











Nutrition status of children in Latin America

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Summary

The prevalence of overweight and obesity is rapidly increasing among Latin American children, posing challenges for current healthcare systems and increasing the risk for a wide range of diseases. To understand the factors contributing to childhood obesity in Latin America, this paper reviews the current nutrition status and physical activity situation, the disparities between and within countries and the potential challenges for ensuring adequate nutrition and physical activity. Across the region, children face a dual burden of undernutrition and excess weight. While efforts to address undernutrition have made marked improvements, childhood obesity is on the rise as a result of diets that favour energy-dense, nutrient-poor foods and the adoption of a sedentary lifestyle. Over the last decade, changes in socioeconomic conditions, urbanization, retail foods and public transportation have all contributed to childhood obesity in the region. Additional research and research capacity are needed to address this growing epidemic, particularly with respect to designing, implementing and evaluating the impact of evidence-based obesity prevention interventions.

Keywords: childhood obesity, children, Latin America, nutrition and physical activity situation.

Introduction

Currently, more than 20% (approximately 42.5 million) of Latin American children aged 0 to 19 years are overweight or obese (1). Without substantial changes, this rate will only continue to rise unabated. Along with the growth in overweight and obesity comes an increase in concomitant non-communicable diseases such as diabetes, cardiovascular disease and some forms of cancer (2). As a result, the disabilities and mortality associated with non-

communicable diseases will start to occur earlier in adulthood (3).

This epidemic is the result of a number of socioeconomic, cultural and demographic changes that have occurred in Latin America in the last decades. Improvements in socioeconomic conditions, increases in women's employment (4), rapid urbanization (5), the proliferation of the food retail and food services sector and increasing use of private transportation have interacted in complex ways to influence diet and physical activity patterns and

ultimately the nutrition status of children in the region. The aim of the present article is to describe the current nutrition, dietary and physical activity status of children in the region considering disparities within and between countries and barriers and facilitators that may impact present and future efforts to ensure adequate nutrition and prevent childhood overweight and obesity. This is the first of a series of papers derived from the NIH sponsored workshop: 'Preventing Childhood Overweight and Obesity in Latin America: Linking Evidence to Policy and Practice'.

Nutrition status of children in the Latin American region

The current nutrition situation of the region reflects the fact that most of the recent economic, cultural and demographic changes (6,7) have not impacted the population equally, resulting in a scenario where undernutrition (primarily stunting) exists alongside overweight and obesity, with micronutrient malnutrition across both conditions. In Latin America, stunting (height-for-age below -2 standard deviation [SD]) is the most common nutritional deficit in children aged 0–59 months (8), although it varies widely between countries with a prevalence as high as 48% in Guatemala and as low as 1.8% in Chile. At the same time,

overweight (weight-for-height over $+2$ SD) is also widespread among children under 5 years old, particularly in the Southern Cone and in Mexico (Table 1) (1,9). For older children, there is less systematic evidence, but available reports and articles mainly in adolescent girls suggest that the prevalence of overweight and obesity exceed 25% of the population in some countries (1,10,11) (Table 1). The coexistence of high prevalence of stunting and high prevalence of overweight at the national level also increases the likelihood of observing double burden at the household level, such as stunted children with overweight/obese mother (Table 2) (8). Moreover, both conditions can be present at the individual level; stunted and overweight children are observed although at low levels (Table 2) (11,12).

Within countries, nutritional disparities vary with ethnicity, the degree of urbanization (13,14) and socioeconomic status (Table 3) (15,16). Nearly 13% of the entire Latin American population and approximately 40% of the rural population are indigenous (17). However, the impact of ethnicity in the growing obesity epidemic has not been well characterized. Studies have reported differences in nutritional studies by ethnicity in Guatemala (18), Chile (19,20) and Mexico (21), among other Latin American countries, but the direction and

Table 1 Prevalence of stunting and overweight in children in Latin America (1)

Country	Children <5 years			Children >5 years			
	Year	Stunting (%)	Overweight (%)	Year	Stunting (%)	Year	Overweight (%)
Argentina	2005	8.2	9.9	–	–	–	–
Barbados	2012	7.7	12.2	–	–	–	–
Belize	2006	22.2	13.7	–	–	–	–
Bolivia	2008	27.2	8.7	2003	24.7	–	–
Brazil	2007	7.1	7.3	–	–	2008–09	20.5
Chile	2014	1.8	9.3	–	–	2005	31.0
Colombia	2010	12.7	4.8	2005	11.2	2010	16.7
Costa Rica	2008	5.6	8.1	–	–	–	–
Cuba	2000	7.0	–	–	–	–	–
Dominican Republic	2013	7.1	7.6	–	–	–	–
Ecuador	2012	25.2	7.5	2012	19.1	2012	26.0
El Salvador	2014	14.0	6.0	2003	28.7	–	–
Guatemala	2009	48.0	4.9	–	–	–	–
Guyana	2014	12.0	5.3	–	–	–	–
Haiti	2012	21.9	3.6	2005	6.5	–	–
Honduras	2012	22.7	5.2	2005	25.0	–	–
Jamaica	2012	5.7	7.8	–	–	–	–
Mexico	2012	13.6	9.0	–	–	2012	43.9
Nicaragua	2006	23.0	6.2	2001	19.7	–	–
Panama	2008	19.1	–	–	–	–	–
Paraguay	2012	10.9	11.7	–	–	–	–
Peru	2013	18.4	7.2	2004–2008	32.1	–	–
Suriname	2010	8.8	4.0	–	–	–	–
Trinidad and Tobago	2000	5.3	4.9	–	–	–	–
Uruguay	2011	10.7	7.2	–	–	–	–

Stunting: height-for-age z score <2 , WHO 2007.

Overweight: weight-for-height z score >2 , WHO 2007.

Table 2 Prevalence of dual burden of malnutrition in the Latin America region (8)

Country	Year	Household level (Stunted child <5 years ¹ and mother excess weight ²) Prevalence of double burden (%)	Individual level children prevalence of double burden (%)		
			Age range (years)	Type of double burden	Prevalence of double burden (%)
Brazil	2006–07	2.7	5–11	Overweight ³	1.0
Colombia	2010	5.1	5–12	Overweight ⁴	0.1
Ecuador	2012	13.1	5–11	Overweight ⁴	2.8
Guatemala	2008	20.0 (overall) 28.2 (indigenous)	<5	Overweight ⁵	1.2 (overall) 2.8 (indigenous)
México	2012	8.4	5–11	Overweight ³	1.0
Uruguay	2004	6.3	6	Overweight ⁴	1.9

¹Height-for-age z score <2.

²Body mass index ≥ 25 kg/m².

³Body mass index-for-age >1 z scores.

⁴Body mass index-for-age >2 z scores.

⁵Weight-for-height >2 z scores.

magnitude of the associations vary across studies. Urban–rural differences on overweight and obesity prevalence have also been described using representative data of children under 5 years of age (Table 3). The data show that in some countries in the region, such as Honduras and Peru, urban areas experience a higher prevalence of overweight and obesity compared with rural areas; similar results have been described for girls 10–19 years old (10). However, in other countries, such as Bolivia and Nicaragua, the opposite is true; with boys from rural areas having the highest prevalence rates. The prevalence of overweight and obesity also differs by maternal education. In most countries, preschool children with mothers with higher education have higher prevalence of overweight and obesity (Table 3); however, there are recent reports that suggest a shift to the poor at least in adults from low-middle income countries with higher economic growth (15,22,23). Overall, these results highlight the complexity and the diversity of each country's local context and thus, the need of better understanding these realities when defining evidence-based interventions to improve nutrition in the region (24,25).

The nutrition transition

Dietary changes

One of the main drivers of the current obesity epidemic among children in Latin America is the rapid dietary change over the last few decades, commonly referred to as the nutrition transition (26). Information on children's dietary changes is limited; however, based on the relationship between parent and child food consumption habits, we are able to extrapolate from adult data findings (27). Across Latin America, intake of energy, fat and protein has increased substantially over the last few decades (28–31).

For example, in Guatemala, Chile, Mexico and Brazil, the consumption of animal products and sugar-sweetened beverages (SSB) has increased, while the intake of nutrient-rich vegetables and legumes has decreased. The result of these changes is a diet high in fat and sugar but low in micronutrients like vitamin A and zinc, which is associated with increased risk for infection and compromised immune system (32).

Without substantial intervention, sales of SSB and processed foods are only expected to continue rising across most countries in the region (Figs. 1 and 2) (33,34). Three of the world's top five SSB consuming nations are in Latin America, and the region as a whole is experiencing increasing levels of SSB intake (34). SSB have been linked to increased childhood obesity risk (35–37). Recent data from Mexico show that for children aged 1 to 19 years, SSB represent 17.5% of their total daily energy intake; an increase of at least 45.3 Kcal per day, which is equivalent to an excess 2.5 pounds per month, between 1999 and 2012 (38–40). Similarly, sales of energy-dense, nutrient-poor foods such as snacks, SSB and frozen ready-to-heat foods have steadily increased since 1998 in many countries in the region (41). In Brazil, these foods have become an increasingly important part of the food expenditure (42,43) that rose approximately 40% between 1990 and 2010 and now constitute approximately 25% of total calorie intake (41). Similarly, in Chile, increased food expenditure in SSB, ready-to-eat meals and eating outside of the home has increased over the last years (Fig. 2) (43). In Guatemala, a 10 percentage point increase in the share of household expenditures on these food products was associated with an increase in body mass index (BMI) of family members 10 years old and older by 4.25%, suggesting that consumption of these foods is a major risk factor for obesity. Therefore, halting consumption of these foods should be a target for intervention strategies (44).

Table 3 Prevalence of overweight¹ among children age 0–5 years according to gender and by urbanicity and by socioeconomic status

	Bolivia (2008)		Colombia (2010)		Dominican Republic (2013)		Honduras (2011)		Nicaragua (2001)		Peru (2012)	
	Boys (n = 3939)	Girls (n = 3939)	Boys (n = 8119)	Girls (n = 7,693)	Boys (n = 1621)	Girls (n = 1554)	Boys (n = 5152)	Girls (n = 4774)	Boys (n = 3009)	Girls (n = 2902)	Boys (n = 4637)	Girls (n = 4527)
Overall, % (n) ²	12.4 (472)	10.2 (371)	5.7 (457)	4.9 (355)	9.5 (142)	8.1 (118)	6.1 (298)	5.3 (235)	9.5 (315)	7.4 (239)	9.5 (253)	7.0 (253)
Rural, % (n)	13.4 (250)	10.8 (189)	5.2 (152)	4.2 (121)	9.2 (39)	7.7 (32)	5.2 (176)	4.1 (103)	10.4 (184)	7.8 (144)	6.2 (116)	4.0 (65)
Urban, % (n)	11.4 (222)	9.6 (182)	5.9 (305)	5.1 (234)	9.6 (103)	8.2 (86)	7.1 (122)	6.8 (132)	8.2 (131)	7.1 (95)	11.2 (270)	8.6 (188)
Maternal education												
Less than primary school, % (n)	13.2 (32)	7.1 (15)	3.0 (7)	3.5 (7)	14.4 (3)	1.2 (1)	3.9 (14)	3.8 (12)	10.7 (85)	7.0 (58)	5.9 (7)	2.9 (6)
Primary school, % (n)	13.1 (258)	10.0 (204)	3.9 (105)	3.6 (80)	8.7 (35)	5.2 (24)	5.3 (163)	4.2 (121)	8.7 (127)	7.6 (107)	7.2 (99)	4.3 (47)
Secondary school, % (n)	11.0 (117)	10.8 (104)	6.2 (258)	5.3 (204)	8.82 (58)	8.2 (47)	6.6 (98)	6.7 (81)	8.7 (79)	7.5 (60)	7.8 (155)	8.3 (131)
Higher than secondary school complete, % (n)	11.8 (65)	11.4 (48)	7.0 (87)	5.6 (64)	11.2 (46)	11.9 (46)	14.9 (23)	12.0 (21)	14.8 (24)	7.4 (14)	16.2 (125)	8.2 (69)

¹Percentage of children overweight for their age (above +2 SD of weight for height according to the WHO standard).²Proportion of excess weight is estimated using sampling weights; unweighted N is provided in parentheses.

Source: Authors' analysis of Demographic Health Surveys.

Changes in food environment

Dietary changes observed in Latin America are the result of a series of changes in the global, national and local food environments that affect availability, accessibility and affordability of foods, as well as people's food demands through higher exposure to advertisement and marketing (45).

Global food environment

Several studies have examined the association between economic globalization and the types of foods and food outlets available in local environments. Trade liberalizations between the USA and Latin America since the 1990s have increased the ease with which multinational companies can export foods (46,47). Compared to the 30 years prior to the North American Free Trade Agreement, the amount of corn, meats (beef/veal, chicken and pork), soybeans, sugars and snack foods exported from the USA to Mexico has increased importantly (48). Trade liberalization is hypothesized to have played a key role in the expansion of supermarkets throughout Latin America (49). Better understanding of how trade and investment agreements impact diets in the region may result critical for ensuring healthy food environments and improving population's nutrition.

National food environment

Supermarkets tend to provide more packaged, ready-to-eat or ready-to-heat foods manufactured by multinational food corporations as opposed to traditional open-air markets. In-store audits have revealed that the foods occupying most of the space in these stores were cookies, SSB, potato chips and canned foods; these foods also tended to be prominently displayed (50). This change in the retail sales of food has been a major driver in shifting the diets of Latin American populations (51). Between 1990 and 2000, supermarkets in Latin America went from occupying 10–20% of the retail share to 50–60%. In most Latin American countries, multinational supermarkets now comprise 60–80% of the top five chains in each country (49) and their growth continues, particularly with their penetration into villages (52). For example, one group looked at the change in retail and subsistence food environments over 15 years in Maycoba, a rural town in Sonora, Mexico, with approximately 1,100 people, many of whom are of indigenous Pima Indian descent (53). Results found that the number of small grocery stores increased from 6 to 11. Moreover, the presence of multinational fast-food chains has grown exponentially in Latin America. In 1995, the region had 100 McDonald's; by 2014, this had increased to 2,268 (54,55). Fast-food consumption has been linked to higher energy consumption and poorer diet quality in US children and adolescents (56).

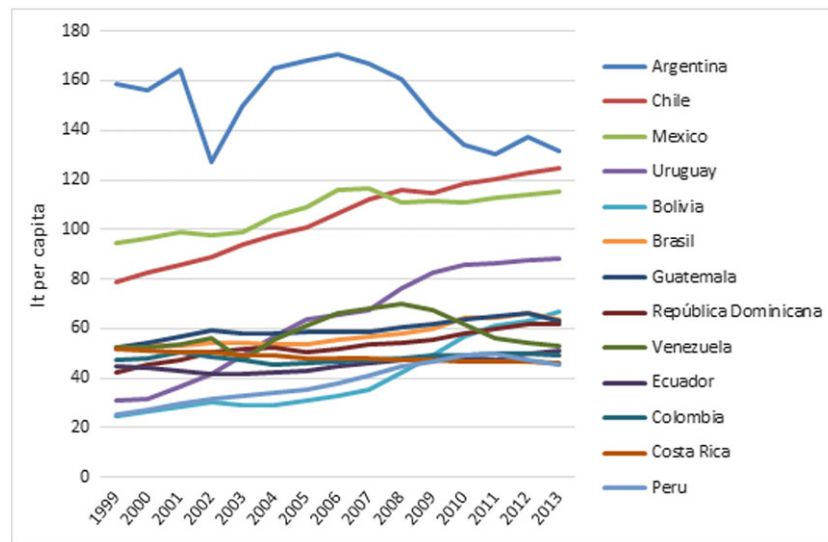


Figure 1 Trends in sales of processed beverages in Latin American countries, Euromonitor 1999–2013. Source: Euromonitor International. [Colour figure can be viewed at wileyonlinelibrary.com]

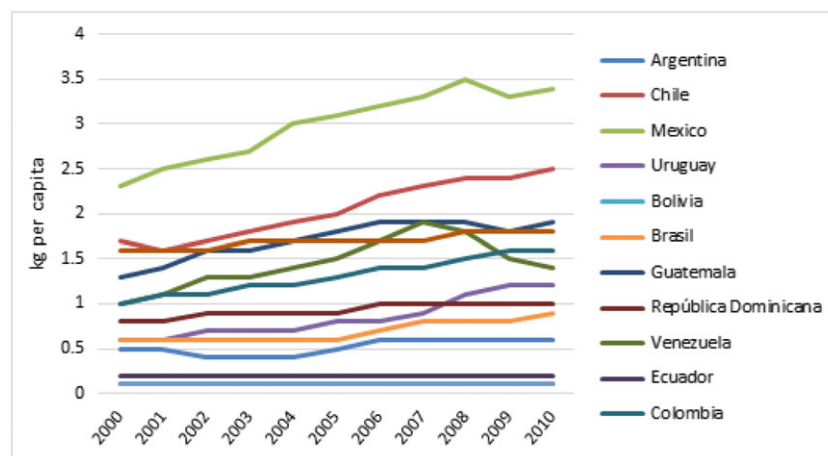


Figure 2 Trends in sales of processed foods in Latin American countries, Euromonitor 2000–2010. Source: Euromonitor International. [Colour figure can be viewed at wileyonlinelibrary.com]

Neighbourhood food environment

It is believed that community food environments influence dietary behaviours (57); however, the exact mechanisms and strength of the associations remain controversial given the difficulty in standardizing study designs, data collection methods and statistical analyses (58). In Guatemala (59), shopping at a supermarket is associated with increased consumption of pastries, chocolates and ice cream and decreased consumption of corn and beans, particularly in poor households (59). These results are in line with studies carried out in the USA (60,61) and other developed countries (62). However, in developing countries, evidence of the net effect of the local food retail environment on people's nutritional status remains controversial (63–65).

In the case of Latin America, developing adequate measurement tools to assess the retail food environment requires the consideration of open-air markets (66) as they are highly prevalent in the region (67).

School food environment

In Brazil, public schools have higher proximity to stores that sell energy-dense, nutrient-poor products than natural foods (68). With some exceptions, studies indicate that higher proximity and density of fast-food and grocery stores to schools are linked to more fast-food purchases (69) and poorer-dietary scores in adolescents (70). However, this finding is not consistent across the research landscape (71,72). In addition, street-food vending is a common

practice in Latin America (73). Recently, a study conducted in 60 schools in two of Mexico's major cities showed that there were on average six mobile food vendors around public schools and that the number of mobile food vendors around schools was positively associated with the children's BMI (74).

There is also strong evidence that the in-school environment shapes diets and therefore, the nutritional status among children (75,76). Recently, a representative sample of Brazilian adolescents showed that availability of energy-dense, nutrient-poor foods, such as SSB and salty snacks inside the schools was associated with higher consumption of these food products (77). In Mexico, it has been also described that the number of stores inside of schools is positively associated with higher BMIs among school children (74).

Food marketing exposure to children

Advertising has been shown to strongly influence consumer choices and likely plays a role in changing diets in Latin America (78–80). It has been previously reported that in Mexico, where approximately 95% of homes have a television, the food group most frequently advertised is SSB (24.6%), followed by chocolate and confectionery sugar (19.7%), cakes, sweet biscuits and pastries (12.0%), savoury snacks (9.3%), breakfast cereals (7.1%), ready-to-eat food (6.4%) and dairy products (6.0%) (81). In addition to television advertising, food companies use the licenced television characters on their packaging to promote their products to children. In Guatemala, a study shows that children prefer the taste of food from packages with a licenced character compared with the same food in packages without the character (82). In several countries, advertising energy-dense, nutrient-poor food products is not only allowed but also highly prevalent in stores within walking distance of schools and kiosks inside schools (83–85).

Physical activity changes

Physical activity levels have decreased worldwide likely because of the adoption of a sedentary lifestyle (86). A number of physical activity factors have contributed to the global epidemic of obesity, namely, (i) reduced walking for transportation as a result of improved access to motorized transportation; (ii) decreased occupational physical activity due to automated processes, leading to more sedentary occupation patterns; and (iii) increased time spent in sedentary leisure activities (45–47,50,86–91). It is difficult to describe children's physical activity status because few countries have established surveillance systems to assess population-level, physical activity using representative samples and consistent measures, and the ones that do are targeted to adults (92,93).

Physical inactivity and sedentary behaviour in Latin America

Given the cost associated with using objective measures like accelerometers and the lack of research in this field in most Latin American countries (94), the prevalence of physical inactivity among children in the region remains not well known. However, findings pertaining to adults and older adolescents indicate that Latin America is the most inactive region in the world with 43% of those over 15 years old categorized as inactive (92). In almost all countries of the region, at least a third of the population over 15 years old is physically inactive except in Guatemala (16.2%) and Dominica (24.4%) (92). Recently, the Active Healthy Kids Canada Report Card on Physical Activity for Children and Youth was replicated in 14 countries, including Colombia and Mexico (95). In Mexico, it was reported that 41% of children and young adolescents 10 to 14 years old participated in at least one organized sport during the previous year and 66% walked to school (96). In Colombia, only 6.1% of preschool and school-aged children, 3 to 12 years old, received physical education classes from a professional instructor (97). Television viewing has been commonly used as a proxy measure for sedentary behaviour among children (98). Studies in Latin America suggest that the mean television watching time is 3 to 4 h per day, with the majority of children in the region spending more than 2 h per day in front of the television. In almost all countries, there is a significant association between television viewing time and childhood obesity (99–101).

Changes in physical activity environment

National physical activity environment

Latin America is the most urbanized region in the world with almost 80% of Latin Americans living in urban areas (5). Over the past decades, the region has transitioned from the more generalized use of public transit systems to privately owned motorized vehicles (102). In most Latin American cities, motor vehicle ownership remains low compared with high-income countries (HIC), but this is rapidly changing. Findings from a global, 12-country study report found that the Latin American region has the lowest levels of physical activity as a form of leisure and was among the highest to use physical activity as a form of transport (94). Because activity in the region seems to be necessity-driven vs. choice-driven, increases in motor vehicle ownership among Latin Americans is of concern in terms of its effect on activity levels. Among children, active travel to school is still relatively high in some countries, such as Mexico (103); however, this is changing rapidly as a result of increased motor vehicle ownership and growing safety-related concerns in the region (104).

Additionally, technological trends are influencing physical activity behaviours (91,105–107). Increasingly, new technologies that encourage sedentary leisure, like tablets, smartphones and internet-connected video game systems, are becoming ubiquitous. Latin America has seen a strong increase in technology sales in the last few years (108). However, the widespread availability of these technologies in Latin America also makes them a potential vehicle to deliver interventions to promote physical activity and healthy diets, particularly among adolescents (109). A recent study demonstrated that while one mobile health technology with advice for lifestyle improvements did not reduce blood pressure, it successfully promoted a small reduction of weight and improved some dietary habits in individuals with prehypertension living in low-resource urban settings in Argentina, Peru and Guatemala (110). Although evidence is currently limited, the recent popularity of interactive games that encourage physical activity, like Pokémon Go, could present opportunities to use technology to improve health; although sustaining effects in the long term may be an issue (111).

Neighbourhood physical activity environment

There is significant evidence from HIC linking physical activity with the built and social environments but relatively few studies from Latin America particularly among children (93,94,112). The findings from HIC suggest that the relationship between physical activity and the built environment may be context specific. For instance, evidence from these countries shows positive associations between mixed land-use, residential density and street connectivity (i.e. US-based walkability index), and physical activity (113). Yet in Latin America and other low- and middle-income countries, findings have been inconclusive (94,114,115). Studies from Brazil, Colombia, and Mexico, have identified key environmental constructs that relate to activity levels among Latin Americans, such as aesthetics, public spaces for activity, social cohesion and safety (116,117). Some very successful and innovative programmes to promote physical activity have emerged from Latin America, such as *Ciclovias*, the open-street programmes, in Colombia (118) and *Academia da Saude*, a national programme that offers physical activity classes, nutrition counselling, among other activities (119). These programmes have been extensively evaluated, and findings show that they have a positive impact on the activity levels of children, adults and seniors (118,120–123).

School physical activity environment

Evidence of the impact of school environment on physical activity levels is also scarce in Latin America and other low- and middle-income countries. However, from evidence of the USA, we know that most of vigorous physical activity as well as sedentary behaviours are concentrated in the

school environment (124,125). The ease of walking and biking on a campus has been related to US college students' walking behaviour and BMI (126); Higher vigorous physical activity in the schools is associated with higher daily vigorous activity suggesting that increasing school-based physical activity could be an effective intervention for increasing overall physical activity in youth (127). A recent systematic review has shown that school-based interventions that are based on mandatory physical activity are the ones more likely to increase moderate to vigorous physical activity in youth (i.e. 23 min per day that corresponds to almost 40% of the WHO physical activity recommendation for this age group), although other less intensive actions also result in significant increases of moderate to vigorous physical activity: classroom activity breaks (19 min); afterschool activity programmes (10 min); standardized physical education curricula (6 min more than traditional physical education); modified playgrounds (6 min); and modified recess (5 min more than traditional recess) (128). A review that included information of five school-based physical education programmes from Latin America (Brazil, Chile and US/Mexico border) shows that different types of interventions have the potential of increasing physical activity levels during physical activity classes and active transportation to schools (129).

Challenges of addressing the childhood obesity epidemic

Paediatric healthcare systems are stressed by this new nutritional scenario, where overweight as well as its associated consequences are increasingly observed at progressively younger ages (130). Healthcare systems – from both the human and infrastructure perspectives – need to rapidly adapt to prevent, identify and treat new conditions associated with overweight and obesity (131) forcing already frail public health structures to respond to complicated childhood health concerns. Existing monitoring systems, traditionally focused on monitoring weight as a way of tracking underweight (weight-for-age below -2 SD), must adapt to incorporate length and height measurements if excess weight is to be adequately monitored. Failure to incorporate length to monitoring systems may result in unintentionally missing the increasing rates of overweight, which is a measure of weight-for-height (132).

In Latin America, social programmes, such as food and nutrition and cash transfer programmes, have played an important role in addressing poverty and decreasing undernutrition; however, there is a concern that these programmes may need to be adapted to avoid inadvertently contributing to an increase in the risk of becoming overweight (133–135). The presence of the dual burden of nutrition requires designing policies and programmes to

address nutrition status at both ends of the spectrum – from undernutrition to overweight – at the individual, household and societal levels (24,136). Presently, in some countries, there are efforts to address the growing obesity epidemic by modifying social and nutrition programmes or improving public school environments in general (137,138). However, in other countries such as Guatemala and Peru, social programmes are still mainly oriented to fighting undernutrition (138,139).

Culturally appropriated, local evidence that considers the particularities of the food and physical activity environment of the region is needed to define effective preventive actions to address the growing obesity epidemic. Unique subpopulation consideration must also be included, especially in Latin America, where nearly 13% of the entire Latin American population is indigenous, a population with known nutritional differences (15–17,19,20). Presently, several large-scale actions such as the taxation of SSB, use of front-of-package warning messages, marketing regulations and so on are taking place in the region (118,140–144); however, rigorous evaluations are needed to assess their impact and guide adjustments or additions to maximize their effectiveness.

Conclusion

In Latin America, there is a coexistence of undernutrition and overweight among children that importantly differ between and within countries. Rapid urbanization combined with greater penetration of the retail food and food service sector has promoted diets that rely on energy-dense, nutrient-poor foods. At the same time, sedentary behaviours have become the norm among children. If no action is taken, the rates of overweight and obese children will continue to rise. As explored in subsequent articles in this supplement, a new research agenda accompanied by strengthened translation of the research into policy and practice and increased research capacity are needed in the region to confront this growing epidemic.

Conflict of interest statement

The Fogarty International Center at the US National Institutes of Health sponsored travel for each, non-local author to attend the ‘Preventing Childhood Overweight and Obesity in Latin America: Linking Evidence to Policy and Practice’ workshop, the precursor for this article. The following authors declare a further conflict of interest as specified in their ICMJE disclosure: Camila Corvalán, Chessa K Lutter, Barry M. Popkin, Manuel Ramirez-Zea, Deborah Salvo and Aryeh D Stein.

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References

- Rivera JA, de Cossio TG, Pedraza LS, Aburto TC, Sanchez TG, Martorell R. Childhood and adolescent overweight and obesity in Latin America: a systematic review. *Lancet Diabetes Endocrinol* 2014; 2(4): 321–332.
- Nishida C, Uauy R, Kumanyika S, Shetty P. The joint WHO/FAO expert consultation on diet, nutrition and the prevention of chronic diseases: process, product and policy implications. *Public Health Nutr* 2004; 7(1A): 245–250.
- Lobstein T, Baur L, Uauy R, TaskForce IIO. Obesity in children and young people: a crisis in public health. *Obes Rev* 2004; 5(Suppl 1): 4–104.
- United Nations, Economic Commission for Latin America and the Caribbean (ECLAC). Economic and Social Panorama of the Community of Latin American and Caribbean States, 2014. Santiago, Chile; 2015.
- United Nations. World urbanization prospects: the 2011 revision, data tables and highlights. New York; 2013.
- Saad P. Demographic trends in Latin American and the Caribbean: United Nations, Centro Latino Americano y Caribeño de Demografía; 2009.
- Rivera JA, Barquera S, Gonzalez-Cossio T, Olaiz G, Sepulveda J. Nutrition transition in Mexico and in other Latin American countries. *Nutr Rev* 2004; 62(7 Pt 2): S149–S157.
- Rivera JA, Pedraza LS, Martorell R, Gil A. Introduction to the double burden of undernutrition and excess weight in Latin America. *Am J Clin Nutr* 2014; 100(6): 1613S–1616S.
- UNICEF. UNICEF data: monitoring the situation of children and women. 2014.
- Pan American Health Organization. Underweight, short stature and overweight in adolescents and young women in Latin America and the Caribbean. Washington D.C: Pan American Health Organization.
- Jaacks LM, Slining MM, Popkin BM. Recent trends in the prevalence of under- and overweight among adolescent girls in low- and middle-income countries. *Pediatr Obes* 2015; 10(6): 428–435.
- Sawaya AL, Roberts S. Stunting and future risk of obesity: principal physiological mechanisms. *Cad Saude Publica* 2003; 19 (Suppl 1): S21–S28.
- Neuman M, Kawachi I, Gortmaker S, Subramanian SV. Urban-rural differences in BMI in low- and middle-income countries: the role of socioeconomic status. *Am J Clin Nutr* 2013; 97(2): 428–436.
- Jaacks LM, Slining MM, Popkin BM. Recent underweight and overweight trends by rural–urban residence among women in low- and middle-income countries. *Journal of Nutrition* 2015; 145: 352–357.
- Jones-Smith JC, Gordon-Larsen P, Siddiqi A, Popkin BM. Is the burden of overweight shifting to the poor across the globe? Time trends among women in 39 low- and middle-income countries (1991–2008). *Int J Obes (Lond)* 2012; 36(8): 1114–1120.

16. Jones-Smith JC. Commentary: jumping the gun or asleep at the switch: is there a middle ground? *Int J Epidemiol* 2013; **42**(5): 1435–1437.
17. International Work Group for Indigenous Affairs (IWGIA). Indigenous peoples in Latin America – a general overview. In; 2016.
18. Ramirez-Zea M, Kroker-Lobos MF, Close-Fernandez R, Kanter R. The double burden of malnutrition in indigenous and nonindigenous Guatemalan populations. *Am J Clin Nutr* 2014; **100**(6): 1644S–1651S.
19. Amigo H, Bustos P, Muzzo S, Alarcón AM, Muñoz S. Age of menarche and nutritional status of indigenous and non-indigenous adolescents in the Araucanía Region of Chile. *Ann Hum Biol* 2010; **37**(4): 554–561.
20. Bustos P, Muñoz S, Vargas C, Amigo H. Poverty and indigenous origin as risk factors of nutritional problems among children who enroll in school. *Salud Publica Mex* 2009; **51**(3): 187–193.
21. Stoddard P, Handley MA, Vargas Bustamante A, Schillinger D. The influence of indigenous status and community indigenous composition on obesity and diabetes among Mexican adults. *Soc Sci Med* 2011; **73**(11): 1635–1643.
22. Jones-Smith JC, Gordon-Larsen P, Siddiqi A, Popkin BM. Cross-national comparisons of time trends in overweight inequality by socioeconomic status among women using repeated cross-sectional surveys from 37 developing countries, 1989–2007. *Am J Epidemiol* 2011; **173**(6): 667–675.
23. Quezada AD, Lozada-Tequeanes AL. Time trends and sex differences in associations between socioeconomic status indicators and overweight-obesity in Mexico (2006–2012). *BMC Public Health* 2015; **15**: 1244.
24. Urke HB, Mittelmark MB, Valdivia M. Trends in stunting and overweight in Peruvian pre-schoolers from 1991 to 2011: findings from the Demographic and Health Surveys. *Public Health Nutr* 2014; **17**(11): 2407–2418.
25. Loret de Mola C, Quispe R, Valle GA, Poterico JA. Nutritional transition in children under five years and women of reproductive age: a 15-years trend analysis in Peru. *PLoS One* 2014; **9**(3): e92550.
26. Popkin BM. The nutrition transition in low-income countries: an emerging crisis. *Nutr Rev* 1994; **52**(9): 285–298.
27. Robinson LN, Rollo ME, Watson J, Burrows TL, Collins CE. Relationships between dietary intakes of children and their parents: a cross-sectional, secondary analysis of families participating in the Family Diet Quality Study. *J Hum Nutr Diet* 2015; **28**(5): 443–451.
28. Grünberger K. Estimating food consumption patterns by reconciling food balance sheets and household budget surveys. Rome: Food and Agriculture Organization of the United Nations; 2014.
29. Food and Agriculture Organization of the United Nations. FAOSTAT, retrieved on 19 July 2016. <http://www.fao.org/faostat/en/#data/FBS>
30. Silberman M, Moreno-Altamirano L, Hernández-Montoya D, Capraro S, García-García JJ, Soto-Estrada G. Dietary patterns, overweight and obesity from 1961 to 2011 in the socioeconomic and political context of Argentina. *Int J Food Sci Nutr* 2016; **68**(1): 1–13.
31. Moreno-Altamirano L, Hernández-Montoya D, Silberman M et al. The nutrition transition and the double burden of malnutrition: changes in dietary patterns 1961–2009 in the Mexican socioeconomic context. *Arch Latinoam Nutr* 2014; **64**(4): 231–240.
32. Carvalho CA, Fonsêca PC, Priore SE, Franceschini SC, Novaes JF. Food consumption and nutritional adequacy in Brazilian children: a systematic review. *Rev Paul Pediatr* 2015; **33**(2): 211–221.
33. International E. Soft drinks in Latin America: keeping a global bright spot bright. London: Euromonitor International; 2014.
34. Popkin BM, Hawkes C. Sweetening of the global diet, particularly beverages: patterns, trends, and policy responses. *The Lancet Diabetes & Endocrinology* 2015.
35. de Ruyter JC, Olthof MR, Seidell JC, Katan MB. A trial of sugar-free or sugar-sweetened beverages and body weight in children. *New England Journal of Medicine* 2012; **367**(15): 1397–1406.
36. Ebbeling CB, Feldman HA, Chomitz VR et al. A randomized trial of sugar-sweetened beverages and adolescent body weight. *New England Journal of Medicine* 2012; **367**(15): 1407–1416.
37. Qi Q, Chu AY, Kang JH et al. Sugar-sweetened beverages and genetic risk of obesity. *New England Journal of Medicine* 2012; **367**(15): 1387–1396.
38. Barquera S, Campirano F, Bonvecchio A, Hernandez-Barrera L, Rivera JA, Popkin BM. Caloric beverage consumption patterns in Mexican children. *Nutr, J.* 2010; **9**(47): 1475–2891 Electronic.
39. Barquera S, Hernandez-Barrera L, Tolentino ML et al. Energy intake from beverages is increasing among Mexican adolescents and adults. *J. Nutr.* 2008; **138**(12): 1541–6100 Electronic.
40. Stern D, Piernas C, Barquera S, Rivera JA, Popkin BM. Caloric beverages were major sources of energy among children and adults in Mexico, 1999–2012. *J Nutr* 2014; **144**(6): 949–956.
41. Monteiro CA, Moubarac JC, Cannon G, Ng SW, Popkin B. Ultra-processed products are becoming dominant in the global food system. *Obesity reviews* 2013; **14**(S2): 21–28.
42. Canella DS, Levy RB, Martins AP et al. Ultra-processed food products and obesity in Brazilian households (2008–2009). *PLoS One* 2014; **9**(3): e92752.
43. Crovetto M, Uauy R. Changes in processed food expenditure in the population of Metropolitan Santiago in the last twenty years. *Rev Med Chil* 2012; **140**(3): 305–312.
44. Asfaw A. Does consumption of processed foods explain disparities in the body weight of individuals? The case of Guatemala. *Health Econ.* 2011; **20**(2): 184–195.
45. Swinburn B, Vandevijvere S, Kraak V et al. Monitoring and benchmarking government policies and actions to improve the healthiness of food environments: a proposed Government Healthy Food Environment Policy Index. *Obes Rev* 2013; **14**(Suppl 1): 24–37.
46. Popkin BM. The world is fat – the fads, trends, policies, and products that are fattening the human race. Avery-Penguin Group: New York, 2008.
47. Popkin BM. Technology, transport, globalization and the nutrition transition. *Food Policy* 2006; **31**: 554–569.
48. Clark SE, Hawkes C, Murphy SM, Hansen-Kuhn KA, Wallinga D. Exporting obesity: US farm and trade policy and the transformation of the Mexican consumer food environment. *International journal of occupational and environmental health* 2012; **18**(1): 53–64.
49. Reardon TA, Berdegue JA, Farrington J. Supermarkets and farming in Latin America: pointing directions for elsewhere?: Overseas Development Institute; 2002.
50. Jacoby E. The obesity epidemic in the Americas: making healthy choices the easiest choices. *Rev Panam Salud Publica* 2004; **15**(4): 278–284.
51. Popkin BM. Nutrition, agriculture and the global food system in low and middle income countries. *Food Policy* 2014; **47**: 91–96.
52. Reardon T, Timmer CP. The economics of the food system revolution. *Annual Review of Resource Economics* 2012; **4**(1): 225–264.

53. Chaudhari L, Begay R, Schulz L. Fifteen years of change in the food environment in a rural Mexican community: the Maycoba project. *Rural and remote health* 2013; 13(2404).
54. Kennedy G, Nantel G, Shetty P. Globalization of food systems in developing countries: impact on food security and nutrition. 2004.
55. Statista. Number of McDonald's restaurants in Latin America in 2014, by country. In; 2015.
56. Powell LM, Nguyen BT. Fast-food and full-service restaurant consumption among children and adolescents: effect on energy, beverage, and nutrient intake. *JAMA Pediatr* 2013; 167(1): 14–20.
57. Giskes K, van Lenthe F, Avendano-Pabon M, Brug J. A systematic review of environmental factors and obesogenic dietary intakes among adults: are we getting closer to understanding obesogenic environments? *Obes Rev* 2011; 12(5): e95–e106.
58. Ni Mhurchu C, Vandevijvere S, Waterlander W *et al.* Monitoring the availability of healthy and unhealthy foods and non-alcoholic beverages in community and consumer retail food environments globally. *Obes Rev* 2013; 14(Suppl 1): 108–119.
59. Asfaw A. Does supermarket purchase affect the dietary practices of households? Some empirical evidence from Guatemala. *Development Policy Review* 2008; 26(2): 227–243.
60. Drewnowski A, Rehm CD. Energy intakes of US children and adults by food purchase location and by specific food source. *Nutr J* 2013; 12: 59.
61. Drewnowski A, Rehm CD. Consumption of added sugars among US children and adults by food purchase location and food source. *Am J Clin Nutr* 2014; 100(3): 901–907.
62. Howard Wilsher S, Harrison F, Yamoah F, Fearn A, Jones A. The relationship between unhealthy food sales, socio-economic deprivation and childhood weight status: results of a cross-sectional study in England. *Int J Behav Nutr Phys Act* 2016; 13: 21.
63. Kimenju SC, Rischke R, Klasen S, Qaim M. Do supermarkets contribute to the obesity pandemic in developing countries? *Public Health Nutr* 2015; 18(17): 3224–3233.
64. Motter AF, Vasconcelos FA, Correa EN, Andrade DF. Retail food outlets and the association with overweight/obesity in schoolchildren from Florianópolis, Santa Catarina State, Brazil. *Cad Saude Publica* 2015; 31(3): 620–632.
65. Matozinhos FP, Gomes CS, Andrade AC *et al.* Neighbourhood environments and obesity among adults: a multilevel analysis of an urban Brazilian context. *Prev Med Rep* 2015; 2: 337–341.
66. Duran AC, Lock K, Latorre MR, Jaime PC. Evaluating the use of in-store measures in retail food stores and restaurants in Brazil. *Rev Saude Publica* 2015; 49: 80.
67. Muñoz de Chávez M, Chávez Villasana A, Chávez Muñoz M, Eichen Vuskovic I. Sale of street food in Latin America. The Mexican case: joy or jeopardy? *World Rev Nutr Diet* 2000; 86: 138–154.
68. Leite FH, Oliveira MA, Cremm EC, Abreu DS, Maron LR, Martins PA. Availability of processed foods in the perimeter of public schools in urban areas. *J Pediatr (Rio J)* 2012; 88(4): 328–334.
69. He M, Tucker P, Gilliland J, Irwin JD, Larsen K, Hess P. The influence of local food environments on adolescents' food purchasing behaviors. *Int J Environ Res Public Health* 2012; 9(4): 1458–1471.
70. Van Hulst A, Barnett TA, Gauvin L *et al.* Associations between children's diets and features of their residential and school neighbourhood food environments. *Can J Public Health* 2012; 103(9 Suppl 3): eS48–eS54.
71. Williams J, Scarborough P, Matthews A *et al.* A systematic review of the influence of the retail food environment around schools on obesity-related outcomes. *Obes Rev* 2014; 15(5): 359–374.
72. Tester JM, Yen IH, Laraia B. Mobile food vending and the after-school food environment. *Am J Prev Med* 2010; 38(1): 70–73.
73. Arámbulo P, Almeida CR, Cuéllar J, Belotto AJ. Street food vending in Latin America. *Bull Pan Am Health Organ* 1994; 28(4): 344–354.
74. Barrera LH, Rothenberg SJ, Barquera S, Cifuentes E. The toxic food environment around elementary schools and childhood obesity in Mexican cities. *Am J Prev Med* 2016; 51(2): 264–270.
75. Briefel RR, Crepinsek MK, Cabili C, Wilson A, Gleason PM. School food environments and practices affect dietary behaviors of US public school children. *J Am Diet Assoc* 2009; 109(2 Suppl): S91–107.
76. Fox MK, Dodd AH, Wilson A, Gleason PM. Association between school food environment and practices and body mass index of US public school children. *J Am Diet Assoc* 2009; 109(2 Suppl): S108–S117.
77. Azeredo CM, de Rezende LF, Canella DS *et al.* Food environments in schools and in the immediate vicinity are associated with unhealthy food consumption among Brazilian adolescents. *Prev Med* 2016; 88: 73–79.
78. Organización Panamericana de la Salud. Recomendaciones de la Consulta de Expertos de la Organización Panamericana de la Salud sobre la promoción y publicidad de alimentos y bebidas no alcohólicas dirigida a los niños en la Región de las Américas. Área de Desarrollo Sostenible y Salud Ambiental (SDE). In. Washington; 2011.
79. Mallarino C, Gomez LF, Gonzalez-Zapata L, Cadena Y, Parra DC. Advertising of ultra-processed foods and beverages: children as a vulnerable population. *Revista de Saúde Pública* 2013; 47(5): 1006–1010.
80. Busse P, Díaz R. What are the television viewing and eating habits of children in Peru? *Glob Health Promot* 2016; 23(1): 50–60.
81. Rincón-Gallardo Patiño S, Tolentino-Mayo L, Flores Monterrubio EA, Harris JL, Vandevijvere S, Rivera JA. Nutritional quality of foods and non-alcoholic beverages advertised on Mexican television according to three nutrient profile models. *BMC Public Health* 2016; 16: 733.
82. Letona P, Chacon V, Roberto C, Barnoya J. Effects of licensed characters on children's taste and snack preferences in Guatemala, a low/middle income country. *International Journal of Obesity* 2014; 38(11): 1466–1469.
83. Chacon V, Letona P, Barnoya J. Child-oriented marketing techniques in snack food packages in Guatemala. *BMC Public Health* 2013; 13: 967.
84. Chacon V, Letona P, Villamor E, Barnoya J. Snack food advertising in stores around public schools in Guatemala. *Crit Public Health* 2015; 25(3): 291–298.
85. Lozada M, Sánchez-Castillo CP, Cabrera GA, Mata II, Pichardo-Ontiveros E, Villa AR. School food in Mexican children. *Public Health Nutr* 2008; 11(9): 924–933.
86. Ng SW, Popkin BM. Time use and physical activity: a shift away from movement across the globe. *Obesity Reviews* 2012; 13(8): 659–680.
87. Katzmarzyk PT, Mason C. The physical activity transition. *J Phys Act Health* 2009; 6(3): 269–280.
88. Bell AC, Ge K, Popkin BM. The road to obesity or the path to prevention: motorized transportation and obesity in China. *Obes Res* 2002; 10(4): 277–283.
89. Bell AC, Ge K, Popkin BM. Weight gain and its predictors in Chinese adults. *Int J Obes Relat Metab Disord* 2001; 25(7): 1079–1086.
90. Monda KL, Adair LS, Zhai F, Popkin BM. Longitudinal relationships between occupational and domestic physical activity

- patterns and body weight in China. *Eur J Clin Nutr* 2008; **62**(11): 1318–1325.
91. Monda KL, Gordon-Larsen P, Stevens J, Popkin BM. China's transition: the effect of rapid urbanization on adult occupational physical activity. *Soc Sci Med* 2007; **64**(4): 858–870.
92. Hallal PC, Andersen LB, Bull FC *et al.* Global physical activity levels: surveillance progress, pitfalls, and prospects. *Lancet* 2012; **380**(9838): 247–257.
93. Bauman AE, Reis RS, Sallis JF *et al.* Correlates of physical activity: why are some people physically active and others not? *Lancet* 2012; **380**(9838): 258–271.
94. Salvo D, Reis RS, Sarmiento OL, Pratt M. Overcoming the challenges of conducting physical activity and built environment research in Latin America: IPEN Latin America. *Prev Med* 2014; **69**(Suppl 1): S86–S92.
95. Tremblay MS, Gray CE, Akinroye K *et al.* Physical activity of children: a global matrix of grades comparing 15 countries. *J Phys Act Health* 2014; **11**(Suppl 1): S113–S125.
96. Rodriguez M, Galaviz K, Jauregui E, Gonzalez-Casanova I, Lopez y Taylor J. Results from Mexico's 2014 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity & Health* 2014; **11**(Suppl 1): S74–S78.
97. González S, Sarmiento O, Cohen D *et al.* Results from Colombia's 2014 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity & Health* 2014; **11**(Suppl 1): S33–S44.
98. Lubans DR, Hesketh K, Cliff DP *et al.* A systematic review of the validity and reliability of sedentary behaviour measures used with children and adolescents. *Obes Rev* 2011; **12**(10): 781–799.
99. Gomez LF, Parra DC, Lobelo F *et al.* Television viewing and its association with overweight in Colombian children: results from the 2005 National Nutrition Survey: a cross sectional study. *Int J Behav Nutr Phys Act* 2007; **4**: 41.
100. Isabela da Costa R, Taddei JA, Colugnatti F. Obesity among children attending elementary public schools in São Paulo, Brazil: a case–control study. *Public Health Nutr* 2003; **6**(7): 659–663.
101. Braithwaite I, Stewart AW, Hancox RJ *et al.* The worldwide association between television viewing and obesity in children and adolescents: cross sectional study. *PLoS One* 2013; **8**(9) e74263.
102. Becerra JM, Reis RS, Frank LD *et al.* Transport and health: a look at three Latin American cities. *Cad Saude Publica* 2013; **29**(4): 654–666.
103. Jauregui A, Medina C, Salvo D, Barquera S, Rivera-Dommarco JA. Active commuting to school in Mexican adolescents: evidence from the Mexican National Nutrition and Health Survey. *J Phys Act Health* 2014.
104. Soares R, Naritomi J. Understanding high crime rates in Latin America: the role of social and policy factors In: Rafael Di Tella SE, and Ernesto Schargrodsky, editors, editor. *The Economics of Crime: Lessons for and from Latin America*; 2010.
105. Pratt M, Sarmiento OL, Montes F *et al.* The implications of megatrends in information and communication technology and transportation for changes in global physical activity. *Lancet* 2012; **380**(9838): 282–293.
106. Ng S, Norton E, Guilkey D, Popkin B. Estimation of a dynamic model of weight. *Empirical Economics* 2012; **42**(2): 413–443.
107. Ng SW, Norton EC, Popkin BM. Why have physical activity levels declined among Chinese adults? Findings from the 1991–2006 China Health and Nutrition Surveys. *Social science & medicine* 2009; **68**(7): 1305–1314.
108. LATINPOST. Latin America tech trends: rise of smartphones, tablets, and internet in the region. 2014.
109. Müller AM, Alley S, Schoeppe S, Vandelanotte C. The effectiveness of e- & mHealth interventions to promote physical activity and healthy diets in developing countries: a systematic review. *Int J Behav Nutr Phys Act* 2016; **13**(1): 109.
110. Rubinstein A, Miranda JJ, Beratarrechea A *et al.* Effectiveness of an mHealth intervention to improve the cardiometabolic profile of people with prehypertension in low-resource urban settings in Latin America: a randomised controlled trial. *Lancet Diabetes Endocrinol* 2016; **4**(1): 52–63.
111. Howe KB, Suharlim C, Ueda P, Howe D, Kawachi I, Rimm EB. Gotta catch'em all! Pokemon GO and physical activity among young adults: difference in differences study. *BMJ* 2016; **355**: i6270.
112. Arango CM, Paez DC, Reis RS, Brownson RC, Parra DC. Association between the perceived environment and physical activity among adults in Latin America: a systematic review. *Int J Behav Nutr Phys Act* 2013; **10**: 122.
113. Sallis JF, Glanz K. The role of built environments in physical activity, eating, and obesity in childhood. *Future Child* 2006; **16**(1): 89–108.
114. Salvo D, Reis RS, Stein AD, Rivera J, Martorell R, Pratt M. Characteristics of the built environment in relation to objectively measured physical activity among Mexican adults, 2011. *Prev Chronic Dis* 2014; **11** E147.
115. Zakiul M. Children and urban neighborhoods: relationships between outdoor activities of children and neighborhood physical characteristics in Dhaka, Bangladesh. Bangladesh: North Carolina State University; 2012.
116. Salvo D, Rei RS, Hino AA, Hallal PC, Pratt M. Intensity-specific leisure time physical activity and the built environment among Brazilian adults: a best-fit model. *J Phys Act Health* 2014.
117. Sarmiento OL, Schmid TL, Parra DC *et al.* Quality of life, physical activity, and built environment characteristics among Colombian adults. *J Phys Act Health* 2010; **7**(Suppl 2): S181–S195.
118. Sarmiento O, Torres A, Jacoby E, Pratt M, Schmid TL, Stierling G. The Ciclovía-Recreativa: a mass-recreational program with public health potential. *J Phys Act Health* 2010; **7**(Suppl 2): S163–S180.
119. Parra DC, Hoehner CM, Hallal PC *et al.* Scaling up of physical activity interventions in Brazil: how partnerships and research evidence contributed to policy action. *Glob Health Promot* 2013; **20**(4): 5–12.
120. Torres A, Sarmiento OL, Stauber C, Zarama R. The Ciclovía and Cicloruta programs: promising interventions to promote physical activity and social capital in Bogotá. *Colombia. Am J Public Health* 2013; **103**(2): e23–e30.
121. Pratt M, Perez LG, Goenka S *et al.* Can population levels of physical activity be increased? Global evidence and experience. *Prog Cardiovasc Dis* 2015; **57**(4): 356–367.
122. Pratt M, Brownson RC, Ramos LR *et al.* Project GUIA: A model for understanding and promoting physical activity in Brazil and Latin America. *J Phys Act Health* 2010; **7**(Suppl 2): S131–S134.
123. Parra DC, McKenzie TL, Ribeiro IC *et al.* Assessing physical activity in public parks in Brazil using systematic observation. *Am J Public Health* 2010; **100**(8): 1420–1426.
124. Bürgi R, Tomatis L, Murer K, de Bruin ED. Localization of physical activity in primary school children using accelerometry and global positioning system. *PLoS One* 2015; **10**(11) e0142223.
125. Brooke HL, Corder K, Atkin AJ, van Sluijs EM. A systematic literature review with meta-analyses of within- and between-day differences in objectively measured physical activity in school-aged children. *Sports Med* 2014; **44**(10): 1427–1438.

126. Horacek TM, Dede Yildirim E, Kattelman K *et al.* Path analysis of campus walkability/bikeability and college students' physical activity attitudes, behaviors, and body mass index. *Am J Health Promot* 2016.
127. Long MW, Sobol AM, Cradock AL, Subramanian SV, Blendon RJ, Gortmaker SL. School-day and overall physical activity among youth. *Am J Prev Med* 2013; **45**(2): 150–157.
128. Bassett DR, Fitzhugh EC, Heath GW *et al.* Estimated energy expenditures for school-based policies and active living. *Am J Prev Med* 2013; **44**(2): 108–113.
129. Ribeiro IC, Parra DC, Hoehner CM *et al.* School-based physical education programs: evidence-based physical activity interventions for youth in Latin America. *Glob Health Promot* 2010; **17**(2): 5–15.
130. Kain J, Uauy R, Lera L, Taibo M, Albala C. Trends in height and BMI of 6-year-old children during the nutrition transition in Chile. *Obes Res* 2005; **13**(12): 2178–2186.
131. Frenk J. The global health system: strengthening national health systems as the next step for global progress. *PLoS Med* 2010; **7**(1) e1000089.
132. Uauy R, Albala C, Kain J. Obesity trends in Latin America: transiting from under- to overweight. *J Nutr* 2001; **131**(3): 893S–899S.
133. Uauy R, Kain J. The epidemiological transition: need to incorporate obesity prevention into nutrition programmes. *Public Health Nutr* 2002; **5**(1A): 223–229.
134. Fernald LC, Gertler PJ, Neufeld LM. Role of cash in conditional cash transfer programmes for child health, growth, and development: an analysis of Mexico's oportunidades. *Lancet* 2008; **371**(9615): 828–837.
135. Fernald LC, Gertler PJ, Neufeld LM. 10-year effect of oportunidades, Mexico's conditional cash transfer programme, on child growth, cognition, language, and behaviour: a longitudinal follow-up study. *Lancet* 2009; **374**(9706): 1997–2005.
136. Lee J, Houser RF, Must A, de Fulladolsa PP, Bermudez OI. Disentangling nutritional factors and household characteristics related to child stunting and maternal overweight in Guatemala. *Econ Hum Biol* 2010; **8**(2): 188–196.
137. Monterrosa EC, Campirano F, Tolentino Mayo L *et al.* Stakeholder perspectives on national policy for regulating the school food environment in Mexico. *Health Policy Plan* 2015; **30**(1): 28–38.
138. Pehlke EL, Letona P, Hurley K, Gittelsohn J. Guatemalan school food environment: impact on schoolchildren's risk of both undernutrition and overweight/obesity. *Health Promot Int* 2016; **31**(3): 542–550.
139. Gross R, Lechtig A, López de Romaña D. Baseline evaluation of nutritional status and government feeding programs in Chiclayo, Peru. *Food Nutr Bull* 2006; **27**(4 Suppl Peru): S115–S121.
140. Corvalan C, Reyes M, Garmendia ML, Uauy R. Structural responses to the obesity and non-communicable diseases epidemic: the Chilean Law of Food Labeling and Advertising. *Obesity Reviews* 2013; **14**: 79–87.
141. Barquera S, Campos I, Rivera JA. Mexico attempts to tackle obesity: the process, results, push backs and future challenges. *Obes Rev* 2013; **14**(Suppl 2): 69–78.
142. Jaime PC, da Silva AC, Gentil PC, Claro RM, Monteiro CA. Brazilian obesity prevention and control initiatives. *Obes Rev* 2013; **14**(Suppl 2): 88–95.
143. 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* 2016: 1–9.
144. Kain J, Hernández Cordero S, Pineda D *et al.* Obesity prevention in Latin America. *Curr Obes Rep* 2014; **3**(2): 150–155.