [95% CI]** obesity vs normal weight	Normal weight (%)	**OR [95% CI]** overweight vs normal weight	**OR [95% CI]** obesity vs normal weight
Any medical condition	60.0	1.02 [0.60 - 1.73]	0.89 [0.42 - 1.87]	58.8	0.92 [0.68 - 1.24]	1.13 [0.82 - 1.55]	62.6	1.04 [0.70 - 1.53]	1.01 [0.61 - 1.64]
Headache	14.1	1.08 [0.52 - 2.25]	0.83 [0.35 - 1.93]	19.9	0.85 [0.59 - 1.22]	1.1 [0.76 - 1.57]	27.0	1.06 [0.67 - 1.65]	1.03 [0.56 - 1.87]
Stomach-ache	14.7	1.06 [0.52 - 2.20]	1.18 [0.41 - 3.40]	18.7	1.05 [0.69 - 1.58]	0.88 [0.57 - 1.34]	18.6	0.86 [0.51 - 1.42]	0.74 [0.39 - 1.35]
Flu	45.1	0.91 [0.55 - 1.50]	1.2 [0.57 - 2.50]	35.7	1.02 [0.75 - 1.38]	0.96 [0.69 - 1.31]	38.4	0.99 [0.65 - 1.50]	1.02 [0.62 - 1.66]
Respiratory infection	34.9	1.31 [0.75 - 2.27]	0.78 [0.35 - 1.70]	25.9	1.08 [0.75 - 1.55]	1.33 [0.93 - 1.88]	22.3	1.33 [0.84 - 2.09]	0.94 [0.52 - 1.68]
Respiratory distress	5.7	0.77 [0.29 - 2.02]	0.67 [0.19 - 2.30]	5.0	1.78+ [0.90 - 3.50]	**2.30** [1.24 - 4.28]**	6.3	0.76 [0.34 - 1.67]	1.46 [0.48 - 4.40]
Vomit	7.3	1.57 [0.69 - 3.60]	1.57 [0.65 - 3.73]	6.1	0.57 [0.27 - 1.19]	1.5 [0.74 - 3.04]	5.5	1.51 [0.59 - 3.84]	1.89 [0.57 - 6.30]
Fever	16.9	0.82 [0.42 - 1.59]	0.68 [0.29 - 1.57]	11.1	0.95 [0.59 - 1.50]	1.35 [0.78 - 2.32]	7.5	0.98 [0.49 - 1.92]	0.59 [0.27 - 1.25]
Diarrhea	3.3	0.8 [0.17 - 3.62]	0.06 [0.00 - 1.50]	3.7	0.98 [0.44 - 2.15]	1.56 [0.76 - 3.16]	4.1	**3.01* [1.13 - 8.03]**	2.68 [0.73 - 9.79]
Asthma	2.3	0.86 [0.16 - 4.41]	0.57 [0.09 - 3.39]	3.3	0.98 [0.41 - 2.29]	1.18 [0.53 - 2.57]	2.9	**2.58 [0.95 - 6.94]**	**3.25* [1.03 - 10.19]**
Other chronic diseases	2.4	0.33 [0.08 - 1.33]	1.62 [0.31 - 8.46]	2.8	0.48+ [0.21 - 1.07]	1.76 [0.75 - 4.13]	2.8	2 [0.74 - 5.41]	0.29 [0.06 - 1.45]
Perfect or good health	80.3	**2.81* [1.22 - 6.48]**	**3.03* [1.12 - 8.14]**	80.5	1 [0.69 - 1.44]	1.14 [0.76 - 1.69]	73.2	1.39 [0.88 - 2.16]	**0.56* [0.33 - 0.93]**
Physician visits	17.2	0.8 [0.43 - 1.48]	1.07 [0.45 - 2.54]	8.7	0.98 [0.61 - 1.55]	1.33 [0.81 - 2.21]	7.7	0.92 [0.50 - 1.66]	0.84 [0.38 - 1.85]
Hospitalizations	1.5	0.85 [0.26 - 2.73]	4.03 [0.62 - 25.88]	1.8	0.86 [0.28 - 2.57]	0.59 [0.17 - 2.02]	1.8	1.57 [0.42 - 5.78]	0.39 [0.11 - 1.37]

Logistic model adjusted by sex, age, socioeconomic status, parent's BMI and parent's schooling. 95% confidence interval in brackets. ** p<0.01, * p<0.05. Survey design was considered for all analysis. BMI: body Mass Index. OR: Odds ratio. CI: confidence interval

Discussion

This study aimed to describe the population of children in Mexico according to BMI categories and to determine the association between children's BMI status and their medical conditions, health status, and healthcare resource use, as reported by their caregivers. Based on a nationally representative survey, findings suggest that the prevalence of obesity among Mexican children aged 2-15 years is a significant public health concern, with 15% of children living with obesity and 21% living with overweight. According to the information reported by the children's caregivers, 14% of children were in perfect health, 65% were in good health and 60% had at least one health condition. Additionally, 10% visited a physician (excluding routine visits) in the last month, and 2% were hospitalized in the last year. After adjusting for all covariates, results indicated that BMI status was not statistically significantly associated with any medical conditions except for respiratory distress, for which obesity increased the odds of the condition. The temporality of this association cannot be established and may be reverse causality or a bidirectional relationship. While obesity in children and adolescents is a known risk factor for respiratory issues (7,32), having respiratory limitations could be a risk factor for obesity by limiting physical activity in the patients (32). However, studies have suggested that the direction primarily went from obesity as a risk factor for respiratory disorders, rather than the other way around (33).

Perhaps surprisingly, our unadjusted and adjusted analyses indicated that caregiver-reported health status was higher in children living with overweight than in children with normal weight. Although this result might seem counterintuitive, this finding could be explained by several factors. First, a systematic review of 91 international articles examining parental underestimation of children's weight and its factors showed that less than 50% of parents could correctly identify their children as overweight (34). This is important as although BMI was measured in our study, caregivers may have attributed a perfect health score to their children thinking they had a normal weight while in fact they were overweight. In addition, overnight children could be perceived as healthy by the caregivers. Besides, as the stratified analysis by age groups showed, the association between children overweight and having perfect or good health status was only statistically significant for the younger age group. In this group, being “heavy and big” is usually desirable as children are perceived as stronger and healthier (35,36).

Results showed that BMI status in children was not statistically significantly associated with increased use of hospitalization or physician visits as reported by the children's caregiver. Although these results might seem unexpected, association with physician visits could be explained by reasons other than weight. First, Mexican beliefs lean towards traditional medicine and, more often, self-medication. A nationally representative study showed that almost half of the Mexican population self-medicates children, especially when the medical condition is similar to flu or cough (37,38) and the symptoms are perceived as not serious. This association was stronger for children living with obesity or a chronic condition who reported higher rates of self-medication (38). Besides self-medication, parents usually provide herbal or traditional medicine in Mexico without needing a physician's visit (39,40), which could explain the low number of physician visits over the last month observed in our child population. Furthermore, other studies that have not found any statistically significant associations between physician visits and hospitalizations with children's weight have discussed the temporality of the question, sometimes too short for physician visits, and the possibility of recall bias due to the low severity of the disease for hospitalizations (30,41,42).

Finally, when analyzing by age, results showed that older children had a higher likelihood of asthma if living with overweight or obesity, as well as respiratory distress when living with obesity. This could be explained because, as shown in a clinical analysis, age was a modifier for the relationship between asthma and obesity (43). Adolescents with obesity presented worse lung function and more complicated symptoms compared to those with normal weight (43), which could increase the likelihood of diagnosis compared to younger age groups. These findings could suggest that certain medical conditions may be more prevalent among specific subgroups of children living with overweight or obesity.

Comparing our results with the published literature, the prevalence of BMI categories for children was consistent with reports in Mexico for 2012 (44). Due to the absence of Mexican data on children's outcomes per BMI status, it is difficult to compare our results with the international literature, given differing healthcare systems and study designs. However, some comparisons are useful, and our results differ from international studies. In an Australian study, most parents reported no concern regarding their children's weight. However, if a specialist identified a weight issue, parents were more likely to report poor health status for children living with obesity after the diagnosis (45). Similar results were found in two US studies. (46,47). In a study conducted in Hawaii, living with overweight or obesity increased the odds of parents reporting poor health (47), especially for those in with lower SES. Similarly, Wallander et al. found an association between children living with obesity and severe obesity and poor reported health (46) but not with overweight in three US metropolitan areas.

Cultural differences could explain differences between these studies and our study conducted in Mexico. For example, research conducted in Mexico has shown that parents did not perceive extra weight as a health issue but rather as an aesthetic aspect (48,49). It is also possible that in Mexico, where overweight and obesity are prevalent among children and adults, parents tend to normalize heavyweight (35,50,51) and recognize obesity as a disease only for adults (52). Regarding healthcare utilization or medical conditions, descriptive results by BMI are consistent with few studies (30,53), but not with the aforementioned systematic review (13).

Although this is the first study in Mexico exploring the association between obesity in children and caregivers' self-reported medical conditions, health status, and healthcare utilization, the study has some limitations. First, it is a cross-sectional study; thus, causality cannot be established. Second, health status was reported by caregivers. It is known that the agreement between parents or caregivers and children might differ depending on the children's age, especially for older children (54). Third, there is a potential loss of information using categorical variables instead of continuous variables (i.e., BMI, caregiver age, SES). However, we kept caregivers' BMI as a categorical variable in our models to an ease interpretation. Additionally, physician visits were only asked about for the last month, which may not be long enough to capture healthcare resource utilization appropriately. Additionally, most of the health issues captured on the survey were for infectious symptoms, while most cardiometabolic health indicators and mental health which would be most importantly associated with children obesity's status were missing. Finally, the sample size was not large enough to analyze differences for extreme weight levels (underweight or severe obesity). Furthermore, the estimates on the subgroups analysis were not precisely estimated due to smaller sample sizes (i.e., the confidence intervals were fairly wide). Despite these limitations, the study has some strengths. It used a nationally representative sample of the Mexican population with measured (instead of reported) information on weight and height. Additionally, it is the first study analyzing healthcare utilization and children's obesity status in Mexico, as well as medical conditions and caregiver-reported health status, providing relevant information about these associations. Moreover, the caregiver's perception of health status provides evidence of some cultural aspects of weight perception, opening the door for research in related areas (e.g., framing bias).

Even though this work did not find an association between BMI status and healthcare utilization, or the medical conditions included in the survey, understanding these relationships is important for designing effective policies to reduce the burden of obesity and overweight in children and adolescents. Besides, these associations could become more important, especially due to the link between childhood obesity and the probability of obesity during adulthood, increasing health problems and chronic conditions (9–12). Designing policies that consider parental BMI, cultural contexts, and perception of weight and its consequences could optimize efforts. Further research is needed to explore the factors that contribute to the burden of obesity in children in Mexico and to inform the development of targeted interventions to reduce the prevalence of obesity and overweight among children and adolescents.

References

1. Kumar S, Kelly AS. Review of Childhood Obesity. Mayo Clin Proc. 2017;92(2):251-265. doi:10.1016/j.mayocp.2016.09.017
2. Di Cesare M, Sorić M, Bovet P, et al. The epidemiological burden of obesity in childhood: a worldwide epidemic requiring urgent action. BMC Med. 2019;17(1):212. doi:10.1186/s12916-019-1449-8
3. Sanyaolu A, Okorie C, Qi X, Locke J, Rehman S. Childhood and Adolescent Obesity in the United States: A Public Health Concern. Glob Pediatr Health. 2019;6:2333794X1989130. doi:10.1177/2333794X19891305
4. Rankin J, Matthews L, Cobley S, et al. Psychological consequences of childhood obesity: psychiatric comorbidity and prevention. Adolesc Health Med Ther. 2016;Volume 7:125-146. doi:10.2147/AHMT.S101631
5. Jankowska A, Brzeziński M, Romanowicz-Sołtyszewska A, Szlagatys-Sidorkiewicz A. Metabolic Syndrome in Obese Children—Clinical Prevalence and Risk Factors. Int J Environ Res Public Health. 2021;18(3):1060. doi:10.3390/ijerph18031060
6. Abbasi A, Juszczyk D, van Jaarsveld CHM, Gulliford MC. Body Mass Index and Incident Type 1 and Type 2 Diabetes in Children and Young Adults: A Retrospective Cohort Study. J Endocr Soc. 2017;1(5):524-537. doi:10.1210/js.2017-00044
7. di Palmo E, Filice E, Cavallo A, et al. Childhood Obesity and Respiratory Diseases: Which Link? Children. 2021;8(3):177. doi:10.3390/children8030177
8. Xanthopoulos M, Tapia IE. Obesity and common respiratory diseases in children. Paediatr Respir Rev. 2017;23:68-71. doi:10.1016/j.prrv.2016.10.002
9. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis: Adult obesity from childhood obesity. Obes Rev. 2016;17(2):95-107. doi:10.1111/obr.12334
10. Biro FM, Wien M. Childhood obesity and adult morbidities. Am J Clin Nutr. 2010;91(5):S1499-S1505. doi:10.3945/ajcn.2010.28701B
11. Fang X, Zuo J, Zhou J, et al. Childhood obesity leads to adult type 2 diabetes and coronary artery diseases: A 2-sample mendelian randomization study. Medicine (Baltimore). 2019;98(32):e16825. doi:10.1097/MD.0000000000016825
12. Drozdz D, Alvarez-Pitti J, Wójcik M, et al. Obesity and Cardiometabolic Risk Factors: From Childhood to Adulthood. Nutrients. 2021;13(11):4176. doi:10.3390/nu13114176
13. Hasan T, Ainscough TS, West J, Fraser LK. Healthcare utilisation in overweight and obese children: a systematic review and meta-analysis. BMJ Open. 2020;10(10):e035676. doi:10.1136/bmjopen-2019-035676
14. Bechere Fernandes MT, Ferraro AA, Danti GV, Garcia DML. PP276-SUN: Excess Weight in Children Increases Hospitalization Days. Clin Nutr. 2014;33:S122-S123. doi:10.1016/S0261-5614(14)50317-2
15. Bertoldi AD, Tavares NUL, Hallal PC, Araújo CL, Menezes AMB. Medicine use among adolescents: the 11-year follow-up of the 1993 Pelotas (Brazil) birth cohort study. Cad Saúde Pública. 2010;26(10):1945-1953. doi:10.1590/S0102-311X2010001000011

16. Ng M, Fleming T, Robinson M, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. The Lancet. 2014;384(9945):766-781. doi:10.1016/S0140-6736(14)60460-8
17. Popkin BM, Reardon T. Obesity and the food system transformation in Latin America: Obesity and food system transformation. Obes Rev. 2018;19(8):1028-1064. doi:10.1111/obr.12694
18. Shamah-Levy T, Vielma-Orozco E, Heredia-Hernández O, et al. Encuesta Nacional de Salud y Nutrición 2018-19: Resultados Nacionales.; 2020. https://ensanut.insp.mx/encuestas/ensanut2018/doctos/informes/ensanut_2018_informe_final.pdf
19. Tarride JE, Burke N, Bischof M, et al. A review of health utilities across conditions common in paediatric and adult populations. Health Qual Life Outcomes. 2010;8(1):12. doi:10.1186/1477-7525-8-12
20. Musich S, MacLeod S, Bhattarai GR, et al. The Impact of Obesity on Health Care Utilization and Expenditures in a Medicare Supplement Population. Gerontol Geriatr Med. 2016;2:233372141562200. doi:10.1177/2333721415622004
21. Rubalcava L, Teruel G. Encuesta Nacional sobre Niveles de Vida de los Hogares, Tercera Ronda. Published online 2013. www.ennvih-mxfls.org
22. WHO. Obesity and Overweight: Key Facts.; 2020. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
23. Tchicaya A, Lorentz N. Relationship between Children's Body Mass Index and Parents' Obesity and Socioeconomic Status: A Multilevel Analysis Applied with Luxembourg Data. Health (N Y). 2014;06(17):2322-2332. doi:10.4236/health.2014.617267
24. Sigmund E, Sigmundová D, Badura P, Madarasová Gecková A. Health-related parental indicators and their association with healthy weight and overweight/obese children's physical activity. BMC Public Health. 2018;18(1):676. doi:10.1186/s12889-018-5582-7
25. Linchey JK, King B, Thompson HR, Madsen KA. Parent Underestimation of Child Weight Status and Attitudes towards BMI Screening. Health Behav Policy Rev. 2019;6(3):209-218. doi:10.14485/HBPR.6.3.1
26. Austin PC, White IR, Lee DS, Van Buuren S. Missing Data in Clinical Research: A Tutorial on Multiple Imputation. Can J Cardiol. 2021;37(9):1322-1331. doi:10.1016/j.cjca.2020.11.010
27. Royston P. Multipleimputationofmissingvalues. Stata J. Published online 2004.
28. Doherty E, Queally M, Cullinan J, Gillespie P. The impact of childhood overweight and obesity on healthcare utilisation. Econ Hum Biol. 2017;27:84-92. doi:10.1016/j.ehb.2017.05.002
29. Hong H, Hou W, Kaur S, Bianchi-Hayes JM. The association of co-morbid asthma and overweight/obese status with healthcare utilization and caregiver perception of health in children 4–17 years, a NHANES study. J Asthma. 2022;59(6):1181-1187. doi:10.1080/02770903.2021.1914651

30. Bianchi-Hayes J, Calixte R, Huang J, Cataldo R, Wong A, Pati S. Healthcare Utilization by Obese and Overweight Children. J Pediatr. 2015;166(3):626-631.e2. doi:10.1016/j.jpeds.2014.11.044
31. Yang S, Berdine G. The receiver operating characteristic (ROC) curve. Southwest Respir Crit Care Chron. 2017;5(19):34. doi:10.12746/swrccc.v5i19.391
32. Ogino J, Basravi S, Salazar A, Chan RY. Effect of childhood obesity on admissions for respiratory disease. Acta Paediatr. 2022;111(3):646-652. doi:10.1111/apa.16177
33. Fiorino EK, Brooks LJ. Obesity and Respiratory Diseases in Childhood. Clin Chest Med. 2009;30(3):601-608. doi:10.1016/j.ccm.2009.05.010
34. Alshahrani A, Shuweihdi F, Swift J, Avery A. Underestimation of overweight weight status in children and adolescents aged 0-19 years: A systematic review and meta-analysis. Obes Sci Pract. 2021;7(6):760-796. doi:10.1002/osp4.531
35. Hager ER, Candelaria M, Latta LW, et al. Maternal Perceptions of Toddler Body Size: Accuracy and Satisfaction Differ by Toddler Weight Status. Arch Pediatr Adolesc Med. 2012;166(5):417. doi:10.1001/archpediatrics.2011.1900
36. Flores-Peña Y, He M, Sosa ET, Avila-Alpirez H, Trejo-Ortiz PM. Study protocol: intervention in maternal perception of preschoolers' weight among Mexican and Mexican-American mothers. BMC Public Health. 2018;18(1):669. doi:10.1186/s12889-018-5536-0
37. Ortiz MI, Martínez Jiménez B, Ramírezhernández R, Castelán-Campos M de LÁ, Cariñocortés R, Ponce-Monter HA. Self-Medication in Mexican Pediatric Patients. Iran J Public Health. 2019;48(12):2293-2295.
38. Alonso-Castro AJ, Ruiz-Noa Y, Martínez-de la Cruz GC, et al. Factors and Practices Associated with Self-Medicating Children among Mexican Parents. Pharmaceuticals. 2022;15(9):1078. doi:10.3390/ph15091078
39. Valdivia-Correa B, Gómez-Gutiérrez C, Uribe M, Méndez-Sánchez N. Herbal Medicine in Mexico: A Cause of Hepatotoxicity. A Critical Review. Int J Mol Sci. 2016;17(2):235. doi:10.3390/ijms17020235
40. Zolla C. Traditional medicine in Latin America, with particular reference to Mexico. J Ethnopharmacol. 1980;2(1):37-41. doi:10.1016/0378-8741(80)90028-8
41. Tully L, Sorensen J, O'Malley G. Hospital Service Use Among Children With Obesity in Ireland: A Micro-costing Study. Child Care Pract. 2022;28(4):593-609. doi:10.1080/13575279.2022.2035682
42. Ortiz-Pinto MA, Ortiz-Marrón H, Esteban-Vasallo MD, et al. Demand for health services and drug prescriptions among overweight or obese preschool children. Arch Dis Child. 2020;105(3):292-297. doi:10.1136/archdischild-2019-316895
43. Lang JE, Hossain J, Dixon AE, et al. Does Age Impact the Obese Asthma Phenotype? Chest. 2011;140(6):1524-1533. doi:10.1378/chest.11-0675
44. Oropeza Abúndez C, Instituto Nacional de Salud Pública (Mexico), Mexico, eds. Encuesta Nacional de Salud y Nutrición 2012: Resultados Nacionales. Primera edición. Instituto Nacional de Salud Pública : Secretaría de Salud; 2012.
45. Wake M, Salmon L, Waters E, Wright M, Hesketh K. Parent-reported health status of overweight and obese Australian primary school children: a cross-sectional population survey. Int J Obes. 2002;26(5):717-724. doi:10.1038/sj.ijo.0801974

46. Wallander JL, Kerbawy S, Toomey S, et al. Is obesity associated with reduced health-related quality of life in Latino, black and white children in the community? Int J Obes. 2013;37(7):920-925. doi:10.1038/ijo.2013.31
47. Teranishi K, Hayes DK, Iwaishi LK, Fuddy LJ. Poorer general health status in children is associated with being overweight or obese in Hawai'i: findings from the 2007 National Survey of Children's Health. Hawaii Med J. 2011;70(7 Suppl 1):16-20.
48. Casarrubias-Jaimez AI, Legorreta-Soberanis J, Sánchez-Gervacio BM, et al. Body image and obesity in children from public primary schools in Acapulco, Mexico: A cross-sectional study. Bol Méd Hosp Infant México. 2020;77(3):4097. doi:10.24875/BMHIM.20000027
49. Rendón-Macías ME, Rosas-Vargas H, Villasís-Keever MÁ, Pérez-García C. Children's perception on obesity and quality of life: a Mexican survey. BMC Pediatr. 2014;14(1):131. doi:10.1186/1471-2431-14-131
50. Guevara-Cruz M, Serralde-Zúñiga AE, Frigolet Vázquez-Vela ME, Blancas Galicia L, Islas-Ortega L. Association between maternal perceptions and actual nutritional status for children in a study group in Mexico. Nutr Hosp. 2012;27(1):209-212. doi:10.1590/S0212-16112012000100026
51. Altered perception of the nutritional status of preschoolers by their parents: A risk factor for overweight and obesity. Arch Argent Pediatr. 2016;114(3). doi:10.5546/aap.2016.eng.237
52. Mendez N, Barrera-Pérez M, Palma-Solís M, et al. "You Are Not Fat, You Are <I>Hermosa</I>": Mexican Caregivers Share Their Perceptions About Their Role Supporting Their Morbidly Obese Children. Hisp Health Care Int. 2014;12(4):174-182. doi:10.1891/1540-4153.12.4.174
53. Turer CB, Lin H, Flores G. Health Status, Emotional/Behavioral Problems, Health Care Use, and Expenditures in Overweight/Obese US Children/Adolescents. Acad Pediatr. 2013;13(3):251-258. doi:10.1016/j.acap.2013.02.005
54. Varni JW, Limbers CA, Burwinkle TM. How young can children reliably and validly self-report their health-related quality of life?: An analysis of 8,591 children across age subgroups with the PedsQLTM 4.0 Generic Core Scales. Health Qual Life Outcomes. 2007;5(1):1. doi:10.1186/1477-7525-5-1
55. Flores-Peña Y, Camal-Ríos NY, Cerda-Flores RM. [Evaluation of the maternal perception of her child's weight and body mass index heritability in mestizas dyads in Southeastern Mexico]. Arch Latinoam Nutr. 2011;61(4):389-395.

Chapter 5. Conclusions

This dissertation consists of three original research studies (Chapters Two to Four) that examined childhood obesity through a review of health policies and interventions in Latin America (Chapter Two), an analysis of the association of caregivers' time preferences & childhood obesity in Mexico (Chapter Three), and an analysis of the association between medical conditions, self-reported health and healthcare resource utilization and childhood obesity in Mexico (Chapter Four). This concluding Chapter summarizes the main findings of each study and their contributions and policy implications. Additionally, this Chapter presents the strengths and limitations of each study before suggesting avenues for future research on childhood obesity and discussing the thesis contribution to the field of health policy.

Main findings and contributions

Childhood obesity was first recognized as a public health problem by the WHO in 1997 (1). Since then, many countries have implemented policies and interventions to reduce the prevalence of childhood obesity worldwide (2). To inform future policies, Chapter Two presented a scoping review to determine to which extent the ten policies included in the five-year PAHO’s Plan of Action for the Prevention of Obesity in Children and Adolescents, signed by 19 Latin American countries, have been implemented and evaluated (3). The results of this review– which identified 115 PAHO’s policies implemented in Latin America– showed that Mexico and Ecuador implemented all ten suggested policies, and almost all countries had implemented policies suggested in Line of Action 1, like food guidelines, breastfeeding programs, and school feeding programs. On the contrary, only one-third of the Latin American countries implemented fiscal and marketing policies such as taxes and food labeling. However, evaluations of policies and interventions were scarce, even in countries where policies were broadly implemented (such as Mexico and Ecuador). Furthermore, most evaluations focused on short-term or intermediary outcomes, and none measured the impact of the health policy on childhood obesity. Overall, this study underscores the need for continued efforts to prevent childhood obesity in the Latin American region and for the long-term evaluation of these health policies using meaningful outcomes.

This study made several contributions to the literature. First, this work provided an inventory of interventions to prevent childhood obesity in the Latin American region, complementing other trackers such as the World Cancer and Research Fund database and the World Obesity Atlas. It also identified other types of policies (e.g., multifactorial policies) not captured in the trackers, as mentioned earlier, while providing detailed information on the characteristics of these policies. This work also identified 44 policies that have been evaluated using quantitative or qualitative methods. It is relevant as it provides a catalog of policies and interventions that have been implemented and evaluated, which could help governments set up policies to reduce childhood obesity in Latin America. Finally, knowing which countries have implemented which policies opens the door for further research about policy analysis, focusing on facilitators (lobbyists), barriers, and pathways for a policy passing from the agenda to implementation.

This study also identified important avenues of research for preventing childhood obesity, as the work presented in Chapter Two highlighted the limited number of policies and interventions which were evaluated. While some policies received more attention (e.g., SSB taxes in Mexico) than others (e.g., Baby Friendly Hospital Initiative), these evaluations were concentrated in a few countries and for a few policies/interventions. Furthermore, none of the studies evaluated the impact of a policy on children's BMI or weight. Future research should evaluate the long-term impact of these policies using longer follow-up and anthropometric measures. While PAHO's suggested policies have been an important step forward, more work must be done to address the complex multi-factors contributing to childhood obesity in the region, for example, to evaluate whether policies are still in place and reasons for discontinuation. Also, there is a need for a deep policy analysis to evaluate how policies go from the agenda to implementation, identifying lobbyists, political forces, or pathways. Finally, the Chapter emphasized the need for evaluations to ensure effective policies. Therefore, it is important that countries have reliable datasets to evaluate policies.

Chapter Three explored an important issue that has been scarcely explored in the literature on childhood obesity. Specifically, this study used the Mexican Families and Life Survey (MxFLS), a nationally representative survey, to examine the association between caregivers' time preferences and childhood overweight or obesity in Mexico. While previous studies have extensively investigated the link between time preferences and unhealthy lifestyles, excess body weight, and addictions in adults, only one study in the U.S. examined parental or caregiver time preferences and their impact on children (4). The results showed that inconsistent caregivers’ time preferences, whether present or future-biased, were associated with increased odds of childhood overweight or obesity in Mexican children. Other results showed that caregivers' own obesity status was the variable with the strongest association with children's overweight or obese status. Overall, this study highlighted the significant impact of caregivers' time preferences on childhood obesity in Mexico. By recognizing the importance of caregivers’ time preferences, policymakers can better understand the underlying causes of childhood obesity and develop effective interventions to prevent and reduce this growing health issue.

This study made several contributions to the literature. First, this study addressed a gap in the literature and provided evidence that can inform policy design to prevent childhood obesity in Mexico. As shown in Chapter Two, with an increasing focus on policymaking to reduce the burden of childhood obesity in Mexico, understanding unexplored elements of this complex health problem has become essential to designing effective policies. This work showed that more than half of caregivers or parents in Mexico are impatient but time consistent, which might be a relevant aspect to consider when designing policies that aim to modify behaviors or are incentive-based. Also, results indicated that those time preferences were associated with the likelihood of overweight and obesity in children. Therefore, considering the Mexican context, policies should be framed with short-term outcomes (instead of long-term results) or reduced times to receive incentives.

This study identified important areas for future research. For example, design specific tools to measure the time preferences of children and adolescents; considering time preferences using lifestyle decisions (not only with monetary trade-offs) should be made and implemented in Mexico or countries with similar socio-economic characteristics. Finally, the study opened the door for the need for longitudinal studies to observe whether time preferences are transmitted from parents to children and if this changes with age while exploring causality with weight and lifestyle decisions.

Finally, Chapter Four documented the burden of childhood obesity in Mexico and its association with medical conditions, health status, and healthcare utilization reported by caregivers. Although such associations have been documented internationally, no study has been conducted in Mexico. Using the latest available round of MxFLS, the study found that more than half of the caregivers reported at least one medical condition in children, but only respiratory distress was associated with obesity. Surprisingly, children living with overweight were more likely to have perfect or good health reported by their caregivers. Furthermore, no statistically significant association was found between children's BMI status and caregiver-reported hospitalizations and physician visits among children.

Understanding the burden of childhood obesity is crucial from a policy perspective due to its costs and consequences in the short term during childhood, such as hypertension, asthma, diabetes, and mental health disorders, as well as the long-term health consequences during adulthood. The work presented in Chapter Four contributed to the literature as it is the first study in Mexico to analyze healthcare utilization and childhood obesity, along with caregivers' reported health status. The study also provided insights into weight perception or cultural concerns (i.e., younger heavy children might be perceived as healthier than children with normal weight). Thus, family perceptions about weight should be considered in designing effective policies to prevent childhood obesity, because a parent or caregiver not recognizing overweight as a health problem could not address the issue early.

Further research is required to identify and understand the factors that contribute to the burden of obesity in children in Mexico. This work highlighted the need for a more specific survey capturing obesity-associated diseases such as diabetes, hypertension, or mental health disorders, as well as a more detailed record of physician visits (i.e., type of physician, use of medication) and having a longer observation period through longitudinal studies. In addition, results regarding caregivers' health status perception of children living with overweight display the need for a deep understanding of cultural aspects of obesity and related areas (i.e., policies considering framing bias). All this will better inform the development of targeted interventions to reduce the prevalence of obesity and overweight among children and adolescents.

Strengths and limitations

The three studies presented in this dissertation have several strengths. First, by using a scoping review, Chapter Two provided a broad inventory of policies and interventions, allowing us to focus on the state of policy development rather than evaluate the quality of policy implementation. It also allowed the description of the main characteristics of each implemented policy by each country, allowing comparison of similarities and differences. Finally, the first review was supplemented by a systematic review of policy evaluations, complementing the evidence. The findings suggested a need for further improvements in policy evaluation to address the issue of childhood obesity effectively.

Chapters Three and Four were based on a nationally Mexican representative survey, including adults and children. This dissertation underscores the importance of broad national surveys to evaluate the causes and consequences of health issues and policies. Methodologically, these papers used easy-to-interpret methods, and both based the analysis on measured BMI instead of reported. Specifically, Chapter Three used a multinomial logistic regression that provides interpretability for multiclass outcomes such as MI categories. Besides, the results of other regression approaches used in sensitivity analyses showed consistent results, strengthening the conclusions. We also used a well established method for measuring time preferences based on monetary trade-offs. Finally, the study considered not only parents but caregivers, who are the person spending more time with the children and maybe, making the decisions when parents are not available. Lastly, Chapter Four is the first study evaluating the association between children's obesity status and caregiver-reported healthcare utilization, medical conditions, and health status among Mexican children, thus providing important information for policy making. In addition, caregivers' reported health status provided evidence of some cultural aspects of weight perception, which provides useful insights for research and policy development.

Despite the strengths, some limitations must be acknowledged. While I conducted a scoping review of the published literature and government websites to identify PAHO policies implemented in Latin America to reduce obesity in children and adolescents, I may have missed some policies. The analyses did not document whether policies were still in place, but I documented whether a policy had been implemented. Additionally, I did not evaluate the strength of the policy design (e.g., tax magnitude) or the impact of a change in the environment due to a combination of policies. Therefore, it is not possible to compare their design, strengths or reach of the various policies identified in our review. Chapters Three and Four have some limitations as well. Both were cross-sectional studies, and therefore, causality cannot be established. Besides, there was a potential loss of information by using categorical variables. However, both studies explored models with some categorical variables as continuous (i.e., BMI, socio-economic status, age), and the main results did not change. Third, analyses were limited by information captured in the survey, and we could not explore, for example, the association of obesity status with several comorbidities known to be associated with obesity. Moreover, the dataset is ten years old, which may limit the generalizability of the results to present times. Finally, the children's caregivers reported children's medical conditions, past healthcare resource utilization, and health status, which may have introduced some bias.

Implications for Policy and Practice

This sandwich thesis has several implications for the implementation of policy for preventing childhood obesity in Mexico and Latin America. First, it highlights the need for continued efforts to prevent childhood obesity and the relevance of evaluating policies and interventions to analyze their effectiveness and cost-effectiveness and understanding the causes and limitations for a policy to be implemented in a country (i.e., political forces, economic constraints, government willingness) as this aspect has been limited in Latin America. Finally, continuously monitoring and evaluating policies implemented is crucial to avoid missing relevant information that could help other governments or ensure policy continuation. This last element should be considered for future research in the region.

Another important element revealed is recognizing that caregivers' time preferences are associated with childhood obesity. Several studies have shown that incorporating time preferences when designing policies aiming a behavioral change is key to success. However, different from policies addressed to adults, policies targeting children should consider that– in addition to a direct obesity transmission— often parents make all lifestyle decisions for their children regarding food availability and time allocation (i.e., school, leisure, physical activity). Thus, policies and interventions to prevent childhood obesity need to be considered by both parents and children.

Policymakers can use the evidence presented in Chapter Three first to promote the development of similar studies in other countries from Latin America to understand better the impact of caregivers' time preferences on children's obesity. Furthermore, policies should take into account the cultural and socio-economic context where policies are being made. For example, knowing that most adults in Mexico are impatient is the first step to understanding the obesity epidemic in the country. This study highlighted the importance of considering time preferences when designing policies to reduce obesity in children and adults. For example, policies offering short-term incentives or immediate rewards could be more effective for impatient populations than policies focusing on long-term rewards (5). Thus, not considering time preferences when developing health policies could lead to unsuccessful interventions in Mexico or other countries with a high proportion of impatient individuals.

Lastly, it is important to document the burden of childhood obesity in Mexico and understand its association with medical conditions, health status, and healthcare utilization. Although the study did not provide evidence of the association between BMI status and healthcare utilization, different tools could be used to understand the associations. For example, designing specific surveys to better document and understand the impact of overweight and obesity and medical conditions or healthcare demand in children and adults in Mexico with more detail on associated diseases, type of physician visited, or a longer tracking for visits and health problems. Besides, policymakers should consider family perceptions about weight in designing effective policies to prevent childhood obesity. The previous study in Chapter Four of this thesis provides valuable insights into weight perception that involve cultural aspects, such as younger heavy children being perceived as healthier than children with normal weight.

Overall, the thesis highlights the need for continuous efforts, evaluations, and policy considerations to prevent and address childhood obesity in Mexico effectively. Policymakers can use the evidence presented to understand better some factors associated with childhood obesity in order to design effective policies that consider cultural and socio-economic contexts. Additionally, policymakers should consider caregivers' time preferences by designing policies that modify caregiver's behaviors while reducing the prevalence of obesity.

References

1. WHO. Obesity: Preventing and managing the global epidemic of obesity. Report of the Who consultation of obesity. Published online 1997.
2. WHO. Taking Action on Childhood Obesity. Published online 2018. https://apps.who.int/iris/bitstream/handle/10665/274792/WHO-NMH-PND-ECHO-18.1-eng.pdf
3. Molina M, Anderson LN, Guindon GE, Tarride J. A review of implementation and evaluation of Pan American Health Organization's policies to prevent childhood obesity in Latin America. Obes Sci Pract. 2022;8(3):352-362. doi:10.1002/osp4.572
4. Stoklosa M, Shuval K, Drope J, et al. The intergenerational transmission of obesity: The role of time preferences and self-control. Econ Hum Biol. 2018;28:92-106. doi:10.1016/j.ehb.2017.12.004
5. Christensen HS, Rapeli L. Immediate rewards or delayed gratification? A conjoint survey experiment of the public's policy preferences. Policy Sci. 2021;54(1):63-94. doi:10.1007/s11077-020-09408-w

Supplemental Materials Chapter 2

Table SP1.1. PAHO's Lines of actions and objective from the Plan of action for the prevention of obesity in children and adolescents.

PAHO's lines of actions	Objectives
1. Primary health care and promotion of breastfeeding and healthy eating	1. To include in health care services the promotion of healthy eating based on national food-based dietary guidelines as well as other activities related to the prevention of obesity
	2. To reinforce efforts to implement the Global Strategy for Infant and Young Child Feeding (i.e Baby Friendly Hospital Initiative)
2. Improvement of school nutrition and physical activity environments	1. To ensure that national school feeding programs as well as the sale of foods and beverages in schools ("competitive foods") comply with norms and/or regulations that promote the consumption of healthy foods and water and prevent the availability of energy-dense nutrient-poor products and sugar-sweetened beverages.
	2. Promote and strengthen school and early learning policies and programs that increase physical activity
3. Fiscal policies and regulation of food marketing and labelling	1. Implement policies to reduce children and adolescents' consumption of sugar-sweetened beverages and energy-dense nutrient-poor products.
	2. To enact regulations to protect children and adolescents from the impact of marketing of sugar-sweetened beverages, energy-dense nutrient-poor products, and fast foods.
	3. To develop and implement norms for front-of-package labeling that promote healthy choices by allowing for quick and easy identification of energy-dense nutrient-poor products.
4. Other multisectoral actions	1. To engage other government institutions and, as appropriate, other sectors
	2. To improve access to urban recreational spaces such as the "open streets" programs
	3. To take measures at national or subnational level to increase the availability of and accessibility to nutritious foods
5. Surveillance, research, and evaluation	1. To strengthen country information systems so that trends and determinants of obesity, disaggregated by at least two equity stratifiers, are routinely available for policy decision- making.

Source: Author's construction with information from (1)

Table SP1.2. Policies/Interventions implemented in Argentina

Policy/intervention	Specific program/regulation	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guías alimentarias para la Población Argentina (GAPA) [*Dietary Guidelines for the Argentine Population*]	Information is summarized in 10 key messages, a plate with six food groups (including candies and processed food). Includes specific recommendation for water consumption, and physical activity. Provides recipes.
Baby Friendly Hospital Initiative	Hospitales Amigos del Niño [*Baby Friendly Hospital Initiative*]	
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa de Alimentación Escolar. [*School Feeding Program*]	Menus must follow recommendations from Food-Based Guidelines. Schools provide breakfast (250 kcal) and lunch (450-500kcal). Potable water should be available all the time. Part of the National Program of healthy eating and obesity prevention. Law 26.396.
Food sales regulation at schools	Guía de entornos escolares saludables [*Healthy School Environments Guide*]. *Healthy Kiosks*	Kiosks within the school must offer products that integrate a healthy diet and varied, according to a list determined by the enforcement authority. The products mentioned and the list that determines them must be in a prominent and visible place in the establishment. Part of the National Program of healthy eating and obesity prevention. Law 26.396.
Programs for physical activity at school	Entornos Escolares Saludables y de Educación Física [*Healthy School Environments and Physical Education*]	Classes of physical activities with a note at the end. No inactivity longer than 40min, with at least a 5 min pause of physical activity. Extracurricular activities of 60 min at least three days per week.
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Programa Nacional de Seguridad Alimentaria -Hambre Más Urgente. Ley 25724 [*National Food Safety Program-Hunger More Urgent. Law 25724*]	For families with children younger than 14 years old, pregnant women, people with disabilities and adults socially unfavorable. People decide whether to get a card with money to make food purchases (deciding what to buy), money transferences for specific centers to provide free food, or money transfers to build an in-house sustainable garden
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuesta Nacional de Factores de Riesgo 2005, 2009, 2013 y 2018. Encuesta Nacional de Nutrición y Salud 2005 y 2019. [*National Survey of Risk Factors, and National Survey of Nutriotion and Health*]	Representative of individuals living in urban localities of at least 5,000 habitants. It contains anthropometric measurements, biomarkers (blood and urine) measured by trained personnel. Risk factors are self-reported for the NSRF. Not publicly available

Table SP1.3. Policies/Interventions implemented in Belize

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Food-based dietary guidelines for Belize	The food guide chosen is a basket filled with seven food groups (including fats and oils, sugars and sweeteners). Information summarized in eight key messages. Provide recipes.
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa de Alimentación Escolar Sostenible [*Sustainable School Feeding Program*]	Limited to poor and vulnerable children. It includes schools' gardens and nutritional education
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Food Pantry Program	Weekly program which grants a basic food basket valued at USD$25, which can be bought at half the value. For urban and rural areas.

Table SP1.4. Policies/Interventions implemented in Bolivia

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guías alimentarias para la población boliviana [*Food-based dietary guidelines for the Bolivian population*]	Targets population of two years and older. Presented stratified by age: children, adolescents, adults, breastfeeding women and elderly. Information is summarized in 10 key messages and an arch with seven foods groups and the recommended proportions of each one according to age and physiological status. Promote water consumption and physical activity.
Baby Friendly Hospital Initiative	Hospitales Amigos del Niño [*Baby Friendly Hospital Initiative*]	
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	De Alimentación Escolar en el marco de la Soberanía Alimentaria y la Economía Plural. Ley 622 [*School Feeding. The framework of Food Sovereignty and the Plural Economy Law 622*]	Aims all students at pluractional education system. Food must be adequate and culturally appropriate. Besides, promotes use of local farmer, and seasonal products
3. Fiscal policies and regulation of food marketing and labelling		
Marketing regulation of unhealthy food and beverages	Ley de promoción de alimentación saludable. Ley 775 [*Law of Healthy Eating Promotion. Law 775*]	All publicity targeting children (below 18 years old) should promote health food and physical activities. Must give adequate proportions. Should avoid expectative about social status, happiness or promoting discrimination. Must avoid the use of natural resources when it does not contain them and mislead nutrimental benefits.
Food labeling for packaged food and beverages	Ley de promoción de alimentación saludable. Decreto 2452 [*Law of Healthy Eating Promotion. Subsection 2452*]	Traffic lights: Red for those products high-dense in energy, high in sodium, sugar, and saturated fat. Yellow to moderate and green to low
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Programa multisectorial desnutrición cero [*Zero malnutrition. A multisectorial program*]	Distribution of supplementary food for children 6-23 months old, pregnant women. Provision of meat, fruits and vegetables produced by the community. Targets population that is vulnerable, with special emphasis on children under five
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuesta Nacional sobre factores de Riesgo para enfermedades crónicas 2018 [*National Survey on Risk Factors for Chronic Diseases*]	First round. It contains information about weight, exercise, hypertension, tobacco consumption, alcohol use and others risk factors. No results published or publicly available data

Table SP1.5. Policies/Interventions implemented in Brazil

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guía alimentaria para la población brasileña [*Food guide for the Brazilian population*]	Categorizes food by level of processing (i.e., ultra-processed, processed, no processed). Provides general recommendation by food group instead of portions. Summarizes all in 10 steps for healthy eating. Recommendations include cooking and eating environments
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa Dinheiro Direto na Escola aos alunos da educação básica. Lies 10.880 [*Program of Direct Money at School for feeding basic education students. Law 10.880*]	Mandatory to all students enrolled in public schools. School meals are required to provide at least 30% of daily nutritional requirements in school that offer two or more meals a day, 70% in full time basic education and 20% in part time education. Sodas and cookies are not allowed. Sugar must be limited. Started in 1954, but become national in 2009
Food sales regulation at schools	Prevenção da obesidade infantil e a promoção da alimentação adequada nas escolas de educação básica [*Prevention of childhood obesity and the promotion of adequate nutrition in primary schools*]	Establishments located in schools of basic education, public or private, are prohibited from commercialize drinks and food not suitable for the nutrition of child and adolescent. Sellers must inform in writing all products, eliminating industrialized products.
Programs for physical activity at school	Programa nacional para a promoção da actividade física. Lei de Diretrizes e Bases da Educação Nacional, Nº. 9.394 [*National program for promoting physical activity*]	Mandatory in the curricula of elementary and secondary education. Students must practice at least one hour of vigorous or moderate physical activity per day
3. Fiscal policies and regulation of food marketing and labelling		
Marketing regulation of unhealthy food and beverages	No name. Published in Diário Oficial da União [*Official Diary of the Union*] April 4, 2014.	All marketing and publicity targeting children (<18 years old) is forbidden on Television, printed media, radio, banners, internet and stands on selling points
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Fome Zero [*Zero Hunger*]	Cash transfers (various). Basic earnings: $20USD to extremely poor families; with children at school (<17 yo) $40USD; pregnant women and nursing women $40USD (9 months of pregnancy+6 breastfeeding). Aims families living in poverty and extreme poverty, families with a per capita income less than $40USD with children (<17 yo). Families must comply with educational and health responsibilities
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuesta Nacional de Nutrición 1996, 2006 [*National Survey of Nutrition*]	National representative, metropolitan, rural and urban strata. It contains information about anthropometrics, food consumption, oral health and nutritional behaviors. Data publicly available

Table SP1.6. Policies/Interventions implemented in Chile

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guideliness	Guías alimentarias para la población Chilena [*Food guidelines for the Chilean population*]	Provides only 11 key messages. Summarized proportions and recommendation in a plate. Promotes water consumption, suggests reducing scree-time and increasing physical activity.
Baby Friendly Hospital Initiative	Hospitales Amigos del Niño [*Baby Friendly Hospital Initiative*]	
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa de Alimentación Escolar [*School Feeding Program*]	Targeting vulnerable children enrolled in Municipal and private subsidized educational establishments. It included from kindergarten to middle-school. Should cover at least 33% of nutritional requirements for basic and middle school and 45% in kindergarten.
Food sales regulation at schools	Sobre composición nutricional de los alimentos y su publicidad. Ley 20606. [*About nutritional composition of food and advertising. Law 20606*]	Allowed products containing fat, calories, sodium and sugar below stablished thresholds. Products with any label indicating "High" in front hexagons are forbidden.
Programs for physical activity at school	Plan Nacional de Actividad Física Escolar [*National School Physical Activity Plan*]	Physical activities should take place at different times per day. Activities are aimed to all students, regardless their motor skills.
3. Fiscal policies and regulation of food marketing and labelling		
Taxes for sugar-sweetened beverages	Sistema Elige Vivir Sano y la Reforma Tributaria 2014 Ley Nº 20.670 [*Choose Living Healthy System and the Tax Reform 2014. Law 20.670*]	10% for non-alcoholic beverages (natural or artificial). 18% if contains more than 5gr of sugar per 240 milliliters (≈6.25gr per 100gr)
Marketing regulation of unhealthy food and beverages	Reglamento Sanitario de los Alimentos. Decreto 977 [*Food Sanitary Regulations. Order 977*]	All marketing and publicity targeting children below 14 years old is forbidden in all media and possible spots for the food containing sodium, calories, sugar or saturated fat above the permitted threshold. The type of publicity will be defined by the characters, music and colors used.
Food labeling for packaged food and beverages	Sobre composición nutricional de los alimentos y su publicidad. Ley 20606. [*About nutritional composition of food and advertising. Law 20606*]	Hexagons. To all food products for human consumption. Thresholds are 275 kcal, 400 mg/100gr sodium, 10gr/100gr sugar and 4gr/100gr saturated fat. Companies must also eliminate cartoons from packing
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuesta Nacional de Salud 2003, 2010, 2016 [*National Survey of Health*]	National representative, rural/urban and all regions across Chile. It contains information on physical activity, anthropometric measurements, and alcohol/tobacco use, as well as lab tests, HIV self-reported status and diet. No publicly data available

Table SP1.7. Policies/Interventions implemented in Colombia

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Plato Saludable de la familia Colombiana [*Healthy plate of the Colombian family*]	Information is summarized in 9 key messages, a plate with six food groups. Includes specific recommendation for physical activity but not for water consumption.
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa de Alimentación Escolar [*School Feeding Program*]	Children in vulnerability: Indigenous, afro Colombians and gypsies; victims of national war, and low socio-economic status. At least one meal, according to the scholar shift. Meals should provide at least: breakfast 20%, afternoon Snack 20%, lunch 30%, morning snack 10% of daily nutritional requirements.
Food sales regulation at schools	Tiendas Escolares Saludables [*Healthy School Stores*]	Food stores inside schools must promote a healthy diet; complete, balance, and adequate according to the National Food Guidelines. Also, schools must provide free clean water, ready to drink.
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuesta Nacional de la Situación Nutricional 2005, 2010, 2015 [*National Survey of the Nutritional Situation*]	National representative, rural/urban. It contains information about health status, perceived food security, anthropometric measurements and biomarkers (blood and urine). Also includes a qualitative component about diet perception. Publicly available

Table SP1.8. Policies/Interventions implemented in Costa Rica

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guías alimentarias para Costa Rica [*Food Guidelines to Costa Rica*]	Information is summarized in 11 key messages, a plate with four food groups. Includes specific recommendation for water consumption, and physical activity.
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Ley para Fortalecer el programa de Comedores Escolares y Nutrición Escolar y Adolescente. Ley 9435 [*Law to Strengthen the School Canteens and Nutrition program. Law 9435*]	Children in rural/urban areas with high incidence of poverty and extreme poverty. Feeding may be given during non-school time as well.
Food sales regulation at schools	Regulaciones para la venta de alimentos en sodas estudiantiles [*Regulations for food selling at schools' stores*]	Limited the offer of products high in sugar, fats and energy. Pre-packaged beverages (even light or diet) are not allowed. Snacks whose main ingredient is sugar or fat are also forbidden.
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuesta Nacional de Nutrición 1996, 2006 [*National Survey of Nutrition*]	National representative, metropolitan, rural, and urban strata. It contains information about anthropometrics, food consumption, oral health, and nutritional behaviours. Data publicly available

Table SP1.9. Policies/Interventions implemented in Cuba

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guías Alimentarias para la población cubana mayor de dos años de edad [*Food guideliness for the Cuban population of two years and older*]	Information is summarized in 9 key messages; it does not include figures. Contains seven food groups. Includes specific recommendation for physical activity. Provides recipes.
Baby Friendly Hospital Initiative	Hospitales Amigos del Niño [*Baby Friendly Hospital Initiative*]	
Line of action 2. Improvement of school nutrition and physical activity environments		
Programs for physical activity at school	Programs for physical activity at school	No additional information reported

Table SP1.10. Policies/Interventions implemented in Ecuador

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guía de alimentación y nutrición para padres de familia [*Food and Nutrition Guide for Parents*]	Aims school-aged children and adolescents. Summarized information in seven key messages and four food groups. Provides recommendation for water consumption and physical activity. Contains example of healthy recipes.
Baby Friendly Hospital Initiative	Hospitales Amigos del Niño [*Baby Friendly Hospital Initiative*]	
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa de Alimentación Escolar [*School Feeding Program*]	All children attending school. Institutions must provide breakfast and lunch. All breakfast must include fortified milk daily.
Food sales regulation at schools	Reglamento de bares escolares del sistema nacional de educación [*Regulation of school bars of the national education system*]	Food and beverages sold inside school must be healthy, harmless and nutritive. Must be fresh, nature, and healthy. All processed food must have sanitary registry, and with a clear nutritional declaration. High-energy dense food is not allowed.
Programs for physical activity at school	Aprendiendo en movimiento [*Learning in movement*]	At least three hours per week, additional to curricular physical education.
3. Fiscal policies and regulation of food marketing and labelling		
Taxes for sugar-sweetened beverages	Modifications in Article 76 from the fiscal law	Non-alcoholic beverages and soft drinks with sugar added; above 25gr per liter. It would be taxed according to the level of sugar multiplied by 18%.
Marketing regulation of unhealthy food and beverages	Reglamento para la autorización y control de la publicidad y promoción de alimentos procesados [*Regulation for the authorization and control of advertising and promotion of processed foods*]	All marketing and advertising for processed food should not: claim to fulfil nutrimental requirements, being compared with natural products, suggest that the product determine socioeconomic status, intellectual or sexual features to individuals, should not use children to advertise.
Food labeling for packaged food and beverages	Reglamento sanitario de etiquetado de alimentos procesados para el consumo humano [*Regulation for the authorization and control of advertising and promotion of processed foods*]	First country worldwide. Traffic light but indicating the nutriment in which is high/moderate or low. Fat: low <=3gr/100gr, moderate: 3-20gr/100gr, high >=20gr/100gr. Sugar <=5gr/100grs, moderate 5-15gr/100grs, high >=15gr/100gr. Sodium Low: <=120mg/100gr, moderate 120-600mgrs/100grs and high>=600mgr/100gr
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Bono de desarrollo humano [*Human development aid]*	Monthly $50USD given to the household head, elderly or people with disabilities (either case). Aims families living in poverty and extreme poverty, families with a per capita income less than $40USD with children (<17 yo). Families must comply with educational and health responsibilities
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuesta Nacional de Salud y Nutrición 2011 [*National Survey of Health and Nutrition*]	National representative, urban/rural, by region and ethnic groups. It contains information about breastfeeding, nutritional status, anthropometric and biomarkers, food consumption, physical activity and risk factors such as alcohol and tobacco use.

Table SP1.11. Policies/Interventions implemented in El Salvador

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guía de alimentación y nutrición de la familia Salvadoreña por grupos etareos [*Food and nutrition guide of the Salvadoran family by age groups*]	It is presented stratified by age: children, adolescents, adults, breastfeeding women and elderly. Information is summarized in 10 key messages and an arch with seven foods groups and the recommended proportions of each one according to age and physiological status. Promote water consumption and physical activity.
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa de alimentación y salud escolar [*School feeding and nutritional program*]	It includes mothers cooking. Provides at least one meal to all students in basic and middle school.
Food sales regulation at schools	Normativa de tiendas escolares saludables [*Law for healthy school stores*]	Food sold at school must: have less than 10% of total energy from sugar, 1mg of sodium per kcal, less than 30% of energy from fats, should not contain artificial colorants or any sanitary limitation. Ultra processed food and food which main ingredient is sugar of fat are not allowed.
3. Fiscal policies and regulation of food marketing and labelling		
Taxes for sugar-sweetened beverages	Ley de impuestos sobre las bebidas gasesosas, isotónicas, fortificantes o energetizantes, jugos, néctares, refrescos y preparaciones concentradas o en polvo para la elaboración de bebidas [*Tax law on gassy, isotonic, fortifying or energizing drinks, juices, nectars, soft drinks and concentrated or powdered preparations for making beverages*]	Specific tax of 0.20 cents per liter. Ad valorem tax of 10% soft-drinks and energetic beverages. 5% juices, nectar and sport drinks.
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Rural communities in solidarity program	Monthly cash transfers $30USD for children younger than 18yo. $50USD to elderly. Aims families from the 100 rural municipalities in Extreme Severe Poverty and High Poverty. Families must comply with educational and health responsibilities

Table SP1.12. Policies/Interventions implemented in Guatemala

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guías Alimentarias para Guatemala [*Food Guidelines to Guatemala*]	Information is summarized in 10 key messages, a pot with seven food groups (including candies and processed food). Includes specific recommendation for water consumption, and physical activity. Provides recipes. Stratified recommendations by age group (children 5-17 yo, adults, and elderly)
Baby Friendly Hospital Initiative	Hospitales Amigos del Niño [Baby Friendly Hospital Initiative]	
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Ley de alimentación escolar. Decreato 16-2017 [*Law of school feeding. Order 16-2017*]	It includes breakfast for all children in kindergarten and elementary school. Meals are prepared by the mothers.
Food sales regulation at schools		In-school stores should have food and beverages contained in the law
Programs for physical activity at school¥	Guatemala, país activo, saludable, ganador [*Guatemala, active, healthy and winner country*]	Students should do at least 30 minutes of physical activity at the beginning of the school day. Session will be led by teachers.
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Estrategia nacional para la prevención de la desnutrición crónica [*National strategy for the prevention of chronic malnutrition*]	Provision of supplements for pregnant women and children younger than 6 yo. Promotion and monetary aid for household gardens and families' farms (chicken). Aims regnant women and children younger than 6yo especially rural families.
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuesta Nacional de Salud Materno-Infantil 1987,1995, 1999, 2002, 2009, 2015 [*National Maternal and Child Health Survey]*	It contains information about anthropometric, sexual behaviours, breastfeeding, vaccination, infectious diseases in children of 5yo and younger, child mortality, HIV/AIDS, and maternal health

Table SP1.13. Policies/Interventions implemented in Honduras

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guía alimentaria para Honduras [*Food Guidelines to Honduras*]	Information is summarized in 7 key messages, a pot with five food groups. Includes specific recommendation for water consumption, and physical activity. Provides recipes.
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Ley de Alimentación Escolar [*Law for School Feeding*]	For all students in kindergarten, elementary and middle school. At least one meal daily. It is design to "complement" nutritional requirements, not to provide them as a whole.
Food sales regulation at schools	Reglamento de venta de alimentos en centros educativos gubernamentales y no gubernamentales [*Regulation of the sale of food in governmental and non-governmental educational centers*]	In-school stores should sell nutritive food. Must offer fresh veggies and fruit. All processed food should have sanitary registry.
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuesta Nacional de Demografía y Salud 2019 [*National Survey of Demography and Health*]	It contains information about nutritional status of children, VIH/AIDS, health services utilization, sexual behaviours, and general health

Table SP1.14. Policies/Interventions implemented in Mexico

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guía de alimentos para la población Mexicana [*Food guidelines for the Mexican population*]	Information is summarized in a plate with five food groups. Includes recommendation for proportions. Provides recipes and examples for daily menus.
Baby Friendly Hospital Initiative	Hospitales Amigos del Niño [*Baby Friendly Hospital Initiative*]	
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa de desayunos escolares [*School breakfast Program*]	It includes either breakfast or lunch, according to the scholar shift. Should include milk or water, a complete meal with an animal protein, veggies, beans, cereal, and fruit. It targets children in rural areas, indigenous and urban with high marginality.
Food sales regulation at schools	Mi escuela saludable [*My healthy School*]	Soft drinks (even diet), flavoured milk, salty snacks, cookies, pre-packed cakes, candies, sweet bread, and sweetened yogurt are not allowed. Fresh fruit, veggies, whole grain cereals, nuts, peanuts are allowed. All stores must provide free clean water.
Programs for physical activity at school		Daily students must do at least 30 minutes of physical activity at school. Besides, 15 minutes at the beginning of school day.
3. Fiscal policies and regulation of food marketing and labelling		
Taxes for sugar-sweetened beverages	Impuesto a bebidas con azúcares añadidas y alimentos con alta densidad calórica [*Tax sugar-sweetened drinks and foods with high caloric density*]	Specific tax of 1 Mexican peso (0.05USD) per liter on drinks and 8% ad valorem on food
Marketing regulation of unhealthy food and beverages	Regulación de publicidad de alimentos y bebidas no alcohólicas en horarios infantiles [*Regulation of advertising of food and non-alcoholic beverages during children's hours*]	All marketing and advertising targeting children (<12 years old) is forbidden from all media for 14:30 to 19:30 hrs during weekdays and from 07:00 to 19:30 hrs on weekend. Also, in movie heaters for movies targeting children
Food labeling for packaged food and beverages	Reforma a la Ley General de Salud en materia de sobrepeso, obesidad y etqieutado de alimentos y bebidas no alcohólicas [*Reform of the General Health Law on overweight, obesity and labeling of food and non-alcoholic beverages*]	Hexagons. To all food products for human consumption. Thresholds are 275 kcal, 400 mg/100gr sodium, 10gr/100gr sugar and 4gr/100gr saturated fat. Eliminate cartoons from packing
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Programa México Sin Hambre [*Mexico without hunger national program*]	Based on money transfers, increasing availability to low-cost food products, supplements for malnutrition populations. Promotes community food trades to reduce prices and incentivize rural production. Aims people in extreme poverty and/or in a state of food insecurity. Two components: 1) Families must comply with educational and health responsibilities 2) strengthened national agricultural production and community participation
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuestra Nacional de Salud y Nutrición 2006, 2012, 2016, 2018 [*National Survey of Health and Nutrition*]	National representative. Urban/rural and by region. It contains information about anthropometric measurements, self-reported chronic diseases, biomarkers for chronic diseases, physical activity, health services utilization and health expenditure

Table SP1.15. Policies/Interventions implemented in Nicaragua

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
Baby Friendly Hospital Initiative	Hospitales Amigos del Niño [*Baby Friendly Hospital Initiative*]	
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa integral de nutrición escolar [*Comprehensive school nutrition program*]	Snacks for students from pre-school and primary of all public schools in the country. School breakfast to students for municipalities in critical nutritional situation. The lunch should provide at least 30% of require energy to the children. Children between 3-12 years old.
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Cero hambre [*Zero Hunger*]	Production grants, certified seeds, access to financing and credit, development of productive chains. It helps local producers to produce quality products and distribute them in the communities. Aims women in any age range with 1 to 10 acres of land in rural or semi-rural areas. Also increase access to lower-price food and provide the community with high-quality food.

Table SP1.16. Policies/Interventions implemented in Panama

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guías alimentarias para Panamá [*Food guidelines to Panama*]	Information is summarized in eight key messages, in a plate with five food groups. It also provides recommendations for water consumption and physical activity. It contains recipes for fruit shakes and natural juices.
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Merienda Escolar [*School meals program*]	Aims all Children from kindergarten to middle school. The program provides a nutritious school lunch which consists of nutritionally enhanced biscuits, milk and enriched cream (custard), consisting of a package of 34 grams of biscuits, 8 ounces of milk or 8 ounces of nourishing cream. Supplemental food contains 320-330 kcal (snacks). Also contains an educational component for parents.
Food sales regulation at schools	Reforma a la Ley Alimentación Escolar Saludable [*Reform to Healthy School Eating Law*]	All kind of soft drinks, sweetened beverages, jelly, salty and grassy snacks, fried snacks, candies and desserts are not allowed to sell. However, 100% natural juices and flavoured milks are allowed.
Programs for physical activity at school	Reforma a la Ley 16 sobre el Instituto Nacional del Deporte [*Reform of Law 16 on the National Sports Institute*]	No information provided
3. Fiscal policies and regulation of food marketing and labelling		
Taxes for sugar-sweetened beverages	Plan de acción para mejorar la salud Ley 114 [*Action plan to improve the health. Law 114*]	7% for soft-drinks, 5% other SSB, 10% powder, concentrates and sirops. All beverages above 7.6 gr per 100ml.
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Programa solidaridad alimentaria [*Food Solidarity Program*]	Subsidize basic food products and selling them at "reasonable" prices in an "on-wheels" market
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuesta Nacional de Salud 2019 [*National Survey of Health*]	It contains information about risk factors of health, utilization and quality of health services, nutritional factors (weight, height), and biomarkers

Table SP1.17. Policies/Interventions implemented in Paraguay

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guías Alimentarias del Paraguay [*Food Guidelines of Paraguay*]	Information is summarized in 12 key messages, a pot with seven food groups (including candies and processed food). Includes specific recommendation for water consumption, and physical activity. Provides recipes, proportions, and advises for hygiene.
Baby Friendly Hospital Initiative	Hospitales Amigos del Niño [*Baby Friendly Hospital Initiative*]	
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa de alimentación escolar del Paraguay [*School Feeding Program in Paraguay*]	Aims all children between 6 and 12 years old enrolled in public or private schools. Children receive a complete lunch and a snack including milk.
Programs for physical activity at school	Promoción de actividad física [*Physical activity promotion*]	Suggestions are for activities outside school, stratified by age. Government suggests at least one hour of vigorous and moderate physical activity daily.
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Programa Tekoporã [*Tekoporã program*]	Monetary transfer: food bonus $13.5 USD, (per people at home) children 0-18yo $6 USD, pregnant woman $13.5 USD, elderly $13.5 USD, people living with disabilities $13.5USD. Unique bonus for indigenous families $33.9 USD. Targets families in poverty and vulnerability. Indigenous population
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuesta Nacional de Factores de Riesgo para enfermedades no transmisibles [*National Survey of Risk Factors for Noncommunicable Diseases*]	National representative. Urban/rural and by ethnic group. It contains information about tobacco/alcohol use, physical activity, Fruit and veggies consumption, obesity, diabetes, and seat bell use

Table SP1.18. Policies/Interventions implemented in Peru

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guía alimentaria para la población peruana [*Food guidelines for the Peruvian population*]	Information is summarized in 1 key messages, in a plate with seven food groups (including candies and fats). It also provides recommendations for water consumption and physical activity. Provides menus examples
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa nacional de alimentación escolar Qali Warma [*National School Feeding Program Qali Warma*]	The program provides two servings (breakfast and lunch) to students attending schools in districts of greater poverty and one serving (breakfast) to students attending schools in districts with lower poverty. Targets children from three to 11 (12) years old in public schools.
Food sales regulation at schools	Quiscos saludables [*Healthy Kiosks*]	All products with "warning hexagons" labels are forbidden in selling points inside schools
Programs for physical activity at school¥	Plan de Fortalecimiento de la Educación Física y el Deporte Escolar [*Plan to Strengthen Physical Education and School Sports*]	At least three hours of physical activity per week in elementary and middle schools
3. Fiscal policies and regulation of food marketing and labelling		
Taxes for sugar-sweetened beverages	Impuesto Selectivo al Consumo (ISC) de las bebidas azucaradas [*Selective Consumption Tax for sugary drinks*]	Ad valorem tax of 25% to all non-alcoholic beverages with 6gr (or more) of sugar per 100ml (added)
Marketing regulation of unhealthy food and beverages	Ley de promoción de la alimentación saludable. Decreto 017-2017-SA [*Promotion of healthy eating law. Order 017-2017-SA*]	All marketing and advertising targeting children below 16 years old should not: Incentivize over consumption, misuse proportions, generate expectative about superiority, suggest increments on social status or popularity, promote the product as a gift or reward, show natural resources when it does not contain them
Food labeling for packaged food and beverages	Ley de etiquetado y verificación de los reglamentos técnicos de los productos industriales manufacturados. Decreto 1304. [*Law on labeling and verification of technical regulations for manufactured industrial products. Order 1304*]	Hexagons. To all food products for human consumption. Thresholds are 300 kcal, 800 mg/100gr sodium, 22.5gr/100gr sugar and 6gr/100gr saturated fat. Eliminate cartoons from packing
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Programa nacional de apoyo directo a los más pobres [*National program of direct support to the poorest*]	The program in responsible for providing a CCT in the amount of PEN$200 (USD$60), directly to families (which have pregnant women as members as well as children and youths of up to 19 years of age) that face situations of poverty or extremely rural and urban poverty. Families must comply with educational and health responsibilities
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuestra Nacional de Indicadores nutricionales, bioquímicos, socioeconómicos y culturales relacionados con las enfermedades crónicas degenerativas 2006 [*National Survey of Nutritional, Biochemical, Socioeconomic and Cultural Indicators Related to Chronic Degenerative Diseases*]	It contains information on physical activity, anthropometric measurements, alcohol/tobacco use, food consumption. Data no available

Table SP1.19. Policies/Interventions implemented in Uruguay

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guía alimentaria para la población Uruguay [*Food guideliness for the Uruguayan population*]	Information is summarized in 11 key messages, with three food groups. It also provides recommendations for water consumption and physical activity. Categorizes food by level of processed and gives general recommendations and not proportions
Baby Friendly Hospital Initiative	Hospitales Amigos del Niño [*Baby Friendly Hospital Initiative*]	
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa de alimentación escolar [*School feeding program*]	All public schools. Depending on scholar shift, provide breakfast, lunch, dinner and snacks
Food sales regulation at schools	Protección de la salud de la población infantil y adolescente a través de la promoción de hábitos alimenticios saludables. Ley 19140 [*Protection of the health of the child and adolescent population through the promotion of healthy eating habits*]	Natural food and beverages, as well as minimally processed food is allowed. Food and beverages cooked at school on indicated proportions.
3. Fiscal policies and regulation of food marketing and labelling		
Food labeling for packaged food and beverages	Rotulado frontal de alimentos. Decreto 272/018 [*Front food labelling. Order 272/018*]	Hexagons. To all food products for human consumption. Thresholds are 300 kcal, 800 mg/100gr sodium, 3gr/100gr sugar and 12% of saturated fat of total energy. Eliminate cartoons from packing
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Tarjeta Uruguay Social [*Social Uruguay Card*]	Money transfers through a card. Amount change according to household composition (from 28USD to 151USD). Card works only for selected healthy food purchases. Aims families in extreme economic vulnerability or with food insecurity
Line of action 5. Surveillance, research, and evaluation		
Development and implementation of national surveys/census of nutritional and anthropometric status	Encuesta de Nutrición, Desarrollo Infantil y Salud 2013, 2016, 2018 [*Nutrition, Child Development and Health Survey*]	It is a cohort of children of 0-3 yo (baseline). It contains information about health behaviour of parents when pregnant, food consumption of children, children's diets, violence, and childhood development. Not publicly available

Table SP1.20. Policies/Interventions implemented in Venezuela

Policy/intervention	Specific program/law	Key Characteristics
Line of action 1. Primary health care and promotion of breastfeeding and healthy eating		
National Food-Based Guidelines	Guías de alimentación venezolana [*Venezuelan food guidelines*]	Information is summarized in 12 key messages. Includes specific recommendation for water consumption, and physical activity.
Line of action 2. Improvement of school nutrition and physical activity environments		
National school feeding programs	Programa de alimentación escolar [*School feeding program*]	All schools. Depending on scholar shift, provide breakfast, lunch, dinner and snacks
Line of action 4. Other multisectoral actions		
National programs of food subsidies and money transferences	Misión alimentación [*Food mission*]	Subsidize basic products selling them at "reasonable" prices in an "on-wheels" market. All products are distributed by a national and governmental firm. Aims general population. Special focus on low-income families

Table SP1.21. Specific results for policy/intervention qualitative/process evaluation by country and line of action

Line of action	Policy/Intervention	Country, author, and year	Objective	Design/ Study type	Study population (N)	Results
1. Primary health care ad promotion of breastfeeding and healthy eating	1. Implementation of national food-based dietary guidelines	Brazil (Olveira et. al, 2017) (2)	To analyse the strengths and limitations in the second edition of the Dietary Guidelines for the Brazilian Population, compared with the first edition	Discourse analysis through four stages	Dietary Guidelines for the Brazilian Population 2006 and 2014 (2)	The new guideline strengthened the socio-cultural dimensions of feeding. It evokes pleasure in food, stimulates culinary practices and promotes healthy eating habits. No apparent limitations were found comparing the second guideline with the first.
		Uruguay (Machín, et. al, 2017) (3)	To identify barriers and facilitators for the adoption of the new Uruguayan dietary guidelines from a citizen perspective	Semi structured Focus groups	Uruguayans between 18-64 years old (91)	There were multifaceted barriers such as preferences for unhealthy food and unsupportive customs and social norms were found, as well as adverse food market environment. Potential facilitators were related policies and regulations to restrain unhealthy habits and the provision of information.
2. Improvement of school nutrition and physical activity environments	1. Implementation of national school feeding programs	Bolivia (Valdivia, 2017) (4)	Identify best practices and experience to extrapolate to similar programs, measure appropriation and acceptation levels.	Summary. Critical interpretation	Key actors, general population, and NGOs	Families fed better, have high knowledge about cooking and sustainable food. People perceived the program as highly efficient and they feel that they belong.
	2. Regulation of sale of foods and beverages in schools	Mexico (Macari, 2019)	Review the topical literature to date and makes policy recommendations aimed at fostering healthy school food environments	Case study	Policy documents	School food policy needs to be based in a human rights framework. It emphasizes how policy needs to consider the economic and structural realities of schools to be effective.
	3. Physical activities at school	Mexico (Thédore et al, 2018) (5)	To assess the implementation of an obesity prevention policy in elementary schools in Mexico and learn from it to improve the implementation process.	A logic model with a systematic random sampling of schools	Principals (116), Members of the Food and Physical Activity Committees (165), food school food vendors (132), teachers (119), parents (348)	The study evidences a significant deviation in implementation from what had been planned. It was found that all types of actors had a superficial knowledge and understanding of the policy. Also, there was found a lack of concrete objectives, goals and clearly stated roles that hinder the translation of the policy activities.
3. Fiscal policies and regulation of food marketing and labelling	1. Implementation of policies to reduce children and adolescent's consumption of Sugar-Sweetened Beverages and High-Energy Dense Products products	Mexico (Ortega-Avila, et. al., 2018) (6)	To explore awareness and perceptions of the sugar-sweetened beverage (SSB) tax implemented in Mexico in 2014 among a sample of Mexican adolescents, and to investigate how the tax has affected their purchases and intake of SSB.	Semi-structured interviews. Thematic analysis	Adolescents residing in north-west Mexico aged 15-19 years (29).	Participants were mostly unaware of the tax and perceived that it would not cause reductions in their intake of SSB; they felt that the price increase was low and insufficient to affect intake. Taste preferences and 'addiction' to SSB were highlighted as the main reasons why participants perceived taxation would not affect intake.
	2. To enact regulations to protect children and adolescents from the impact of marketing of	Ecuador (Freire, et. al., 2017) (7)	To analyse patterns of knowledge, comprehension, attitudes, and practices regarding the traffic light label to	Focus-group	Ecuadorians between 5 and 24 years old (178)	Participants knew about the traffic light label and understood the information it conveys. Representatives of companies that manufacture or market processed foods generally opposed the policy, stating that the information is misleading. Companies

	Sugar-Sweetened Beverages and High-Energy Dense Products, and fast food		inform Ecuadorian consumers about levels of added fat, sugar, and salt.			have reduced levels of added fat, sugar, or salt in their products; traffic light label is an effective tool for conveying complex information.
		Chile (Correa, et. al., 2019) (8)	To examined mothers' understanding, perceptions, and behaviors associated with the regulation one year after its implementation, using a qualitative approach	Focus-group	Mothers of children between 2-14 years old (84)	Mothers declared that they perceived that the regulation was changing the perceptions, attitudes, and behaviors toward healthier eating patterns. Also expressed that they perceived an important shift toward healthier eating, which may lead to a change in eating social norms
4. Other multisectoral actions	1. To increase the availability of and accessibility to nutritious foods.	Argentina (Abeyá, 2016) (9)	Review nationwide State-run food programs with the objective of contributing to the food security of the families in greatest need, and arguments for analyzing current programs using a typology based in the components of food security are proposed	Critical evaluation	Food national programs	Programs are conceptualized in terms of food availability, accessibility, and utilization, easing comprehension. Money transfers generates higher money flow, and autonomy of use. Programs oriented to best use of food products and nutrients are supported by education but limited by advertisement.

Table SP1.22. Specific results for Implementation of national school feeding programs

Country, author, and year	Objective	Design	Outcome(s)	Study population (N)	Time after implementation	Results
Argentina (Adrogué et. al., 2013) (10)	To estimate the effect of the in-school feeding program on academic performance	Quasi-experimental study using difference-in-difference approach	Standardized scholar test scores	Elementary Schools (1,793)	13 years after first implementation	Language test scores showed statistically significant improvement by 3.5% (near 2 points) compared with control group. There were no noticeable effects reported in math scores.
Brazil (Rocha, et al, 2018) (11)	To analyze the implementation of the Brazilian National School Feeding Program as a food and nutritional security policy in public schools	Mixed methods. Cross-sectional description and semi-structure interviews	Acceptance of food provided as proportion of food from home. Knowledge about the program.	Schoolchildren aged eight to nine years old (268)	6 years	Children reported low adherence (63.9% consumed it less than 3 times per week) to the school feeding program and most of them used to bring food from home.
Brazil (Ferreira et al, 2019) (12)	Identify the perception operating agents have on the Brazilian National School Feeding Program	Mixed methods. Cross-sectional description and narrative analysis	Perception of the National Schooling Feeding Program	Stakeholder and key informants (43 nutritionists, 41 members of the School Feeding Board, and 16 school feeding administrators from 38 cities)	6 years	The perception of the implementation of the National School Feeding Program has been characterized by some challenges. The adequacy of the number of nutritionists showed statistically significant association with the purchase of family farming products and with the food and nutritional education activities ($p<0.02$).
Chile (McEwan, et al., 2013) (13)	Evaluates the impact of higher-calorie meals on the education outcomes of public, rural schools and their students.	Quasi-experimental. Regression-discontinuity analysis	School enrollment and attendance. Grade repetition	Elementary Schools (8,727)	36 years, but using data of the last 5 years (2000-2005)	There is no evidence that additional calories, provided by meals at school, affects scholar variables such as attendance and grade repetition ($p>0.1$ for all variables).
Colombia (Arsenault, et al., 2009) (14)	To examine whether the snack program improve children's nutritional and health status.	Observational study. Mean differences between groups.	Children nutritional and health status	Children aged between 5-12 years old (3,202)	5 yeas	Children at schools receiving the snack had greater increases in plasma vitamin B-12 (42 pmol/L; $p < 0.01$) and a smaller decrease in height-for-age Z-scores than children who did not received snacks ($p=0.001$). Provision of scholar snack was associated with significantly fewer reported days with morbidity symptoms, 44% fewer doctor visits ($p=0.02$), and 23% fewer days of school absenteeism ($p=0.003$).
Colombia (Pérez Carrillo et. al., 2015) (15)	Evaluate whether the School Feeding Program has impact on scholar dissertation and academic performance	Quasi-experimental study using difference-in-difference approach	Dropout rates and academic performance	Elementary Schools (1,560)	7 years after implementation. 5 years follow up	The program had not had a significant impact on dropout or in academic test Saber 11. However, it was found that children who receive breakfast and lunch have a significant decrease in school dropout rate (2.49%, $p<0.05$).
Ecuador (Cadena Minotta, et al. 2004) (16)	Evaluate the impact of In-School feeding program on attendance	Quasi-experimental. Instrumental variables and propensity score matching	Attendance rate	Children in elementary school (2,794)	10 years	Results suggest that the program have null impact in attendance ($p>0.05$ between treatment and no-treatment groups).
Mexico (Shamah-Levy, et al., 2017) (17)	To assess the effect of Education in Nutrition and Food Assistance	Quasi-experimental study using difference-in-	Personal hygiene, nutrition knowledge,	Children in elementary school (1,620)	12 years after implementation.	Program SaludArte has positive effects on personal hygiene ($p=0.045$), nutrition knowledge ($p=0.003$) and increase in fiber

	components of the SaludArte program in participant schools during 2013-2015	difference and a logistic regression	fiber intake, sugar intake		2 years of follow up	Intake (p=0.064). Sugar intake, contrary to expected showed a significant increase (p=0.037).

Table SP1.23. Specific results for Regulation of sale of foods and beverages in schools

Country, author, and year	Objective	Design	Outcome(s)	Study population (N)	Time after implementation	Results
Chile (Massri. et. al., 2019) (18)	Quasi-experimental. Uncontrolled before-after analysis	To evaluate the impact of a national law banning sales of competitive food and beverages (CF&B) in schools on the availability of CF&B sold at school kiosks.	Percentage of food exceeding the cut-off levels defined in the law	Public Schools (21)	2 years	Food exceeding any cut-offs decreased from 90.4% in 2014 to 15.0% in 2016. Solid products had a substantial reduction in calories, sugar, saturated fat, and sodium. Liquid products had a reduction in calories, total sugar, and saturated fat, whereas sodium increased. This was a result of changes in product mix.
Mexico (López-Olmedo, et. al., 2017) (19)	Cross-sectional descriptive and unadjusted time differences	To evaluate the consumption of food and beverages during school hours, in two different stages of the implementation of the Guidelines: stages II (2011–2012) and stage III (2012–2013) in 565 elementary school students.	Energy intake/consumption	Children in elementary schools (565)	2 years	There are differences in both stages in energy intake according to the foods' origin (p<0.01); Children that buy at school has the lowest energy and macronutrients consumption (p<0.01), as well as the closer compliance with Food Guidelines, while children that also have food from home have a higher consumption and the less compliance with Guidelines.

Table SP1.24. Specific results for Implementation of policies to reduce children and adolescent's consumption of Sugar-Sweetened Beverages and High-Energy Dense Products

Country, author, and year	Objective	Design	Outcome(s)	Study population (N)	Time after implementation	Results
Chile (Nakamura, et. al., 2018) (20)	Quasi-experimental. Before and after with fixed effects	Evaluate changes in purchases of beverages after tax modification in Chile	Household-level grocery-purchases	Households located in urban areas of Chile (2,836)	1 Year	Changes in purchases. Monthly purchases for higher-taxed beverages was 21.6%. Higher reduction in higher socioeconomic groups (31.3% less).
Chile (Cuadrado, et al, 2020) (21)	Quasi-experimental. Interrupted time-series analysis	Evaluate the tax modification passed-on to consumers through prices and changes in affordability for soft drinks	Changes in price and affordability (price relative to wages)	Soft drinks (41 products)	2 Years	The price of soft drinks incremented by 5.60% and a small increment was also observed in water. No difference for juices and energy-sports drinks. Reduction in affordability for soft drinks, concentrates and water (5.77%).
Chile (Caro, et al, 2018) (22)	Quasi-experimental. Before and after with fixed effects	Examine changes in beverages prices and household beverage purchases after the tax reform	Prices and household purchases for beverages in Chile	Households located in urban areas of Chile (2,000)	2 years	Prices of high-SSBs increased 2.0% for carbonated and 3.9% for non-carbonated. Prices for Low SSB concentrates decreased by 6.7% and 1.5% for ready-to-drink low SSB. Household purchases decreased 3.4$ for H-SSBs and L-SSB incremented 10.7%
Mexico (Ng, et al, 2018) (23)	Quasi-experimental. Before and after with fixed effects	To estimate changes in taxed and untaxed beverages by volume of beverage purchased after a sugar-sweetened beverage (SSB) tax was introduced in 2014 in Mexico	Beverages purchases after tax implementation in Mexico	Household located in metropolitan areas of Mexico (6, 253)	2 years	Households with lower purchases of untaxed beverages had the largest absolute and relative increases in untaxed beverages (14%). Taxed beverages reduced 20% on high consumers.
Mexico (Colchero, et al, 2017) (24)	Quasi-experimental. Before and after with fixed effects	Estimate changes in beverage purchases two years after tax implementation.	Beverages purchases after tax implementation in Mexico	Household located in metropolitan areas of Mexico (6, 253)	2 years	Purchases of taxed beverages decreased by 8.2% over the two years on average (-5.5% in 2014; -9.7% in 2015). Untaxed beverage purchases increased 2.1% in the post-tax period.
Mexico (Colchero, 2016) (25)	Quasi-experimental. Before and after with fixed effects	To evaluate changes in the purchases of consumer beverages after the implementation of the excise tax.	Beverages purchases after tax implementation in Mexico	Household located in metropolitan areas of Mexico (6, 253)	1 year	Purchases of taxed beverages decreased by an average of 6% (-12 mL/capita/day), and decreased at an increasing rate up to a 12% decline by December 2014. All three socioeconomic groups reduced purchases of taxed beverages, but reductions were higher (9%) among the households of low socioeconomic status.
Mexico (Mendoza-Velázquez, et. al., 2019) (26)	Time series. Regime-switching models	Study the persistence of SSB and junk food tax in Mexico in terms of inflation rates	Inflationary rates and persistence	Taxed products (72)	3 years	The tax contributed gradually to price inflation for some high-calorie products (i.e. 3% for soft drinks, 5% on pre-packed breads and 2% on candies), before returning to pre-tax inflation levels. The continuity of the tax did not affect the inflationary dynamics of the food after 2015.
Mexico (Colchero, et al, 2017) (27)	Quasi-experimental. Before and after.	To examine the heterogeneity of changes in non-alcoholic beverage purchases after the tax was implemented	Changes in beverages purchases at household level	Mexican households (29 million)	1 year	It was found a 6.2% reduction in SSB purchases and a 16.2% increase in plain water purchases
Mexico (Colchero, et al. 2016) (28)	Adjusted time series.	To estimate changes in sales of sugar sweetened beverages (SSB) and plain water after a SSB tax was implemented in Mexico	Industry sales for non-alcoholic beverages	2 categories of beverages	1 year	It was found a decrease of 7.3% in per capita sales of SSB and an increase of 5.2% of per capita sales of plain water in 2014-2015 compared to the pre-tax period (2007-2013).

Mexico (Colchero, et al, 2015) (29)	Quasi-experimental. Before and after with fixed effects	To study whether and to what degree these taxes passed through onto SSB prices in urban areas overall	Price incidence after tax implementation	6 categories of beverages	1 year	The SSB tax passed along to consumers for all SSBs and we found over shifting for the carbonated SSBs (0.12 USD cents). A greater effect is seen among the small package sizes (0.15 USD cents). Also, there were heterogeneous effects by country's region
Mexico (Guerrero-Lopez, et al, 2017) (30)	Quasi-experimental. Interrupted time-series analysis	To assess changes in employment in the manufacturing industry, the commercial sector and national unemployment rates, associated with the fiscal policies implemented in 2014 in Mexico	Employment rates for industry and stores	2 categories of industry	2 years	There were no significant changes in employment associated with the taxes in the manufacturing industries (for beverages and nonessential energy-dense food; p=0.365). It was found a very small increasing trend in the post-tax period for employment in commercial stores and a decreasing trend in the unemployment rate (p=0.002).
Mexico (Álvarez-Sánches,, et al, 2018) (31)	Cross-sectional. Adjusted logistic regression	To evaluate the potential signaling effect of the Mexican tax on SSBs by analyzing the association between awareness of and opinions about its effectiveness with current consumption of taxed SSBs and with a self-reported change in consumption of SSBs since the implementation of the tax	Probability of a person self-reporting a decrease in SSB consumption	Mexican adults (6,650)	2 Years	Compared with adults not aware, adults who were aware of the SSB tax were more likely (OR = 1.30) to report a decrease in SSB consumption (p = .012). Self-efficacy and liking of SSBs were significantly associated with a reported decrease in consumption and with current consumption (p<0.001)
Mexico (Colchero, et al, 2017) (32)	Quasi-experimental. Before and after with fixed effects	To estimate changes in prices associated with the implementation of the tax to sugar sweetened beverages (SSB) and to nonessential energy dense food in 2014	Price incidence after tax implementation	6 categories of beverages	1 year	The SSB tax did not pass completely through prices: prices increased on average 0.08 USD cents per liter in rural areas of Mexico
Mexico (Batis, et al, 2016) (33)	Quasi-experimental. Before and after with fixed effects	To examine changes in volume of taxed and untaxed packaged food purchases in response to these taxes in the entire sample and stratified by socioeconomic status (SES)	Changes in food purchases at household level	Household located in metropolitan areas of Mexico (6, 248)	1 year	The mean volume of purchases of taxed foods in 2014 changed by -25 g per capita per month, or a 5.1%, with no corresponding change in purchases of untaxed foods. Low SES households purchased on average 10.2% less taxed foods than expected; medium SES households purchased 5.8% and high SES households' purchases did not change.
Mexico (Hernández-F, et al, 2019) (34)	Quasi-experimental. Before and after.	To estimate changes in household purchases of taxed food	Changes in food purchases at household level	Mexican households (154,777)	2 years	It was observed a reduction in purchases of taxed food of −5.4 grams/week per capita (−5.3%). The largest relative reductions were in urban areas (−6.9%), among households with children (−7.0%), households where the head had an intermediate educational level (−9.9%) and the southern region (−14.8%).
Mexico (Taillie, et al, 2017) (35)	Quasi-experimental. Before and after with fixed effects	To examine whether the effect of Mexico's 2014 8% nonessential energy-dense foods tax increased in the second-year post-implementation and whether it differentially affected households by pre-tax purchasing pattern	Changes in food purchases at household level	Household located in metropolitan areas of Mexico (6, 089)	2 years	Post-tax declines taxed food purchases from -4.8% in year one to -7.4% in year two. Post-tax change in % taxed food purchases varied by pre-tax purchasing level. Healthy purchasers showed no post-tax change in taxed food purchases.

Table SP1.25. Specific results for to enact regulations to protect children and adolescents from the impact of marketing of Sugar-Sweetened Beverages and High-Energy Dense Products, and fast food

Country, author, and year	Objective	Design	Outcome(s)	Study population (N)	Time after implementation	Results
Peru (Busse , et. al, 2018) (36)	Cross-sectional. Content analysis	To identify the food and beverage advertisements showing health cues, the types of health cues and the length of time	Health cues	Food advertisement (799)	3 years	Health cues appeared on over 70% of advertisements for sugary drinks and tended to promote healthy diets more so than physical activities. The duration of the advertisements exhibiting the health cues was positively correlated with the duration of the cue (r = 0.37, p<0.01)
Chile (Dillman Carpentier et al, 2020) (37)	Quasi-experimental. Before and after.	To evaluate the effects of Chile's 2016 regulation restricting child-directed marketing of products on reducing children's exposure to "high-in" television food advertising.	Hours and channels of television and amount of food advertising	Preschoolers (879) and adolescents (753)	3 years	Preschoolers' and adolescents' exposure to high-in food advertising in total decreased significantly by an average of 44% and 58%, respectively. Exposure to high-in food advertising with child-directed appeals, such as cartoon characters, decreased by 35% and 52% for preschoolers and adolescents, respectively.
Chile (Correa et al, 2020) (38)	Quasi-experimental. Before and after.	To study changes in food advertising on television after Chile's food marketing restriction was implemented in June 2016	Content of food advertisement	T.V. Channels (8)	1 year	The percentage of ads for foods high in energy, saturated fats, sugars, or sodium decreased from 41.9% before the regulation to 14.8% after the regulation. This decrease occurred in programs intended for children (from 49.7% to 12.7%; p<0.001) as well as general audiences (from 38.5% to 15.7%; p<0.001).

Table SP1.26. Specific results for to develop and implement norms for front-of-package labeling

Country, author, and year	Objective	Design	Outcome(s)	Study population (N)	Time after implementation	Results
Chile (Taillie et al, 2020) (39)	Observational study	To evaluate the impact of this package of policies on household beverage purchases	Packaged beverage purchases at household level	Urban-dwelling households (2,383)	2 years	The volume of high-in beverage purchases decreased 22.8 mL/capita/day (23.7%), post regulation. Calories from high-in beverage purchases decreased 11.9 kcal/capita/day (27.5%). Calories purchased from beverages classified as "not high-in" increased 5.7 kcal/capita/day (10.8%). Calories from total beverage purchases decreased 7.4 kcal/capita/day (7.5%).
Ecuador (Sandoval et al, 2019) (40)	Quasi-experimental. Before and after. Non-linear Almost Ideal Demand System	To evaluate the effect of the TL supplemental nutritional information on consumers' buying behavior in Ecuador. More specifically, we concentrated on the purchasing behavior of carbonated soft drinks	Purchases of SSB	Households (1,646)	1.5 years	Before the introduction of traffic lights, SSB purchases averaged 1.71 liters per capita per month, while after the introduction it averaged 1.62 (p = 0.08). It also was identified that over time purchases of high sugar soft drinks decreased while purchases of low and no sugar soft drinks increased

Table SP1.27. Specific results for to increase the availability of and accessibility to nutritious foods

Country, author, and year	Objective	Design	Outcome(s)	Study population (N)	Time after implementation	Results
Brazil (Lignani et al, 2011) (41)	Cross-sectional survey. Poisson regression	To analyse changes and predictors of change in self-reported food intake among Brazilian families that benefitted from conditional cash transfer (CCT) implemented in the Program Bolsa Familia of the Brazilian Federal Government.	Consumption by food group	Households (5,000)	4 years	Families reported increased consumption of all food groups analyzed, mainly cereals, processed foods, meat, milk and dairy, beans, and sugar. A twofold increase in the self-reported intake of soft drinks (relative risk (RR) = 2·3, 95% CI 1·8, 2·9) and sugar (RR = 2·5, 95% CI 2·1, 3·1) compared with the first quartile of conditional cash transfer dependence.
Ecuador (Moncayo, et al, 2019)(42)	Quasi-experimental. Before and after with fixed effects using a negative binomial regression model with fixed effects	To evaluate the effect of the BDH program on mortality of children younger than 5 years, particularly from malnutrition, diarrheal diseases, and lower respiratory tract infections.	Mortality rates due to malnutrition and respiratory infections	Ecuadorian counties (144)	6 years after implementation. 5 years follow up	For each 1% increase in BDH county coverage there would be a decrease in malnutrition of 3%. An effect of BDH county coverage on mortality resulting from respiratory infections was also observed. The BDH also reduced hospitalization rates in children younger than 5 years, overall and for diarrhea.

Figure SP2.1. Sample flow

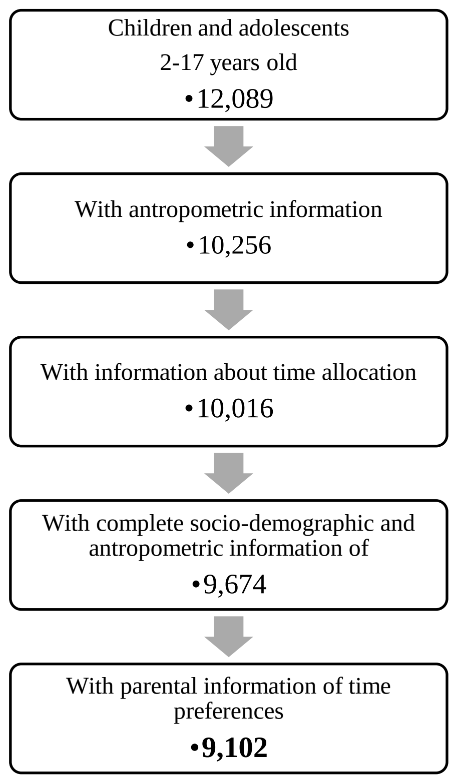

Table SP2.1. Minimum accepted in a month/year over 1,000 today ($1,000 are those preferring today)

	Month	Year
1000	54%	79%
1200	12%	3%
1500	10%	3%
2000	17%	8%
3000	7%	6%

Table SP2.2. Comparison two time preference measures

	Time consistent	Present biased	Future biased	Total
Patient	6.97%	29.92%	63.11%	100
Medium patience	20.14%	8.60%	71.25%	100
Impatient	82.34%	5.74%	11.92%	100

Table SP2.3. Gologit and logit for children obesity status and caregiver's patience level, and time-consistency. By age group, and by sex.

	GOLOGIT										Logit				
	Girls		Boys		2-7 years		8-12 years		13-17 years		Girls	Boys	2-7 years	8-12 years	13-17 years
Odds Ratio (Normal weight as reference)	Overweight and obesity	Obesity	Overweight and obesity	Obesity	Overweight and obesity	Obesity	Overweight and obesity	Obesity	Overweight and obesity	Obesity	Overweight and obesity	Overweight and obesity	Overweight and obesity	Overweight and obesity	
Caregiver's patience (reference: patient)															
Medium patience	1.23	1.23	1.64	0.48	0.94	1.44	1.37	1.37	1.23	0.74	1.23	1.6	0.89	1.53	1.28
	[0.78 - 1.95]	[0.78 - 1.95]	[0.73 - 3.70]	[0.19 - 1.21]	[0.54 - 1.61]	[0.91 - 2.27]	[0.97 - 1.94]	[0.97 - 1.94]	[0.78 - 1.94]	[0.39 - 1.40]	[0.76 - 1.98]	[0.74 - 3.45]	[0.53 - 1.51]	[0.96 - 2.44]	[0.82 - 1.98]
Impatient	0.9	0.9	1.43	1.02	1.24	2.99*	1.15	1.15	1.31*	1.31*	0.91	1.42	1.13	1.11	1.33*
	[0.58 - 1.40]	[0.58 - 1.40]	[0.84 - 2.41]	[0.64 - 1.62]	[0.92 - 1.68]	[2.12 - 4.22]	[0.69 - 1.91]	[0.69 - 1.91]	[1.05 - 1.63]	[1.05 - 1.63]	[0.59 - 1.39]	[0.87 - 2.33]	[0.83 - 1.55]	[0.64 - 1.94]	[1.04 - 1.71]
Caregiver's time consistency (Reference: Time consistent)															
Present bias	1.1	1.1	1.81	1.81	3.02*	9.08*	1.92*	2.94*	1.57	2.19*	1.09	1.78	2.55*	1.88*	1.50
	[0.60 - 2.04]	[0.60 - 2.04]	[1.00 - 3.27]	[1.00 - 3.27]	[1.43 - 6.36]	[5.81 - 14.21]	[1.19 - 3.10]	[1.33 - 6.50]	[0.96 - 2.55]	[1.29 - 3.70]	[0.59 - 2.01]	[0.96 - 3.32]	[1.15 - 5.63]	[1.11 - 3.18]	[0.95 - 2.36]
Future bias	1.05	1.05	1.75*	1.75*	1.51	3.84*	1.25	1.25	1.65*	1.65*	1.07	1.78*	1.4	1.19	1.57*
	[0.72 - 1.55]	[0.72 - 1.55]	[1.52 - 2.02]	[1.52 - 2.02]	[0.91 - 2.50]	[3.02 - 4.87]	[0.84 - 1.86]	[0.84 - 1.86]	[1.23 - 2.23]	[1.23 - 2.23]	[0.71 - 1.63]	[1.60 - 1.99]	[0.81 - 2.39]	[0.79 - 1.81]	[1.20 - 2.05]
Caregiver's obesity status (Reference: Normal weight)															
Overweight	2.08*	1.18	1.67*	1.67*	1.87*	1.87*	2.46*	2.46*	1.68*	1.68*	2.09*	1.71*	1.85*	2.48*	1.73*
	[1.36 - 3.20]	[0.65 - 2.13]	[1.33 - 2.09]	[1.33 - 2.09]	[1.56 - 2.24]	[1.56 - 2.24]	[1.77 - 3.42]	[1.77 - 3.42]	[1.34 - 2.11]	[1.34 - 2.11]	[1.35 - 3.23]	[1.43 - 2.06]	[1.54 - 2.22]	[1.68 - 3.67]	[1.39 - 2.16]
Obesity	3.39*	3.39*	3.12*	3.12*	3.58*	3.58*	4.18*	7.43*	2.76*	2.76*	3.36*	3.17*	3.27*	4.23*	2.83*
	[2.17 - 5.28]	[2.17 - 5.28]	[2.29 - 4.23]	[2.29 - 4.23]	[2.80 - 4.59]	[2.80 - 4.59]	[3.05 - 5.74]	[4.86 - 11.34]	[2.12 - 3.58]	[2.12 - 3.58]	[2.20 - 5.14]	[2.40 - 4.18]	[2.74 - 3.90]	[2.95 - 6.08]	[2.16 - 3.72]
Caregiver's age group															

(reference 18-39)															
40 and older	1.25	1.25	0.85	0.85	0.87	0.87	0.98	1.27*	0.85	0.85	1.25	0.81	0.82	0.96	0.84
	[0.78 - 2.00]	[0.78 - 2.00]	[0.62 - 1.17]	[0.62 - 1.17]	[0.64 - 1.17]	[0.64 - 1.17]	[0.76 - 1.27]	[1.04 - 1.56]	[0.68 - 1.05]	[0.68 - 1.05]	[0.80 - 1.96]	[0.61 - 1.08]	[0.64 - 1.04]	[0.75 - 1.22]	[0.65 - 1.09]
Caregiver's marital status (Reference: Married)															
Single	0.78	0.78	0.51	0.51	0.46*	0.46*	0.49*	0.49*	0.62	0.62	0.8	0.5	0.43*	0.47*	0.58
	[0.37 - 1.64]	[0.37 - 1.64]	[0.20 - 1.29]	[0.20 - 1.29]	[0.24 - 0.90]	[0.24 - 0.90]	[0.27 - 0.89]	[0.27 - 0.89]	[0.21 - 1.87]	[0.21 - 1.87]	[0.37 - 1.76]	[0.21 - 1.23]	[0.25 - 0.74]	[0.25 - 0.88]	[0.21 - 1.62]
Caregiver's schooling level (Reference: Less than high school)															
High School & more	1.01	1.01	1.82*	1.82*	0.73	0.54	0.89	0.89	1.51	1.51	1.03	1.95*	0.72	0.89	1.62
	[0.65 - 1.57]	[0.65 - 1.57]	[1.32 - 2.51]	[1.32 - 2.51]	[0.37 - 1.43]	[0.28 - 1.05]	[0.59 - 1.33]	[0.59 - 1.33]	[0.97 - 2.34]	[0.97 - 2.34]	[0.67 - 1.58]	[1.20 - 3.18]	[0.38 - 1.36]	[0.64 - 1.25]	[0.94 - 2.77]
Household socioeconomic status (reference: Low)															
Medium	0.94	0.94	0.8	0.8	2.07*	4.04*	0.76	0.76	1.1	1.50*	0.94	0.70*	2.04*	0.73*	1.07
	[0.60 - 1.47]	[0.60 - 1.47]	[0.58 - 1.10]	[0.58 - 1.10]	[1.21 - 3.54]	[2.57 - 6.35]	[0.58 - 1.01]	[0.58 - 1.01]	[0.87 - 1.38]	[1.08 - 2.07]	[0.58 - 1.52]	[0.50 - 1.00]	[1.21 - 3.44]	[0.53 - 1.00]	[0.85 - 1.34]
High	1.35	1.35	0.95	0.95	2.54*	5.62*	1.3	1.3	1.08	1.77*	1.27	0.82	2.40*	1.22	1.04
	[0.82 - 2.21]	[0.82 - 2.21]	[0.56 - 1.61]	[0.56 - 1.61]	[1.29 - 5.00]	[3.70 - 8.52]	[0.86 - 1.96]	[0.86 - 1.96]	[0.75 - 1.55]	[1.21 - 2.59]	[0.74 - 2.17]	[0.44 - 1.53]	[1.20 - 4.80]	[0.79 - 1.88]	[0.69 - 1.56]
Household location: Urban/rural (reference: Rural)															
Urban	1.57*	1.57*	1.22*	1.22*	1.1	0.66*	1.27*	1.27*	1.40*	1.16	1.58*	1.29*	1.14	1.34*	1.42*
	[1.21 - 2.04]	[1.21 - 2.04]	[1.00 - 1.48]	[1.00 - 1.48]	[0.86 - 1.40]	[0.47 - 0.93]	[1.08 - 1.50]	[1.08 - 1.50]	[1.15 - 1.69]	[0.96 - 1.41]	[1.20 - 2.08]	[1.08 - 1.53]	[0.91 - 1.43]	[1.15 - 1.56]	[1.20 - 1.68]
Age group (reference: 2-7 years old)															
8-12 years old	3.33*	3.33*	3.17*	3.17*							3.59*	3.16*			

	[2.67 - 4.16]	[2.67 - 4.16]	[2.62 - 3.84]	[2.62 - 3.84]							[2.70 - 4.77]	[2.56 - 3.89]			
13-17 years old	3.06*	3.06*	2.27*	2.27*							3.17*	2.39*			
	[2.25 - 4.16]	[2.25 - 4.16]	[1.38 - 3.74]	[1.38 - 3.74]							[2.25 - 4.45]	[1.52 - 3.76]			
Sex															
Reference: female															
Male					1.65*	1.65*	1.19	1.80*	1.02	1.02			1.66*	1.2	1.07
					[1.33 - 2.05]	[1.33 - 2.05]	[0.87 - 1.62]	[1.40 - 2.32]	[0.65 - 1.60]	[0.65 - 1.60]			[1.32 - 2.09]	[0.86 - 1.67]	[0.67 - 1.71]
Child's physical activity															
(hours per week)	0.99*	0.99*	0.98*	0.98*	0.96*	0.96*	0.98*	0.98*	0.99*	0.99*	0.98*	0.98*	0.96*	0.98*	0.99*
	[0.98 - 0.99]	[0.98 - 0.99]	[0.98 - 0.99]	[0.98 - 0.99]	[0.94 - 0.99]	[0.94 - 0.99]	[0.97 - 0.99]	[0.97 - 0.99]	[0.98 - 1.00]	[0.98 - 1.00]	[0.97 - 1.00]	[0.98 - 0.99]	[0.93 - 0.99]	[0.96 - 0.99]	[0.98 - 1.00]
Child's Screen time															
(hours per week)	1.02*	1.02*	1.01	1.01	1.03*	1.03*	1.03*	1.03*	1	1	1.02*	1.01	1.04*	1.03*	1
	[1.00 - 1.04]	[1.00 - 1.04]	[0.99 - 1.03]	[0.99 - 1.03]	[1.03 - 1.04]	[1.03 - 1.04]	[1.02 - 1.04]	[1.02 - 1.04]	[0.99 - 1.02]	[0.99 - 1.02]	[1.00 - 1.04]	[0.99 - 1.03]	[1.03 - 1.04]	[1.02 - 1.04]	[0.99 - 1.02]
Constant	0.05*	0.02*	0.21*	0.08*	0.10*	0.01*	0.05*	0.01*	0.08*	0.02*	0.05*	0.23*	0.11*	0.05*	0.07*
	[0.03 - 0.08]	[0.01 - 0.03]	[0.15 - 0.30]	[0.05 - 0.13]	[0.05 - 0.19]	[0.00 - 0.01]	[0.03 - 0.09]	[0.00 - 0.02]	[0.06 - 0.11]	[0.02 - 0.03]	[0.03 - 0.08]	[0.15 - 0.35]	[0.06 - 0.23]	[0.02 - 0.10]	[0.05 - 0.11]
Observations	4476		4626		3496		2,699		2907		4476	4626	3496	2,699	2907
	[6,486,408]		[6,912,935]		[4,844,922]		[4,350,232]		[4,022,960]		[6,486,408]	[6,912,935]	[4,844,922]	[4,350,232]	[4,022 ,960]

Table SP2.4. Mlogit for children obesity status and caregiver's patience level, and time-consistency. Using BMI as continuous variable

Odds Ratio (Normal weight as reference)	Overweight	Obesity	Overweight	Obesity
Caregiver's patience (reference: patient)				
Medium patience	1.72**	0.98	1.70**	0.98
	[1.18 - 2.50]	[0.56 - 1.73]	[1.18 - 2.46]	[0.56 - 1.73]

Impatient	1.16 [0.78 - 1.72]	1.27* [1.02 - 1.58]	1.14 [0.78 - 1.65]	1.26* [1.02 - 1.55]
Caregiver's time consistency				
(Reference: Time consistent)				
Present bias	1.05 [0.69 - 1.59]	2.37** [1.51 - 3.73]	1.04 [0.70 - 1.55]	2.36** [1.48 - 3.78]
Future bias	1.18 [0.81 - 1.70]	1.44* [1.00 - 2.07]	1.18 [0.83 - 1.68]	1.44+ [0.99 - 2.09]
Caregiver's obesity status				
First degree	1.31** [1.14 - 1.51]	1.23* [1.04 - 1.44]	1.07** [1.05 - 1.09]	1.12** [1.09 - 1.15]
Second degree	1.00** [0.99 - 1.00]	1 [1.00 - 1.00]		
Caregiver's age group				
(reference 18-39)				
40 and older	0.77 [0.55 - 1.07]	0.96 [0.77 - 1.20]	0.78 [0.58 - 1.07]	0.97 [0.77 - 1.22]
Caregiver's marital status				
(Reference: Married)				
Single	0.60+ [0.35 - 1.01]	0.46 [0.17 - 1.24]	0.60+ [0.36 - 1.02]	0.46 [0.17 - 1.25]
Caregiver's schooling level				
(Reference: Less than high school)				
High School & more	1.28 [0.85 - 1.92]	1.19** [1.07 - 1.33]	1.29 [0.85 - 1.96]	1.19** [1.06 - 1.34]
Household socioeconomic status				
(reference: Low)				
Medium	0.70** [0.57 - 0.87]	0.98 [0.66 - 1.46]	0.70** [0.56 - 0.86]	0.97 [0.65 - 1.46]
High	0.76 [0.51 - 1.13]	1.48 [0.88 - 2.47]	0.76 [0.51 - 1.13]	1.48 [0.89 - 2.47]

Household location: Urban/rural (Reference: Rural)				
Urban	1.47**	1.33**	1.46**	1.33**
	[1.28 - 1.68]	[1.09 - 1.63]	[1.28 - 1.68]	[1.09 - 1.63]
Child's age group (reference: 2-7)				
08-dic	2.91**	3.28**	2.93**	3.29**
	[2.22 - 3.81]	[2.30 - 4.67]	[2.22 - 3.86]	[2.31 - 4.69]
13-17	2.52**	2.39**	2.53**	2.41**
	[1.65 - 3.86]	[1.43 - 4.02]	[1.65 - 3.86]	[1.44 - 4.03]
Child's sex (reference: Female)				
Male	1.04	1.62**	1.02	1.61*
	[0.85 - 1.26]	[1.14 - 2.30]	[0.84 - 1.24]	[1.13 - 2.29]
Child's physical activity (hours per week)	0.99**	0.98**	0.99**	0.98**
	[0.98 - 0.99]	[0.98 - 0.99]	[0.98 - 0.99]	[0.98 - 0.99]
Child's Screen time (hours per week)	1.02**	1.02**	1.02**	1.02**
	[1.01 - 1.03]	[1.01 - 1.03]	[1.01 - 1.02]	[1.01 - 1.03]
Constant	0.00**	0.00**	0.01**	0.00**
	[0.00 - 0.00]	[0.00 - 0.00]	[0.01 - 0.03]	[0.00 - 0.00]
Observations				
Expanded to				