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Obesity and the food system transformation in Latin America

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Summary

The Latin America and the Caribbean (LAC) region faces a major diet-related health problem accompanied by enormous economic and social costs. The shifts in diet are profound: major shifts in intake of less-healthy low-nutrient-density foods and sugary beverages, changes in away-from-home eating and snacking and rapid shifts towards very high levels of overweight and obesity among all ages along with, in some countries, high burdens of stunting. Diet changes have occurred in parallel to, and in two-way causality with, changes in the broad food system – the set of supply chains from farms, through midstream segments of processing, wholesale and logistics, to downstream segments of retail and food service (restaurants and fast food chains). An essential contribution of this piece is to marry and integrate the nutrition transition literature with the literature on the economics of food system transformation. These two literatures and debates have been to date largely ‘two ships passing in the night’.

This review documents in-depth the recent history of rapid growth and transformation of that broad food system in LAC, with the rapid rise of supermarkets, large processors, fast food chains and food logistics firms. The transformation is the story of a ‘double-edged sword’, showing its links to various negative diet side trends, e.g. the rise of consumption of fast food and highly processed food, as well as in parallel, to various positive trends, e.g. the reduction of the cost of food, de-seasonalization, increase of convenience of food preparation reducing women’s time associated with that and increase of availability of some nutritious foods like meat and dairy. We view the transformation of the food system, as well as certain aspects of diet change linked to long-run changes in employment and demographics (e.g. the quest for convenience), as broad parameters that will endure for the next decades without truly major regulatory and fiscal changes.

We then focus in on what are the steps that are being and can be taken to curb the negative effects on diet of these changes. We show that countries in LAC are already among the global leaders in

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Supporting information

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initiating demand-related solutions via taxation and marketing controls. But we also show that this is only a small step forward. To shift LAC's food supply towards prices that incentivize consumption of healthier diets and demand away from the less healthy component is not simple and will not happen immediately. We must be cognizant that ultimately, food industry firms must be incentivized to market the components of healthy diets. This will primarily need to be via selective taxes and subsidies, marketing controls, as well as food quality regulations, consumer education and, in the medium term, consumers' desires to combine healthier foods with their ongoing quest for convenience in the face of busy lives. In the end, the food industry in LAC will orient itself towards profitable solutions, ie those demanded by the broad mass of consumers.

Keywords

Food service; food system; obesity; retailers

Introduction

In the Latin America and the Caribbean (LAC), extensive child and adult obesity, poor diets and inadequate physical activity are causing high levels of diabetes, hypertension and other noncommunicable diseases (NCDs) (1–5). At the same time, large proportions of the children in many nations in the region are malnourished and stunted from poor feeding during the first 1,000 d of their lives (6–8). While the causes this review discusses are complex, the basic solutions lie with changes in food systems and diets. This review focuses on how we got here, what we can do to prevent further escalation and ultimately how we can produce a healthier population.

In the 1980s, the region's diets began to change, and the alterations accelerated in subsequent decades. Declines in physical activity have contributed to the obesity problem but not to the malnutrition issues (9). With the limited data from the region and more complex data from other regions, we will describe briefly the modern technological revolution in market production. Aspects of employment, home production, transportation and leisure have contributed to the problem, but while they importantly impact good health, they do not represent the solutions for this region. Rather, the food system and dietary shifts must be addressed to ensure that the nations' healthcare systems are not burdened by sizable proportions NCDs among of their populations (10).

Modern food systems impact LAC supply and demand through midstream and downstream processing and wholesale, retail and transportation methods. These are combined with liberalization and privatization, foreign investment, infrastructure investment and urbanization. Supermarkets, large processors and fast food chains are fed by modernized procurement systems and the coevolution among these segments. As a result, urban and even rural LAC areas are experiencing a rapid and ubiquitous transformation.

The diet shifts and declines in physical activity have led to high levels of adult obesity, and now most LAC nations show rapid increases in child obesity. Consequently, the complications of obesity, including prediabetes, diabetes and other health problems, are emerging among children and adolescents (1). In addition, a portion of the population in the

region is at greater risk for these problems owing to genetic and race–ethnic complexities. This portion of the population is experiencing a large rightward shift in the entire body mass index (BMI) distribution, a rapid increase in body fat around the liver and the heart (often measured by increased waist circumference) at unchanged BMI levels and a greater vulnerability to diabetes and hypertension at lower BMI levels than in non-Hispanic Whites in the region (11–14). Finally, many people have faced wasting and stunting during the first 1,000 d of life and are now confronting the consequent nutritional challenges (15–20). In the Americas and the Caribbean, aside from the wasting and chronic undernutrition found in Haiti and limited subgroups, stunting is the major issue (1,2,7,21).

Our review first documents the problem of obesity and the double burden of obesity and malnutrition, even in the same household. We describe the dynamic annualized increases in obesity and the minimal declines in undernutrition with stubborn pockets of malnutrition, mainly stunting (which is extreme in Haiti), highlighting the issue’s dimensions and current accelerating trends. We then discuss diet shifts and provide examples of detailed diets at two or more points in time to address the direct and underlying causes. We then discuss the drivers of and trends in the transformation of the broader food system, and its links back to diet change. We then conclude with policy implications and agenda for the debate.

We believe we contribute to the empirical and conceptual literature in several ways. First, we contribute to the literature on measuring the nutrition transition, undernutrition and obesity dynamics by country for the region, and we link these dynamics with food system changes. Second, we contribute to the literature on food systems and, in particular on food industry transformation, by updating and expanding analysis of this in LAC, with several integrative dimensions that have not yet been undertaken in prior literature. For retail, there has been no update of a systematic view of supermarket sales growth since 2002 in LAC, and we provide that and show a remarkable similarity with the decade in Asia. Even in 2002 and before, sales data of major retail chains were not even available, and just rough estimates of growth trends were provided in earlier literature. For fast food restaurants in LAC, there has never been in the literature a systematic review of sales growth over countries, either for a snapshot view or, as we do, over a decade. For food manufactures, in prior literature, there has not been an in-depth discussion of the rise of non-nutritious processed food supply in LAC, nor its links to foreign direct investment (FDI) and intra-regional as well as extra-regional trade.

Beyond the treatment of the individual segments of the food industry, we believe we have made a contribution to the literature (not just in LAC but also applicable to other emerging markets) of the linkages across the segments of the food industry that mutually reinforce in their engendering ease of access to non-nutritious foods, e.g. in processors’ relations to fast food chains via specialized wholesalers. We believe it is important for the obesity research literature to have a broad and integrated view of these inter-industry linkages and dynamics, and their relations to diet changes, to understand the nature of the challenge facing policymakers in addressing obesity in the region. Finally, we discuss how these dynamics in systemic change limit the future policy options in this region and raise challenges for both the agricultural and health sectors.

Methodology: data and methods used

Background data and measures

Anthropometry—The Demographic and Health Surveys (DHS), a series of nationally representative surveys (available at <http://www.measuredhs.com>), provide most of the information on obesity trends across the LAC region. For the prevalence results, we used all data from any country with quality data without excessive outliers. For the changes in the double burden, we used only countries with two surveys with mother–child pairs, so we could study prevalence levels and trends in the prevalence. We selected the earliest and latest surveys. Details of the DHS sampling methodology are described elsewhere (22–24). Additional data are from the Mexican National Health and Nutrition Surveys (25,26) and the national nutrition surveys of the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística). These are large national or nationwide randomly sampled, representative surveys with comparable measured anthropometry (27,28).

We have data from two time periods for Bolivia, Brazil, Colombia, the Dominican Republic, Guatemala, Guyana, Haiti, Honduras, Mexico, Nicaragua and Peru. Only one survey, the most recent in Brazil, does not include data on preschoolers. We restricted all analyses to nonpregnant women aged 15–49 years. The data on trends in overweight and obesity for children, adolescent boys and adult men are inadequate.

We directly calculated all measures to ensure quality control. All surveys used standardized protocols to measure weight and height. We calculated BMI as weight in kilograms divided by height in square metres. Wasting, stunting and overweight designations for preschoolers are from the World Health Organization (WHO) standards and calculation algorithms (29,30). We defined overweight according to the WHO recommendation, BMI $\geq 25 \text{ kg m}^{-2}$ (24), and also used the WHO standards for wasting (31). We used the International Obesity Task Force cut-offs for overweight for women aged 15–18 (32,33).

Table S1 presents the countries, the years of the surveys and the sample sizes with anthropometry and age data. To compare trends in the prevalence of underweight and overweight, we calculated an annualized percentage point change in the prevalence rates for each country. We have used similar methods in other studies (34).

We also provide some sense of the double burden of wasting and stunting plus overweight and obesity facing LAC countries. We used only surveys for which we could access the raw data and could systematically clean and calculate identical anthropometric measures of undernutrition and overnutrition. Note that the data of several national surveys, e.g. the STEPwise Approach to Surveillance survey in Barbados and a Colombian nationally representative survey to be released next year, were not available to the authors for this analysis.

We do not address micronutrient malnutrition here but rather focus on the rapid shift towards overweight and obesity with continued stunting and some wasting. In a paper forthcoming in 2018, we will address micronutrient malnutrition and its contributions to the nutrition burden. However, its solutions are unique and outside the scope of this paper, although many

of the actions to address nutrition-related NCDs will also impact positively micronutrient malnutrition. Table S1 provides each country's data for each figure presented in the text.

Defining double high burden countries—For children, for the severity of the double burden at the country level, we used the recent WHO-UNICEF guidelines for severe anaemia and high levels of overweight/obesity, wasting and stunting (35). The prevalence levels we used to designate a country's population as high in wasting, overweight or stunting are 15%, 15% and 30%, respectively. For women, there is no clear cut-off for overweight and obesity. We use a 40% cut-off because overweight and obesity are so prevalent in the region.

As background, it is important to note that the governments of Mexico and Brazil have repeated nationally representative surveys with weight and height data. Analyses of the 1988, 1999, 2006 and 2012 surveys reveal that overweight and obesity emerged in Mexico earlier than elsewhere in the region (36–38). These surveys show that Mexico's rates of overweight and obesity were already high but that in the last 20 years they rose higher and became a more serious problem. Studies in Brazil show lower levels of overweight and obesity in the 20th century but rapid increases more recently (39–42). The rapid increases in the past two decades in Brazil and Mexico echo the changes we find in smaller studies in other countries, like Chile (1,43,44). Our focus is on a broader regional pattern rather than these large country studies.

Unfortunately, we do not have directly measured nationally representative data for the Caribbean. A recent Caribbean Public Health Agency report suggests overweight and obesity levels between 28% and 35% in Caribbean countries with high trajectories for children and adults but does so partially from unpublished data (45). However, this seems like an underestimate when we consider surveys that measure overweight. For example, in Barbados, 74.2% of women and 57.5% of men in a nationally representative survey were overweight or obese (46). In much larger Trinidad and Tobago, researchers found that 70.7% of women and 55.5% of men were overweight or obese (47).

Diet analysis data and methods

Mexico is the only country in the region that has repeatedly collected in-depth dietary intake data through its 1988, 1999, 2006 and 2012 national dietary intake surveys (25,26,48,49). The raw data from 1988 were lost, but all the other data are available and have been used to understand food, beverage and nutrient intake changes over time. Colombia in a year or more will have available 2005 and 2015 national dietary intake surveys, but the data are not available yet. Otherwise there have been few national nutrition surveys, Brazil having the most recent. We did not have access to a few other national dietary surveys performed sporadically in South America. We do have sales trends from Euromonitor International that are useful for understanding increases in selected categories of foods (50), and we have many small surveys on selected areas and subpopulations.

Euromonitor International data—We used data on global sales of beverages and less healthy foods from the Euromonitor International Passport database (51,52), which has been used in other studies on sugar-sweetened beverages (SSBs) (50). We defined as SSBs caloric

soft drinks (carbonated, noncarbonated), fruit drinks (sweetened beverages of diluted fruit juice and often other caloric sweeteners and flavouring) and the fast-growing categories of energy drinks, sports drinks and sugar-sweetened (often flavoured) waters (combined in our figures as sports and energy drinks). We combined sales for off-trade volume (i.e. supermarkets and retailers) and on-trade volume (i.e. restaurants and cafeterias) reported in millilitres per capita per day. The caloric data are available only for off-trade sales. We weighted countries in the region by population to create regional averages. Limitations of the data set are that the data are likely to omit many small local bottlers and informal sector products. A few countries, notably Colombia, were off by a large (possibly 50–60% of the total) amount; the data are average sales for the country and include waste but do not shed insights on per capita consumption for the key age groups most likely to consume SSBs (especially ages 10–35) as a recent cross-sectional presentation of global dietary data does (53). The data do appear quite accurate in terms of SSB trends in both volume and kilocalories (kcal), as they correspond very closely with our own research on trends in SSB purchases and dietary intakes in the USA (54) and Mexico (55,56).

The Euromonitor data leave an important gap, as they do not report actual sales for the Caribbean and include only modelled sales for several islands. These results appear incorrect, because the Coca-Cola Company reported that Jamaica was its fastest-growing market globally for the last 4 years (40% per year annual growth) but also noted that Coca-Cola was not yet but would soon be the top-selling soda in Jamaica (57). For this reason and because other local food and diet data suggest much higher levels of SSB intake, we put the Euromonitor data for the Caribbean countries into the Supporting Information and do not discuss them in the text in detail.

Food and Agriculture Organization Corporate Statistical Database—We also used food balance data on available foods from the Food and Agriculture Organization (FAO) of the United Nations (58). These are aggregate data compiled from each country's estimates of production minus waste, imports and exports, so it is essentially food available for consumption. Food and Agriculture Organization Corporate Statistical Database (FAOSTAT) is the only major global source for food consumption trends of reasonably comparable data. We present them per capita. The Euromonitor data have been shown to capture trends quite accurately, whereas the FAOSTAT data can miss changes that affect estimates of production, waste, exports and imports.

Retail and food service sector sales data—The data for sales over years are drawn from our analysis of raw data in www.Planetretail.net. The retail and restaurant chains are all the chains followed by Planet Retail per country. For the retail firms, we limited our analysis to those which sold at least some food. Planet Retail follows the lead chains at mainly the national level but not the local and regional chains, so the totals shown in the tables are an underestimate of the overall food-selling modern retail chains' and restaurant chains food sales in the countries. Because most of the retail and restaurant sectors are still somewhat fragmented, this may be a significant underestimate. There are no official data with which to compare. Details of the companies followed are noted in the tables. Despite the

underestimates, as with the Euromonitor data, we feel the trends established are fairly representative of each country and the region.

Trends in undernutrition, overweight and obesity

Most recent prevalence results

Overweight and obesity—Latin America and the Middle East and North Africa are the two most obese low-income and middle-income regions globally (refer to Tables S2 and S3 for detailed LAC country data for children aged 0–4 and women aged 15–49, respectively). Over half of the women in Latin America are overweight or obese, and in many countries, e.g. Chile and Mexico, the figures reach two-thirds of the women and over half of the men. The data are old for most countries other than Mexico, so we would expect to see a much higher aggregate weighted average in the most recent data. However, rates of increase are well over one percentage point per year in many Latin American countries, and in some cases, like Brazil, they appear to be accelerating. After a decline of obesity among educated women in the 1990s, Brazil has seen a sharp reversal and a rapid increase in the new millennium (59,60). Figure 1 provides the levels and rates of change for all the countries in the region for which we have data.

Child overweight levels have lagged adult levels, and only recently have overweight and obesity increased significantly and rapidly among children (61). At the same time, overweight is widespread among children under 5 years old, particularly in Chile and Mexico, 9.3% and 9.8%, respectively (2,62). There is less systematic evidence for older children, but available reports and articles regarding adolescent girls suggest that their prevalence of overweight and obesity exceeds 25% in some countries (2,34,63). While smaller country surveys or ones whose raw data were unavailable to us point to recent rapid increases in child obesity, the lack of data from Brazil, Chile and some other countries means we are reporting a tiny annualized decline in child overweight and obesity (1). Table S2 provides these data on wasting, stunting, wasting and stunting, and overweight or obese.

For the regional child estimates, we were limited to the ages available in the DHS data, ages 0–4, so results do not match the published data. We find slightly lower levels for children than the 0–5 or 0–6 categorizations. Surprisingly, the DHS plus Mexican national survey results do not show the same rapid increases in overweight for children noted in many countries. But this could be an artefact of older data (Table S2).

Several regional dimensions make these levels of overweight and obesity far more critical in terms of health and economic impact. First, the severity of the rightward shift in the BMI distribution among those overweight and obese has worsened (14). Second, we have found in related research that over the past 20 years waist circumferences in many countries have grown for the same BMI level (11,14). Third, as we have shown for Mexican Americans living in the USA and others have shown in Latin America, the risk of diabetes at each BMI level above 22 is much higher for Latinos than for non-Hispanic Whites (13). This seems also to be true for Indo-Caribbeans, who appear particularly vulnerable to diabetes (64). Figure 1 presents the most recent prevalence of overweight for women and the annualized

change in the percentage points of prevalence for each country for which we have two or more years of data.

Wasting and stunting—Aside from Haiti and Guyana, there is minimal wasting or acute malnutrition in the region, as Table S2 shows. In addition to low levels of wasting, we find a meaningful annualized decline in wasting. For all countries, the annualized percentage point change in wasting shows a decline of 0.22 per year. In contrast, stunting levels remain high, but we see even larger annualized drops in stunting. In the smaller Central American countries and Haiti, we find significant levels of wasting. Stunting is related to poor infant feeding, including low breastfeeding rates, short periods of exclusive breastfeeding and poor weaning and infant foods. Overall for the region, only 16.6% of preschoolers are stunted, yet many smaller countries, including Bolivia, Guatemala, Guyana, Haiti, Honduras and Nicaragua, have rates above 20% among preschoolers.

Thinness in women—Underweight is not a problem among women in this region. Except in Haiti and Guyana, we find low levels and a significant 0.22 annualized decline. Therefore, we do not present data on thinness except in Table S3. Figure 1 summarizes the overweight and underweight data for the most recent survey (refer to Table S1 for dates of each survey) and the oldest survey from the 1990s and the annualized rates of change for women aged 15–49 and children aged 0–4.

Double burden of underweight and overweight—One can understand this double burden at the national, household or community level.

When we look at individual households, we find that about 10% of households have both stunted or wasted children and overweight or obese mothers. But as an important indicator of intergenerational complexities, we find that less than 2% of the children are both stunted and overweight. We know from cohort studies in Guatemala and Brazil that children who are stunted have an increased risk of abdominal obesity, type 2 diabetes and hypertension (17,18,65,66).

The important issue for this region is that the double burden of undernutrition and overnutrition at the household level is low, and it is declining. This is related to the region's low levels of wasting and stunting relative to many other low-income and middle-income countries (LMICs) (67). Refer to Fig. 2 for a summary of regional double burden data.

The WHO would classify Bolivia and Guatemala among the LAC countries as high for stunting, none for high overweight in children and all except Haiti for high overweight or obesity in women. Only Bolivia and Guatemala in the last decade would qualify as high double burden countries, whereas in the 1990s, Honduras, Nicaragua and Peru were the only double burden countries (67).

Major dietary trends

Dietary shifts remain the major driver of current and future shifts in both undernutrition and overnutrition in the region. From smaller studies and reviews, we pulled together the major shifts, none of which are healthful. All of the region's shifts indicate a need for government

programmes and policies and changes in the culture of food preparation and eating to adequately address obesity and stunting. We draw on but do not present data and information from the studies (50,51,58,68–78). Mozaffarian and colleagues used individual dietary surveys of varying quality and representativeness from across the globe to compile a careful review of consumption of SSBs, fruit juices, milk, fats, oils and dietary quality. Later, we address trends that are central to the diets of the Americas.

The dietary data come from a combination of sales data, which are very useful for understanding trends. However, these Euromonitor sales data do not represent total sales or consumption. Similarly, the other major data used from the FAO of the United Nations are based on national per capita food available for consumption. They are useful for trends and general consumption but generally are 20% or more higher per capita than true dietary intake. But they provide a relative picture of trends for various foods. In contrast, few Latin American countries have nationally representative dietary intake data, but we do use studies based on such data when the results fit the topic.

Increased intake of unhealthy food

Global diet shifts—A recent review looked at global sodium increases on the basis of dietary and urinary sodium excretion studies (79). Our work and in-depth studies by others in China, Brazil, Mexico and elsewhere show that consumption of foods with added sugars, added salt and refined carbohydrates; grain-based desserts; and savoury snacks has grown (74,80–83). Latin American countries experienced these dietary shifts earlier than most other LMICs, and for some of the shifts, they are global leaders.

The proportion of kcal per day from macronutrients—Figure 3 shows the proportion of energy per capita derived from major macronutrients in the three major geographic areas of the region. We see in general a decline in carbohydrates and noticeable increases in total fats. The largest increase, as expected, is in vegetable fats owing to the global trend towards processed vegetable oils from a variety of oil-seeds (84).

Sugar is a major element in all Latin American foods and beverages, particularly coffee, pastries, packaged foods and SSBs, as it is globally. Three of the world's five highest SSB-consuming nations are in Latin America, and the levels of SSB intake are increasing in the region as a whole (50,82). Latin Americans consume very high levels of added sugar, more than triple that recommended by the WHO (73,83). Beverages are the largest source of sugar in the diets of most children, adolescents and young adults in the region (72,73,82).

Figure 4 shows the overall levels of SSB sales in Latin America overall and four countries in 2016, and Fig. 5 tracks the trends in SSB sales by category in the same areas. Mexico, Argentina and Chile are three of the five countries with the highest measured per capita sales of calories from SSBs (50). We do not have accurate sales measures for the Caribbean, but we know from other sources that intake in much of the area is exceptionally high (57). As carbon emissions and water use become greater concerns in some of the region's countries, SSB use looms as one critical issue related to excessive water use (85–88).

Junk food—Figures 6 and 7 demonstrate the large amounts of junk food or nonessential food sold in Latin America overall and the selected countries. Figure 6 shows the most recent levels in grams per capita per day, and Fig. 7 shows the trends by category. These foods, except for salty snacks, are high in added sugar and saturated fats, and many are high in sodium, including salty snacks.

The FAO food balance data record the general trends in total per capita sugar available in food in the region from 1961 to 2013, the most recent data. These levels are very high, but clearly the per capita calories available for consumption are an overestimate of the amount actually consumed. Figure 8 presents the numbers for 1990 and 2013 to demonstrate the long-term shifts. These data do not reflect the shift from consuming sugar in food to consuming more sugar in SSBs and other beverages.

Refined carbohydrates—Diets rich in refined carbohydrates are defined by excessive intakes of foods we might term junk food or nonessential foods that contain much sugar, saturated fat and sodium and are often highly processed (83,89–91). While the trend towards higher consumption is global, it seems to be accentuated in the Caribbean, where fewer data are available but all policy documents speak of excessive refined carbohydrates in diets. In Brazil, these foods are an increasingly important part of food expenditures (76,77). As Monteiro *et al.* state in a set of papers, ultra-processed foods composed of refined carbohydrates, excessive sodium and saturated fats represent the key threat (75,76,92–97).

Snacking—We have documented in the USA that increased eating occasions, driven by snacking, represent a major portion of increased caloric intake (98–100). This has been documented in Mexico, Brazil and other countries in the Latin American region as a critical element of unhealthy eating (75,89–91). If the limited studies in the larger countries in the region are indicative, snacking has become a major component of the diet. In Brazil, among those over the age of 10, 21% of kcals per day comes from snacks. Among the segment of the population that does snack (74%), the proportion rises to 34% (101).

Sodium—Powles and colleagues looked at sodium increases globally (79). In the Americas, a combination of highly processed junk food, eating away from home and added sodium is responsible for high levels of sodium intake, particularly in the Caribbean (102).

The data for Central and South America combined on sodium sales from packaged foods and chain restaurants reflect only a proportion of the sodium consumed. They omit measurements of salt in home-prepared food, salt added during consumption and salt consumed at away-from-home informal sources, nonchain restaurants and fast food eateries. These results are far higher than the levels recommended by the WHO and other national and global bodies. The data on the region and four countries are in Fig. 9.

Animal products—Animal source foods appear to be consumed at high levels that are increasing across the region. There is an extensive literature on changes in animal source food intake and the effects on health, climate, water use and antibiotics in water supplies, so these issues are not repeated here (80,102–107). The food balance data in Fig. 10 suggest

very large increases in animal source food consumption across the region following the income growth and regional cooperation on trade that begun in 2005–2007.

Away-from-home consumption—While eating away from home could be positive and healthful, in general, the studies of LMICs support the conclusion that fast food and unhealthy street foods, often deep-fried and high in saturated fats, sodium, sugar and refined carbohydrates, dominate. The Pan American Health Organization (PAHO) and most of the region’s countries have voiced concern about both imported fast food and local vendors that sell such unhealthy foods. But data are sparse, and it is beyond the scope of this review to undertake rigorous analysis. Most of the Monteiro *et al.* papers highlight ultra-processed foods as a major problem, but this away-from-home sector is complex and is composed of both global and national chains and small vendors. Euromonitor data on per capita yearly expenditures on away-from-home food and nonalcoholic beverage expenditures over the past two decades indicate a large increase in many countries (Fig. 11).

Reductions in healthier food options

Legumes—Once staples for the region, these healthy low-fat, high-fibre and high-protein foods have declined as a critical part of the diet over the past decade. Legumes now represent less than 5% or 10% of the daily energy intake (Fig. 12). It is one of the items that Monteiro and others who promote returning to a traditional diet would like to see take a central place (75,108).

Fruits and vegetables—In Latin America, as globally, we find low intake of this component of a healthy diet (109–112). We show that even the quantities of fruits and vegetables available for consumption in this region are remarkably low (Figs 13 and 14). No country comes close to consuming the five to seven servings per day of fruits and vegetables that we wish all adults to consume (113,114).

Whole grains—No accurate measure of consumption of whole grains for the region exists. If the FAOSTAT data in Fig. 15 were to be believed, the bread that Chileans consume would all be whole grain. However, Chilean nutritionists claim that it is made from highly refined white flour. It is hard to know if the other countries’ measures of whole grains are accurate. Mexican scholars often state that their tortillas, mainly made from commercial masa flour, are whole grain owing to the high fibre–carbohydrate ratio. Yet one of the current authors spoke with one of the two millers who dominate the tortilla flour market, and the miller noted that he or she refines the corn and removes the bran. So we are unsure whether whole grains are significant in the diets of any countries in the region. Figure 15 data suggest very high levels for Chile, whereas dietary data suggest that the major source of grain is bread made with refined white flour.

Midstream and downstream food system changes that facilitate diet shifts

Meta-conditioners of food system change

Five ‘meta-conditioners’ have encouraged and facilitated food system changes and diet changes. These conditioners are themselves mutually dependent: income growth, policy

liberalization, infrastructure improvement, urbanization and the rise of rural nonfarm employment. We briefly treat each in turn.

Income growth—‘Over the past 30 years most of the LAC countries moved several steps up the scale towards becoming high-income and low rural poverty nations’ (115). The gross income of LAC was approximately 1 trillion current USD in 1980 and 6 trillion in 2014 (<https://data.worldbank.org/region/latin-america-and-caribbean>). The population rose from 364 million to 624 million. Thus, income rose from \$2,742 to \$9,615 per capita, or 3.5-fold per capita, over the period. Bennett’s law (a statistical regularity linked with two concepts: the ratio of starchy and lower-quality foods goes down as income rises [i.e. the quality of the diet increases as income increases] and the poor spend a great proportion of their income on food) shows a positive correlation (in fact a disproportionate increase) between income increase and the share of the diet from fruits, vegetables, meats, fish, dairy and fats; Bennett’s law has been borne out in empirical studies in LAC (116). Studies also show a correlation between income and the purchase of processed food in LAC (75,117–120).

Policy liberalization and privatization spurring private sector investment—The bulk of policy liberalization and agri-food parastatal privatization occurred during the 1980s and 1990s in LAC. Large private sector companies (e.g. Bimbo in Mexico, discussed in detail later) and small-size and medium-size enterprises (SMEs) developed rapidly, stepped into the void left by privatized parastatals and proliferated to meet urban market demand. For example, Farina (121) discussed the wheat flour milling sector in Brazil. After the privatization of the wheat milling parastatals, a proliferation of milling SMEs diversified the quality of the product available.

Privatization also led to the entry of large foreign firms, e.g. processors, supermarkets and fast food chains. The massive ingress of foreign companies was abetted by liberalization of the once-ubiquitous FDI regulations in the 1980s and 1990s. For example, Farina *et al.* (122) analyse the ingress of multinationals, e.g. Nestlé, in the dairy sector of Argentina and Brazil after FDI liberalization. In many sectors, the large companies merged with and acquired the SMEs that had emerged in the immediate post-liberalization period.

One striking aspect of the conditioners of food system transformation in LAC is that the central influential policy was dismantling of government control of the food system – liberalization of FDI, elimination of food price controls and subsidies, privatization of the government systems of food and farm input distribution – that was largely not accompanied by regulations that managed the rapid development of the private food system, with the exception of some public food safety and phytosanitary standards. The latter were regulations encouraged by global food companies. However, the social consequences of the food system transformation, e.g. the impacts on health we discuss here, were not part of the public debate. There was also little or no regulatory attention to curbing bad health effects (e.g. taxes on sodas and required caloric labelling). Debates on them have only recently begun in LAC. In the Policy implications section, we recommend that these be further developed.

Improvement of infrastructure and reduction of transaction costs—The Economic Commission for Latin America and the Caribbean shows that there was a reversed J curve in public and private infrastructure investment rates in the 1980s (highest rate) and 1990s (lowest rate). Then in a resurgence in the 2000s through the mid-2010s, half the countries attained the 1980s rate, and the other half were not far from it. The report cites gaps and insufficiencies, e.g. regional connectivity, power grids, drinking water and sanitation. Cerra *et al.* (123) note that road density and quality in LAC are well below those in the USA and emerging Asia. But we think it is difficult to compare LAC with emerging Asia in this regard, as the population density is far lower in LAC.

However, Economic Commission for Latin America and the Caribbean notes that in the 1980s and again in the 2000s, most of the infrastructure investment was for transport. The number of vehicles per 1,000 people rose quickly in LAC from 113 to 177 over just 10 years (2002–12) (www.energy.gov). Also, urbanization (discussed next) compared with rural areas constitutes, by definition, an agglomeration and a densification of roads and other infrastructure. The combination of transport infrastructure, vehicles and urbanization has reduced transaction costs in LAC food systems over the past several decades.

Urbanization, women's work outside the home and opportunity cost of time—LAC urbanized early compared with other developing regions. The urban share was roughly 40% in 1950, 55% in 1970, 65% by 1990 and 75% by 2010 (124). As urbanization proceeded, supply chains to feed cities had to lengthen and food had to become more storable. Many studies show a relation between demand for convenience food (away-from-home-prepared food, purchased-for-home processed food or ready-to-heat food) and women working outside the home (125–128).

The latter is itself correlated with the opportunity cost of time for food preparation. In LAC, urban women increasingly work outside the home. A World Bank report (129) shows the share of women in the overall workforce rose from 1990 to 2016 in Argentina from 36% to 41%, in Bolivia 38% to 44%, in Brazil 35% to 43%, in Chile 31% to 41%, in Colombia 30% to 43%, in the Dominican Republic 34% to 41%, in Ecuador 34% to 39%, in Guatemala 26% to 35%, in Honduras 39% to 37%, in Mexico 30% to 37%, in Nicaragua 31% to 40% and in Peru 38% to 45%. The employment rate of women outside the home has also grown fast. Novta and Wong (130) note that

LAC, as a region, saw the largest gains in female labor force participation in the world during the past two decades. Women in LAC are becoming increasingly active in paid work, closing the gap with men and catching up to the counterparts in advanced economies. In 1990, only 44 percent of women in LAC participated in the labor force. In 2014 this ratio increased to 54 percent, close to levels seen in the United States and East Asia.

Rural nonfarm employment and rural women's opportunity costs of time—Rural nonfarm income (RNFI) grew quickly in the 1990s (131), reaching about half of the total rural income by the mid-2000s (132). By the late 1990s, the majority of rural women's income in most Latin American countries was RNFI (131). Moreover, 25% of the population

is in rural areas, and the majority of the rural population is near a city. Barbier and Hochard (133) show that less than 10% of the rural population lives far from a town or a city (134). As we show later, that implies proximity to processed food stockists and large companies' van networks. The rise of RNFI and women's important role in it implies the rise of women's opportunity costs of time, as in cities. That means the growth of demand for convenience foods, e.g. processed foods, in rural areas just as it did in cities. The proximity of most rural households to urban areas means that packaged processed foods are accessible and penetrate rural areas.

All of these changes in employment and opportunity cost of time along with access to modern technology have shifted the demand for convenience foods but also sharply decreased the time women spend on food preparation and cooking. We do not have accurate time use data on cooking for this region, but studies in the USA and globally have shown marked changes in overall time allocation, increased time in leisure and reduced cooking time (9,135–140).

General patterns of the evolution of food systems in the region

Structure-conduct stages of food systems—We use the concept of the transformation of food systems or value chains and identify stages of that transformation (141).

The least advanced stage is the 'traditional' system. This tends to be spatially short ('local') and fragmented in structure, using technologies with little capital and much labour, with no contracts or formal standards and with spot markets linking all segments. The next stage is the 'transitional'. It is spatially long (as cities grow and their catchment areas are larger) but still fragmented. Chain actors use a mix of labour-intensive and capital-intensive technologies. Public standards of quality emerge, but spot market relations still dominate. The most advanced stage is 'modern'. It also is usually spatially long, but it consolidates in a number of segments (e.g. retail and the rise of supermarkets). There is also some disintermediation, e.g. supermarkets buying directly from processors or urban wholesalers directly from farmers. Private standards emerge along with some use of contracts. Capital intensification is common, as the modern stage tends to coincide with higher wages and the food industry demands more quality and safety control.

Recent phases of food system transformation—The bulk of the transformation of food systems in LAC has occurred in two phases. The first, 'preparatory' phase was from fully traditional value chains to partly traditional and partly transitional systems initiated by governments in the region, mostly in the 1960s through the 1980s. Governments set up grain and processed products parastatals in wholesale, processing and retail, and they invested widely in municipal wholesale markets.

The second phase was liberalization and the privatization and globalization of the LAC food system. The isolation of that system from FDI ended in the 1980s and 1990s with liberalization. Constraints to the domestic food systems' internal development and restructuring ended or waned with liberalizations of state-mandated pricing, product

movement and other business regulations. Most of the parastatals (except the public wholesale sector) ended with privatization of these entities.

Privatization and liberalization initiated rapid investment by foreign firms, especially in retail and processing, and by domestic large private sector firms in retail, processing, wholesale and logistics. Liberalization plus infrastructure improvement helped not only the entry of large firms but also a proliferation (especially early in the second phase) of SMEs, particularly in processing, wholesale and logistics. This brought transformation of the food system into the ‘transitional’ and ‘modern’ stages during the past three decades (roughly the mid-1980s to present).

The sectors did not transform all at once but in a cascade of ‘waves of diffusion of transformation’ over time and segments, as follows:

1. Wholesale transformation occurred earliest, its first phase in the 1950s to the 1980s with public sector investment in wholesale markets and parastatals, and continued thereafter as private sector transformation of that segment.
2. Processing transformation occurred mainly in the 1960s and 1970s with government grain, meat and dairy enterprises.
3. Retail transformation as a public sector phenomenon coincided with the rise of urbanization from the 1950s through the 1980s.
4. The private sector ‘supermarket revolution’ was mainly from the 1990s to the present.

To illustrate the heterogeneity over countries, urban versus rural spaces, and products, we discuss details of the retail waves in the next section.

The timing of the transformation of each segment is approximate, as the timing differs by sub-region and country. There is substantial heterogeneity over sub-regions and countries and even within countries (e.g. Southern Brazil vs. the Northern states) in the LAC region, with the earlier ‘waves’ of transformation (and current extent of transformation) figuring more in the larger or higher-income and more urbanized countries of South America (e.g. Brazil and Chile) and Mexico and the later waves in either the poorer and less urbanized areas (e.g. in Central America or Bolivia) or countries that underwent periods of conflict or other processes that initially slowed food system transformation. In what follows, while we continue to refer to these waves of transformation and heterogeneity, as indeed that is important for differentiated policy and strategy approaches now, but in general we emphasize an image of a ‘moving average’ of transformation of food systems in the region, as indeed there is a tendency to convergence.

Retail segment transformation

Evolution of retailers and modern food processors—Traditional retailers – small shops, wet markets and street hawkers – tend to have a limited product assortment and no self-service. The initial evolution of these stores is a shift to self-service and expansion of product diversity. To help them with the latter, stockists buy from wholesalers or factories

and resell products to small retailers (142). Stocking small stores with processed products has modernized in two ways in LAC. First, cash-and-carry chains, e.g. Sam's Club of Walmart, supply small retailers. Second, as noted later with the example of Bimbo, as processing firms become large, they invest in fleets of vans or trucks (or hire third parties) to distribute their branded items directly to retailers in rural or urban areas.

This evolution of 'traditional' retail enables small stores to carry at least a limited assortment of key brands of processed products – the brands also found in supermarket chains. If the store is convenient and accessible to consumers, it may withstand competition from supermarket chains and convenience stores. The trend, however, has been that competition from modern retailers forces small stores selling processed foods out of the market. Supermarket chains set up large distribution centres and specialized or dedicated wholesalers and buy directly from large processors, cutting margins of intermediation that small stores must retain (143). In Chile, Faiguenbaum *et al.* (144) found that over the 1990s, about half of the small stores selling processed dry foods, beverages, meats and dairy exited owing to supermarket competition. This is a common story in other countries in the region.

Waves of supermarket revolution—There has been a much heterogeneity in the evolution of retail over products, over firms, over countries, over subregions in LAC and over time, but some general patterns can be observed. The first transformation wave involved the LAC countries with the earliest post-World War II growth and industrialization, in particular the larger South American countries, e.g. Argentina and Brazil. The retail transformation took off in the early 1990s, when supermarkets' average share of food retail went from 10% to 20% circa 1990 to 50–60% by the early 2000s (143,145). Compare that to the 75–80% share that supermarkets had by 2005 in the USA and western Europe, and one sees a process of convergence. The front runners, Argentina with a 60% supermarket share in 2002 (146) and Brazil with a 75% share (147), saw in a single decade the supermarket diffusion that took some five decades in the USA and the UK. We class with the first wave a second set of countries at the end of the first wave and the start of the second wave. Examples include Costa Rica and Chile with circa 50% by the early 2000s (143,148,149) and the higher-income Caribbean countries, e.g. Trinidad and Tobago (150).

The second wave involved the countries whose growth started later or who had strong internal pressure to limit FDI. These limits were often directed more at retail than at processing. Hence in Colombia, Mexico and Central America, private sector processing transformation took off in the 1980s, but retail transformation did not start until the mid to late 1990s. The modern retail share went from 5–10% in 1990 to 30–50% by the mid-2000s, e.g. Mexico with 56% supermarket share of total food retail (151–153), Ecuador with 40% in 2003 (154), Colombia with 47% (155), Guatemala with 36% in 2002 (156) and the Dominican Republic with 40% (157).

The third wave involved countries with growth in the 1990s and 2000s or in which liberalization occurred in the 1990s, e.g. Bolivia, Nicaragua (158) and Peru. In some cases, like Peru, there was some earlier transformation, a lull with internal crises and a restart of transformation along with overall economic growth. For the third wave, retail modernization

took off in the late 1990s or early 2000s, reaching 10–20% of the national food retail by circa 2003 and 20–30% by 2016, as in Peru (159,160).

The LAC differs from Asia and Africa in the temporal correlation of urbanization and the rise of supermarkets. In Asia, for example, supermarket development was closely correlated with urbanization. By contrast, in Latin America urbanization (assumed to be a *sine qua non* of supermarket development) took place by the early 1980s, before the rise of supermarkets. By 1980, at the very start of liberalization, more than 50% of the population in 14 Caribbean countries, 4 (of 8) Central American countries and 11 (of 14) South American countries were urban (161,162). That prior urbanization was a necessary but not sufficient condition for supermarket diffusion. The other factors were economic growth and especially liberalization.

In 2017, the fastest growth in the modern food retail sector is mainly in the second and third waves (as is usual in the diffusion of new technologies or institutions). The global retail development index of retail growth prospects (163) puts Peru, Colombia, the Dominican Republic, Paraguay, Bolivia and Brazil at global ranks 9, 10, 13, 19, 28 and 29, respectively. Moreover, modern retail was spreading in most LAC countries by the early 2000s. But sales data from leading firms in the region show that supermarket sales continued to grow over the past decade. Table 1 reports retail chain sales of edible groceries for 2002, 2006, 2011 and 2016 along with compound annual sales growth rates compared with real gross domestic product (GDP) growth rates. The data are from Planet Retail, a retail services and analysis company that tracks the leading chains per country. Planet Retail does not track smaller local chains, regional (in-country) chains or independents, so the sales data underestimate all modern food retail. But we think this provides a rough idea of trends, and no official data exist for comparison. We show data for 12 countries covering about 100 chains. We excluded food service (e.g. coffee chains or fast food), as that is in another table. The countries in the table are grouped in the three waves discussed earlier.

Several points emerge in Table 1. First, the total food sales of the chains increased from 40 billion USD in 2002 to 154 billion in 2011, a fourfold increase. The real increase is less, but because the inflation data were ambiguous, we report nominal increases here. For comparison, in Asia, Reardon *et al.* (164) used the same method over approximately the same period for nine countries and included 195 chains whose sales were about 51 billion USD in 2002 and 198 billion in 2009, also a fourfold increase. This means that in LAC and Asia food retail sales grew at a similar rate over the 2000s. For both regions, supermarket sales grew faster than the GDP per capita, indicating a structural shift.

Second, the average yearly sales growth rates for the first wave countries were 10% in the first half decade and 20% in the second with little sales growth in the third. Note the anomaly (among all the waves in the third half decade) that the Argentine and Brazilian economies actually contracted slightly in real terms, while all the other countries and waves in the sample roughly maintained their real GDP growth over the 15 years. For the second-wave countries, the averages were about 14%, 14% and 2%, and for the third-wave countries, they were about 17%, 26% and 11% for the three periods. Thus, the third-wave countries' modern retail sales growth rates were roughly 30%, nearly double those of the

first and second waves (which also had substantial growth). This is as expected, because the more mature modern retail sectors grow more slowly than those starting from a lower base. Interestingly, the Asia results show a similar relation in the first and second waves, also with annual rates of about 15%, versus the third wave, with annual rates of 40% (164).

Diffusion over space and consumer strata—Supermarkets in LAC have tended to start in large cities and spread to intermediate cities and towns and then to small towns in rural areas. The business strategy is the same as that of chains spreading in waves over the richest and largest market first owing to profit per capital invested. Competition and saturation of the initial base drive investment by a given chain into the series of subsequent markets. While the gross return declines, there are cost savings due to economies of scale and procurement system changes. Often a multinational chain acquires or enters a joint venture with a large domestic chain, and both acquire smaller local chains operating regionally in a country. The competition from a larger chain in turn pushes a chain based in an intermediate city to extend into hinterland towns, seeking refuge from the increasing competition in its base market. This process accelerates the diffusion of supermarkets over space. Examples of the latter pattern are published for Argentina (146), Chile (144) and Mexico (152). What begins as a transformation of big city retail ends as a transformation of rural small town retail. Haggblade *et al.* (132) review illustrative evidence of supermarket chains extending into rural small towns in Mexico.

Controlling for the pattern of spatial diffusion, we find similar waves of diffusion over socioeconomic groups-cum-consumer segments. Obeying the same business logic as in spatial diffusion, supermarkets focus first on upper-income consumer segments, move into the middle class and finally move into the markets of the urban poor. For example, in Peru, a third-wave country, over the 2000s, the diffusion of modern retail went from nearly all of the supermarket sector concentrated in Lima to two-thirds of the supermarkets in Lima and the rest in other cities by 2016. The penetration rate (share of supermarkets in total food retail) was still incipient, just 30% in Lima and 12% in other cities. The diffusion went from middle-class and upper-class districts to lower-middle-income districts by 2016 (160).

The factors allowing the extension into lower-income areas in Peru and in other LAC countries include (i) reduction of prices owing to increasing efficiency in procurement and economies of scale; (ii) diversification into discount formats with less product diversity but cost savings to consumers; (iii) diffusion into neighbourhoods with small supermarkets (e.g. in the Dominican Republic) (157) and convenience stores to target lower-income consumers and encourage those without cars to shop there (e.g. the proliferation of ‘gas marts’ in the Dominican Republic), selling mainly snacks and soft drinks; (iv) consumer credit (with linked deep discounts); (v) promotions of key products; and (vi) one-stop shopping for services beyond food retail, having under one roof or in the same commercial centre banking services, restaurants, pharmacies, bakeries, electronic stores and so on.

Especially in first-wave and second-wave countries, this extension of modern retail into poorer areas and even rural areas has displaced a large portion of the traditional small food stores (144,165). The small shops had the advantage of proximity, credit and small packages, all of which modern retailers now offer, especially via small format stores.

However, traditional neighbourhood stores and mom-and-pop stores have sometimes evolved with the competition from modern retail. Carvajal and Marston (157) note this for the Dominican Republic, where the 'colmados and colmadones' have shifted their product compositions and added services (e.g. bars, slot machines, store credit and delivery) to reinforce their local positioning. Moreover, banks also use small shops as part of their growing information technology-based and mobile phone-based banking services, as in Peru, according to Elton (166).

Note that the penetration rates beyond the initial core of a chain's operation (large city, upper-income segment) depends on several interrelated factors: (i) the wave (the more advanced the general penetration, the broader the diffusion), (ii) the degree of the leading chains' procurement system modernization (hence cost reduction that can be passed on, while maintaining profits, into price reductions to win over poorer consumers) and (iii) the product category (with broader diffusion in processed product retail, second in semiprocessed and last in fresh products).

As modern retail spreads, there tends to be format diversification to facilitate the spatial and consumer segment differentiation and penetration. For example, to penetrate the markets of inner cities and small towns, where space is limited and product assortment can be more limited, chains use discount stores, convenience stores and small supermarkets. A typical example is Mexico, where Walmart and Soriana are opening small format supermarkets in small towns. To penetrate suburbs and large cities, where transportation is available, chains use large supermarket and hypermarket formats. Chains also open small, focused 'hard discount' stores and convenience formats to compete with traditional neighbourhood shops on prices, e.g. what Carrefour did with the brand Dia in Argentina in the late 1990s. This format is larger than a convenience store in assortment but smaller than a supermarket and can focus on inner city settings, where traditional shops dominate. Castellanos notes that in Mexico, Walmart has medium-size supermarkets, hypermarkets and warehouse clubs for the middle-income and upper-income segments (153). For the lower-middle-income and lower-income strata, Walmart uses the Bodega Aurrerá format with bulk goods and cheaper prices. Fonseca reports that in Brazil during the recent recession, retail firms developed further the cash-and-carry format as discounters, with prices about 15% lower than those of other formats and with a 40% penetration of the consumer market (167). Vasquez reports that in Guatemala, the leading chains also have formats for lower-middle-income and lower-income consumers (168).

As many chains started operations in the tight real estate markets of large cities, or in commercial centres or as parts of department stores, in the early 1990s, the supermarket format was predominant. Subsequently, to facilitate the spatial and consumer segment differentiation, other formats have proliferated. One such format is the convenience store. In the early 2000s, modern retail chains rapidly developed convenience store chains. While the stores are numerous, each is small, and the aggregate share of modern retail is generally 10–20%. However, the importance of convenience stores has been growing, as they can penetrate dense urban areas and are very convenient because they are open late into the night (as noted for Honduras by Pavon) (169).

A new format is ecommerce, which promises to penetrate into dense urban settings even more easily than convenience stores as the product is brought to the consumer. It lends itself, in particular, to dry processed foods. For Mexico, Castellanos notes that Walmart launched *superama movil*, an app for mobile phones (153). This has become common in Chile. Some firms have been providing Internet access to supermarket purchases and deliveries and have expanded the services, e.g. Telemercados (<https://www.telemercados.cl>). Moreover, in Chile, large supermarket and hypermarket chains have started online ordering services for consumers, e.g. Jumbo (<http://www.jumbo.cl/FO/LogonForm>) and Walmart's Lider (<https://www.lider.cl>).

Finally, akin to format diversification is modern retail's increasing horizontal integration into food service. An example is Walmart's purchase of the VIPS restaurant chain in Mexico and the Wong chain in Peru to sell prepared products or to branch into meal delivery. This is a sort of mirror of processors vertically integrating into food service, as we show later. Moreover, large chains of convenience stores have begun to lease space to fast food chains for drive-through and carryout services (169).

Penetration of modern retail by food product category—Supermarkets penetrate food retailing by food categories. The first category affected is processed foods – canned, dry and packaged items, e.g. rice, noodles and edible oils –due to the economies of scale in procurement and direct relations with processed food manufacturers. Typical of many developing countries, supermarkets quickly took over staples and packaged food retail in Argentina in the 1980s and 1990s (146), in Chile in the late 1990s (144) and in Mexico in the late 1990s (152). Processed foods are usually two-thirds of supermarket sales, so this penetration is important. In Brazil, e.g. the Brazilian Association of Supermarkets (ABRAS), cited in Fonseca (167), found that food is 78% of modern retail. Of that, at least two-thirds is processed food: 27% dry groceries (processed), 14% perishable processed food (e.g. canned beans and vegetables), 16% liquid groceries (milk, juice), 7% bakery and 2% prepared or deli foods. The fresh (nonprocessed) foods are 19% meat (including processed meat), 12% fresh produce and 2% fish. Interestingly, these shares are close to the average diet shares of these categories in LAC consumption studies. In the early years of supermarkets in Latin America, the sales were disproportionately processed foods (as for supermarkets in the USA), as they had economies of scale and eventually of scope in warehousing and retailing. In those early days, supermarket sales were skewed (compared with national diets) towards processed products. However, as we have shown, over time, the importance of processed food in the overall diet has grown greatly in LAC. The causes are of course complex, but it is clear that the processing sector, supermarket sales of processed foods and consumer demand for processed foods evolved together and reinforced each other.

The second category is semiprocessed foods, e.g. dairy products with extensive or minimal processing and chicken, pork, beef and fruit with minimal processing and packaging. As with processed foods, supermarket chains have advantages over mom-and-pop stores and wet market operators owing to economies of scale and relations with processors and packers. For chicken in Argentina (146) and beef in Chile (144) and Costa Rica (170), supermarkets developed large chilling facilities and arranged lower costs with processors relative to traditional butchers. (The exceptions are where the meat is not a commodity but a highly

differentiated product, e.g. beef in Argentina (146).) Taking over the retail of dairy products, supermarkets boost dairy market development and product diversification, as in Chile (144), Brazil and Argentina (122). This is important, as 20–25% of supermarket sales fit this category.

An important qualifier should be noted. One might imagine that supermarkets and convenience stores introduced processed food to the LAC food market, penetrating a market hitherto bereft of processed food. While this is to some extent true for traditional wet markets and grain and produce markets that mainly sell raw products that consumers process and prepare at home, those markets usually have a processed foods section also. Moreover, the hundreds of thousands of small shops in LAC typically carry snacks, beverages and prepared foods (which are mainstays of their sales) and did so before the rise of supermarkets. For example, Pavon (169) notes that convenience store chains in Honduras sell such prepared items as hot dogs, pizza, roasted chicken, snacks (candy, ice cream, cookies) and beverages (soda, beer). He notes that small traditional shops (*pulperias*) also sell similar items. The difference is that the traditional shops have fewer items that tend to be more expensive (and have less diversity) than have supermarkets and convenience stores, because traditional shops lack economies of scale in sourcing and pay the margins of the stockists who distribute the items. Vasquez (168) notes that soft drink suppliers in Guatemala estimate that 80% of their sales are in traditional markets and small shops.

The third category is fresh produce (fruits and vegetables) and is by far the slowest for supermarkets to develop. In the USA, this category accounts for about 15% of supermarket sales. Reardon *et al.* (152) show that in Mexico the share is 10–15%, depending on the chain. A rough rule of thumb emerging from empirical studies is that the supermarket share of fresh produce retail is lower than the supermarket share in overall food retail but that this gap closes as the overall share rises. For instance, the supermarket share of fresh produce retail in Guatemala in 2003 was about 10%, whereas the supermarket share of overall food retail was about 35% (rising to 40% in 2007). Hence, the supermarket penetration rate for produce is one-third of the overall food penetration. By contrast, in Brazil, the supermarket shares were 50% of fresh produce versus 75% overall, or fresh produce was two-thirds of the overall share (147). The Asociación Nacional de Tiendas de Autoservicio y Departamentales in Mexico (151) reported that in 2005, on the basis of consumer surveys, the supermarket share of fresh produce was 25%, the share of cheese was 53% and the share of packaged foods was 84%.

Concentration of modern food retail—A common pattern is that initially family owned supermarkets or department stores with food sections become domestic chains. As domestic chains proliferate, foreign chains enter the market in large cities and push domestic chains into secondary and tertiary cities and towns. In LAC by the 2000s, foreign chains usually occupied the top lucrative spots and large domestic chains the next spots, and small domestic chains or independents focused on particular regions (143,144). Loza and Beillard (160) illustrate this for Peru, where two Chilean chains and one Peruvian chain are the top 3. Pavon (169) illustrates this for Honduras, where Walmart, which acquired the large domestic chains Paiz and Maxi Despensa, PriceSmart (USA owned) and La Colonia (Honduras owned) hold the top 3 positions and a large share of the market. In Mexico, Walmart has

32% of supermarket sales, and the domestic Soriana, which merged with Comercial Mexicana in 2014, has 16% of supermarket sales, the second largest share.

In terms of structural concentration, Brazil, the largest country and has population and the leading economy in LAC, is a partial exception. Like elsewhere in LAC, the concentration in large food retailers is growing (in 2015, the top 10 chains constituted 35% of modern retail sales), as is multinationalization (the four largest companies are French, US and Chilean). But there is also a vibrant sector of small supermarket chains and independents. Using ABRAS's definition of a supermarket as having two or more checkouts, small stores still comprise 55% of stores and 19% of the total volume of the food retail sector (167). Some of this fragmentation is due to Brazil's large size and geographic and cultural regionalization, and some is because the small neighbourhood supermarkets offer greater convenience to consumers through proximity and shorter times spent shopping (122). In some countries, small chains and independent supermarkets have formed procurement associations to achieve economies of scale and bargaining power, e.g. the national union of low-cost supermarkets in the Dominican Republic (157).

Interface of consumers and modern retail—Despite the importance of processed food in diets and supermarkets in the supply chain, there have been few empirical studies of the links among consumers, processed food and supermarkets in LAC. An exception is that of Asfaw (171), who analysed consumer expenditure data and found that, controlling for the endogeneity of shopping at supermarkets, supermarket customers purchased a higher share of partially and highly processed foods than did those who shopped only at traditional stores. While Monteiro and other Latin American scholars present the same hypothesis, longitudinal research on this topic is lacking (76,92,172).

Fast food revolution—To understand the rise of fast food restaurants and other food services, it is necessary to take a half-century perspective. As with supermarkets and food processing, we find that the food service sector started locally on a small scale in the 1950s and 1960s. The sector rose gradually at first and then grew rapidly in the 1990s and 2000s. Here we discuss the patterns and drivers of that sequence and examine recent growth.

Initially the restaurant sector in the 1940s and 1950s and earlier was fragmented. LAC has a rich tradition of small-scale food service, e.g. street vendors selling simplified meals (e.g. *taquerias* in Mexico); independent (nonchain) sit-down restaurants in cities; fixed or mobile vendors of snacks made of grain or roots, tubers or plantains and oil and sugar (e.g. *churro* vendors in Colombia); and bakeries, *tamalerias* and *tortillerias*. In 1960–1980, domestic food service chains proliferated. Urbanization brought mega-cities and secondary cities, urban incomes rose, women increasingly worked outside the home, and men and women often commuted to work; and as a result, the food service sector rapidly expanded. Economies of scale became possible, and chains emerged and served the poor and emerging middle-class markets. For example, Giraffas was founded in 1981 in Brazil and, in 2017, is in 130 cities with 410 outlets (www.giraffas.com.br).

In the 1990s, large domestic or foreign processors and fast food umbrella firms began to acquire domestic chains. Earlier, we noted that domestic food service companies grew into

chains spanning many cities in their countries. From a business perspective, they became 'ripe' for acquisition in the 1990s and 2000s. They supplied large networks of skilled labour and physical assets, in particular real estate, and well-known brand names that were usually maintained after acquisition. From their purchasers, domestic companies gained capitalization, links to large procurement systems for economies of scale and in some cases technology transfer and multinational markets. The effect was the growth of food services. The acquirers are of four types:

First, various multinational supermarket chains wanted to add food service divisions to their portfolios, and FDI liberalization in the 1990s opened that door, e.g. Walmart Mexico's acquisition of VIPS.

Second, large domestic umbrella food service firms bought individual chains to form a portfolio of chain brands, e.g. Alsea's acquisition of VIPS from Walmart in 2013. In turn, the umbrella handled franchising and common procurement systems.

Third, foreign umbrella firms invested their brand names and chains in LAC. A major example is the spinoff in 1997 of Yum! from the US giant PepsiCo, which began with beverages and became a leader in snacks and food services in the 1990s. Yum! owns KFC, Pizza Hut and Taco Bell, which have 17,000 outlets in 'emerging markets' and are important in most LAC countries. Pizza Hut has 154 outlets in Brazil, KFC has 341 outlets in Mexico and Taco Bell has 48 outlets in Guatemala.

Fourth, large processed food conglomerates buy domestic (and foreign) fast food chains. In many cases, they vertically integrate, supplying processed intermediate inputs, e.g. Bimbo's acquisition of El Globo in 2005 or the acquisition in 2014 of the hamburger chain El Corral in Colombia by the giant Colombian food processing company Nutresa (which has about 60% of the processed food market in the country) (173). Note the similarity with PepsiCo's acquisition of fast food chains in the 1980s and 1990s.

Individual chains also made massive investments in the 1990s and 2000s. McDonald's started in the 1980s and grew quickly. In 2007, for management efficiency, it centralized its franchise management in the LAC company Arcos Dorados S.A., which became its largest franchisee in the world. In LAC, Arcos Dorados manages 2,119 restaurants, 335 McCafés and 2,526 pastry centres in 20 countries. McDonald's entered Mexico in 1985 and now has 500 sales outlets in 87 Mexican cities.

The differing product penetration patterns of fast food chains versus restaurants are of special interest for this review. Restaurants in LAC have long offered foreign food but have tended to emphasize sit-down dining and menus with primarily local, traditional dishes, e.g. VIPS's in Mexico. However, the great majority of fast food chains offer products that are not traditional in LAC, e.g. pizzas, hamburgers, US-style fried chicken and French fries. Some fast food not traditional in the USA (pizzas, hamburgers, French fries) had in fact shifted from special event food to everyday food before the 1960s (174). The 'vector' of food habit changes in the USA from the 1960s to the present, represented by cheap and easy food from fast food chains, is remarkable, and those foods have entered LAC.

International chains introducing nontraditional foods have induced competitive investment but also mimicry among domestic chains, e.g. the successful hamburger chain El Corral in Colombia or Giraffas in Brazil. Domestic and foreign chains often include local snacks on the menu, e.g. *churros*, but the main fare is nontraditional (gradually becoming traditional). Also, chains modify sauces and condiments to adapt the taste to local expectations, even for nontraditional foods. The latter have succeeded in the face of strong competition in similar ingredients and meal niches. Perhaps surprisingly, as local researchers had predicted this could not happen, hamburger chains have made headway in Argentina, which has a tradition of beef quality and preparation. Argentina also has a long-standing tradition of European-style coffee shops and bakeries, but McDonald's grew tenfold there in the 1990s.

Paradoxically, fast food chains have even been a vector of diffusion of dishes from one LAC country to another, at least in an approximation of the dishes. The US firm Taco Bell has many outlets selling a US version of Mexican food in Guatemala and other LAC countries (except Mexico). Hamburger and chicken chains are not only vectors of diffusion of high-fat fried meats, fried potatoes and sugary drinks; but most also sell many desserts, snacks and pastries. We noted earlier that McDonald's, for example, has in its portfolio many pastry centres as individual outlets, and the Guatemala McDonald's have pastries and ice cream. Along with it hamburgers and hot dogs, the Colombian chain El Corral has cassava fries, brownies, pies and ice cream (www.elcorral.com). The Giraffas chain in Brazil has hamburgers and restaurant-fare meals (e.g. a plate of rice, French fries, sausage and steak) and salads as well as deep-fried items (onion rings, French fries with cheddar and bacon), ice cream drinks and pastries (www.giraffas.com.br).

The reasons for the take-off of fast food and other food service chains in the 1990s and 2000s in LAC include, on the demand side, rising incomes in the region and urbanization in the 1980s and 1990s and changing employment patterns. Many women entered the labour market outside the home, and male and female workers commuted to work. As in the USA and Western Europe before in LAC, these factors increased the opportunity cost of time and thus the quest for the convenience of eating out and incomes allowing snacking. Home delivery from fast food chains and ecommerce has magnified the convenience of ordering meals from these chains. This common service of international fast food chains has been taken up by domestic chains, e.g. that in the works at El Corral (175). Also the larger chains use an array of marketing techniques via all media, from children's gifts to characters like Ronald McDonald (176,177), to generate demand and customer loyalty.

On the supply side, two large sources of investment created a discrete jump beyond the traditional and transitional food service supply chains discussed earlier to modern food service supply chains. Many countries in the region liberalized FDI in retail and food service in the 1990s. This initiated an avalanche of FDI from chains, e.g. McDonald's, KFC and Pizza Hut. Just as equity firms, processing companies and supermarket chains poured investment into the emerging fast food chains in the 1970s and 1980s in the USA, domestic and foreign firms poured investment into foreign and domestic chains in LAC. The process could take place with less risk and more information from prior innovation than had occurred in the USA and Western Europe, thus accelerating the process.

Another factor on the supply side is the modernization of fast food chain procurement systems, which has proceeded with many parallels to that of supermarket chains. The chains themselves tend to have centralized procurement and distribution centres, allowing economies of scale, bargaining power and lower costs than has the traditional restaurant sector with which they compete. Umbrella food service and processing companies owning the chains further broaden that advantage. Key suppliers and wholesalers (e.g. Marfrig in Brazil) have distribution centres as well, so they cut out the middleman and the supplier link. This is similar to the kind of coordination and transaction cost savings we noted in the retail segment.

As with supermarkets, specialized and dedicated wholesalers have emerged to handle sourcing and distribution for food service retailers, allowing smaller chains and independents to obtain economies of scale and scope and access specific collective assets they could not obtain on their own, e.g. large distribution centres and logistics. In the USA, this trend started in the 1970s, e.g. with the rise of Sysco, now the largest wholesaler for food service in the world. Some US processing and wholesale firms, e.g. OSI (specializing in providing meats to fast food chains), moved into Latin America in the 1980s. OSI innovated with frozen beef patty technology in the early 1970s and became one of the main beef suppliers of McDonald's, growing with it. OSI took the innovation and business model to Brazil and Mexico in the 1980s and 1990s to supply the emerging fast food chains and restaurants. Domestic firms with the same structure and aim of OSI, rising in their own context of growing fast food chains, then bought the beef, chicken and pork operations of OSI in Brazil and Europe in 2008 (178). The European acquisition is an example of how emerging market firms grow along with their markets and acquire first-generation firms and themselves multinationalize.

Among the domestic firms that supply fast food chains in LAC is Marfrig Global Foods (<http://www.marfrig.com.br/en>), which focuses mainly on beef (including patties, like OSI). It is a LAC company that has become multinational through acquisitions and by supplying multinational food service companies. Marfrig has production, sales and distribution units in LAC (Brazil, Chile and Uruguay), the USA and Asia. Marfrig started in 2000 as a beef processor and distributor (Marfrig Beef); began expansion investment in beef, pork and chicken in Brazil, Argentina and Chile in 2006–2008; acquired OSI's operations in Brazil in 2008; and in 2010 acquired Keystone Foods (179), a large specialized US wholesaler for food services. Keystone, which started in 1960, is known for supplying frozen chicken for McDonald's Chicken McNuggets.

The coevolution of processors and farmers has facilitated fast food chains' needs. Ghezan *et al.* (180) note the vertiginous rise of McDonald's in Latin America from only 100 outlets in 1985 to 699 in 1996 and to 1,581 by 2001. In Mercosur (Argentina, Brazil, Paraguay and Uruguay, all traditional beef-cuisine countries), McDonald's went from six outlets in 1985 to 318 in 1996 and to 822 by 2001. Ghezan *et al.* note that in the mid-1990s, McDonald's shifted from local suppliers to the multinational suppliers that supplied McDonald's in other markets, e.g. Keystone Foods and Mc-Cain, the large Canadian multinational that produces French fries for fast food chains internationally (180). In Argentina, McDonald's replaced imports with a local potato supply contracted by McCain, inducing a shift from table

potatoes to processing potatoes (the Atlantic variety). This supply shift was crucial to McDonald's rapid expansion there.

A further facilitator of rapid expansion has been franchising, thus leveraging SME capital, e.g. Mrs. Fields Cookies franchises in Mexico (181). Another major driver of fast food chains first in the USA and then in LAC has been innovations in food processing and preparation technologies, which allow mass production in a given outlet or by off-site processors. For example, KFC invented the oil pressure cooker in the 1960s, OSI developed the freezing and compacting of hamburger patties in the 1970s and Birds Eye invented French fry and fish stick freezing technologies in the 1920s. Large fast food chains invested in this equipment, reducing preparation time costs (and customer waiting time) and increasing food safety, thus gaining a competitive edge over traditional food services. The cooking technologies involved intensive use of oil, thus of course contributing to the fat content of the meals.

The upshot of the demand side and supply side drivers of fast food chain development in LAC has been the evolution and growth of chains in the 1990s and 2000s. We illustrated that with data from individual companies. We now present broader recent data from Planet Retail to show the sales trends of some leading fast food chains (and other food services) in the past 8 years. Tables 2A and 2B present the data in a form similar to that in Table 1. Table 2A shows the sum of the leading fast food chains, café chains and regular restaurant chains that Planet Retail followed in 2008, 2011, 2014 and 2016. Table 2B breaks out fast food chains. The majority of Table 2A is sales at fast food chains except for Mexico, where VIPS is a restaurant and is included in Table 2A but not in Table 2B.

As with supermarket chains, Planet Retail follows the leading chains, and for food service, it mainly follows multinationals except for several domestic Mexican firms. The firms followed include Baskin-Robbins, Burger King, California, Domino's, Domino's Pizza, Doña Tota, KFC, McDonald's, Pizza Hut, Subway, Taco Bell and Wendy's. This, of course, misses the many domestic chains, e.g. El Corral and Pan Pa' Ya! in Colombia. Moreover, sometimes, country totals change a bit because of changes in coverage. For example, Costa Rica's sales went down in the table when Wendy's left after 2014. But we think the table indicates broadly the direction and speed of change of the sector in Latin America.

Several points emerge in Table 2A. First, sales growth has been fast: 8.9 billion USD in 2008 and 16.3 billion USD in 2016, approximately doubling sales in 8 years. Second, there is more variation of sales growth over countries than in the case of supermarkets. As with supermarkets, however, there was some steadiness in the first two periods (3 years each) and then a slowing in the last period from 9% to 9% to 6%. Third, the differences between the first-wave and third-wave countries are less clear. The rates of growth are similar in the first period, but then, like supermarkets, the growth rates are faster in the third wave in the latter periods.

Transformation of food processing in Latin America and the Caribbean

Trends in the growth of meat, dairy, feed and soy production and first-stage processing—From 1970 to 2013, cereal consumption (by disappearance, calculated from

FAOSTAT) in millions of tons in LAC grew from 99 to 230, roughly doubling. By contrast, nonstaples (food products other than cereals, roots and tubers) grew from 310 to 937 million tons, roughly tripling, while the population doubled from 284 million in 1970 to 611 million in 2013. Much of the nonstaples growth was in meat and dairy. In 1965, meat consumption per capita was 31.7 kg and by 2015 doubled to 65.3 kg. Whole milk equivalent consumption per capita was 80 kg in 1965 and by 2015 rose to 125 kg.

For per capita consumption to double as the population doubled means that meat and dairy output quadrupled over those 40 years. The great majority of that went to domestic consumption. Home consumption and home processing of meat and dairy declined over those 40 years (based on scattered case study evidence), which implies that first-stage processing of livestock and dairy rose at least 400% and probably around 600% over that period. The effect on consumer prices was equally substantial. For example, the price of milk dropped quickly in Brazil in the 1990s as consumption steeply rose (147). Livestock and dairy production and to an even greater extent first-stage processing of those concentrated rapidly, especially in the 1990s and 2000s. Large companies, e.g. JBS, Marfrig and Perigao in Brazil and Bachoco (an integrated feed, farming, and processing firm) in Mexico, emerged then. Furthermore, to literally feed that large increase in livestock and dairy production required in the early period mainly grazing land and gathered inputs and later mainly commercial concentrated feed from soy and yellow corn. The use of feed concentrates doubled from 1980 to 2005 (64 million tons to 114 million tons in 25 years), keeping up with the increase in livestock and dairy production. As feed processing rose, sector concentration occurred, and Brazil's BFR and Mexico's Bachoco became the number 3 and number 4 feed companies, respectively, in the world by 2015. The rise of feed processing made livestock and dairy production more intensive and efficient, adding to its growth.

The translated effect of the rapid increase in feed processing on soy production was massive. For example, soy output in Brazil went from 1.5 million tons in 1970 to 102.0 million tons in 2017. (As does the USA, Brazil exports about 58% of its soy.) This implied a significant increase in first-stage processing of soy, and as soy processing rose, sector concentration occurred. Huge integrated operations emerged, like Grupo Maggi (with a million hectares under soy, owned or contracted, as well as logistics and processing) in Brazil. A large wave of FDI in first-stage processing, like the US Archer Daniels Midland, started in Brazil in 1997 and in Argentina in 1998.

In the next section, we treat second-stage processed foods, including as a subset highly processed, fattening foods. But first we should note that the benefit to consumers of the essential 'industrialization' of proteins discussed earlier is the cheapening and consistent supply of proteins to LAC consumers in the form of animal products. There is a reverse side, however. Those products, cheapened and made easily available, have also been combined with oil, salt and bread to produce the fast food boom.

The rise and consolidation of second-stage food processing—As shown in sections General patterns of the evolution of food systems in the region and Retail segment transformation, LAC consumers have increased purchases of second-stage processed foods

over the past several decades. Of course, consumption of these foods is age-old, as households long made or bought first-stage processed ingredients, e.g. maize or wheat flour, oil and sugar, and made tortillas, arepas, bread, cookies and churros. Brazilians used cassava flour to make tapioca and Caribbeans' cassava bread. In that sense, second-stage processed products, even ultra-processed, with substantial oil, sugar and refined flour, are traditional and traditionally homemade. Several forces moved these products from homemade to purchased.

Demand side trends developing the second-stage processed food sector—On the demand side, as women increasingly worked outside the home, especially in urban but also in rural areas (131), their opportunity costs of time to prepare these products increased, and they sought the convenience of ready-to-heat or ready-to-eat products (97). In Mexico, this shift towards small store, or retailer made tortillas started much earlier but accelerated in the past two decades (182). This started at low-income levels (poor women also needed to save time), but the capacity and incentive to buy these products increased with rising incomes. Some households moved from making maize tortillas at home to buying bread, so there was a product composition shift towards more convenient cereals and forms (182). This trend was evident by the 1970s, as in Peru (183). Some items that had been festival foods increasingly became common foods, e.g. cookies, and some seasonal foods increasingly became everyday items, e.g. dairy products. As Bennett's law (116) predicts, the demand side for processed food started with purchases of processed staples and moved to processed dairy products and meats and only recently to processed fruits, e.g. packaged fruit juices.

In addition to the economic reasons on the demand side, there were two sets of psychosocial reasons. The first set is emulation coupled with former luxuries becoming cheap commodities: luxury foods and festival foods purchased often as they became cheap and storable. The other set is that the rise of advertisement by large processing companies appears to have played an important demand side role, perhaps especially for ultra-processed foods (75,120). The WHO and other major health organizations worldwide point to pervasive, unhealthy food marketing to children as a significant risk factor for childhood obesity (184–191). Children are exposed daily to food marketing where they live, learn and play – on TV, at school and sports practice, in stores, at the movies, on mobile devices and online (191–194). While TV has historically been the medium of choice to reach children, marketing via newer online, mobile, viral and social media has exploded, with elements of immersion, interactivity, user-generated and peer-to-peer content, and sophisticated location-based and demographic-based targeting that offer marketers more tools to target young audiences (191,195–197). Foods and drinks are promoted to children more than any other product type and in far greater proportions than to adults (184,190,198). Product packaging with characters linked with brand identification and specific foods has also been an important component.

The vast majority of promoted products are calorie dense and nutrient poor, with added sugar, saturated fats and sodium well above recommended levels (e.g. sugary breakfast cereals, soft drinks, candy, salty snacks and fast food) (190–194,198–202). The food, beverage and restaurant industries spend billions of dollars every year to reach children with

targeted marketing and lobbying against laws that might prevent them from doing so, demonstrating the value they see in the children's market (193,201,203–206). As noted in the diet section, this has led to increased intake of ultra-processed foods and beverages, snacking and many other unhealthy behaviours linked with excessive intake of energy, sugar, sodium and unhealthy saturated fats (75,89).

Supply side trends developing the second-stage processed food sector—On the supply side, three major trends led to second-stage processed foods becoming far cheaper and storable over time. First, there was a massive cascade in the 20th century of processing and food technology innovations that reduced the cost, increased the shelf life and augmented the hedonic attributes of processed products. For instance, in baking, there were advances in extrusion, frozen dough production, emulsifiers and enzymes, microwaves, ovens and automation (207). These technological advances were mainly undertaken in Europe and the USA first and then transferred to LAC. The shift from butter and lard to vegetable oils is one of the many dynamics that, when combined with major agricultural breeding shifts for oilseeds, led to a shift in global diets (84,208).

Second, packaging technology advances have been crucial to second-stage processing in LAC. These include (i) canning, paperboard and folding cartons (first used by Nabisco in the USA in 1896), invented in the 1800s; (ii) cellophane, invented in Switzerland in 1908; (iii) plastics for packaging developed in the 1920s and 1930s; (iv) milk cartons developed in 1934; (v) frozen food packaging developed in 1940; (vi) Tetra Pak 1951; (vii) polypropylene in 1954; and (viii) cheap soft drink cans in 1966. Bimbo of Mexico, now the largest baking company in the world (discussed more later), was among the first to adopt and implement these technologies on a large scale in LAC. Bimbo was founded in 1943 and by 1945 sold bread in storable cellophane bags, an advantage over small traditional bakeries. Bimbo sold cakes in individual packages by 1958, fundamentally changing the cake market from event cakes bought whole to snack cakes. In the early 1970s, Bimbo built the largest bread bakery in Latin America, among the top 10 in the world, putting out 1.5 packaged bread loaves per second, reducing the price of bread and other baked goods. Bimbo also made them more attractive to consumers with flavourings as well as packaging.

Nestlé and Tetra Pak, large processors and packaging firms, transferred processing and packaging technologies to LAC by co-locating and co-evolving in Brazil and Argentina. Nestlé brought in the most advanced milk processing technology for production of ultra-high temperature (UHT) pasteurized milk when it intensified its FDI in Brazil at the end of the 1980s. Tetra Pak of Sweden brought in its vacuum packaging technology for UHT milk (later also applied to juices in Brazil). These firms, along with Parmalat and several other major competitors, rapidly transformed the milk processing industry in Brazil in the 1990s, greatly reducing the consumer price of milk, bringing UHT shelf-stable milk to both middle-class and poor areas of Brazil and diversifying products in collaboration with supermarket chains (122,147).

Pan Pa' Ya! in Colombia also transferred processing and freezing technologies to LAC (173). It started in Bogotá as a small bakery and then partly through acquisition of other small firms and partly through franchising; it spread to many cities in Colombia. Executives

attended a food processing technology show in the USA in 1997 and obtained new processing equipment and deep freeze technology. The company started a deep freeze firm to supply its chain and other bakeries and developed a line of products, including bread, pasta and pizza, that it sold to supermarkets, small shops and the food service chain it started in the 2000s. The vertical integration between processing and a restaurant chain and adoption of advanced technology allowed Pan Pa' Ya! to hold its own against international competitors with FDI in Colombia, e.g. Bimbo, and large local processors. This example also shows how the new technologies do not just create a bimodal sector with small traditional and large modern processors but small-size and medium-size modern firms as well.

A third supply side factor facilitating the rise of second-stage processing in LAC has been innovation in the industrial organization of the industry. This occurred in three phases.

The first phase corresponds to the 'traditional stage' of food systems as defined earlier. This is when (and where, as it still exists in parallel to later phases) the products are produced by small-scale enterprises using traditional technologies (labour-intensive, small equipment). These include, e.g. the many small *tortillerias* and traditional bakery shops still operating in Mexican cities and rural areas.

The second phase is the rise of small-size or medium-size companies in the 1940s and 1950s that then grew rapidly in the following decades with urbanization and income increases and the growth of distribution networks from large cities to small cities, towns and villages.

The third phase is the rise of large processing firms, both foreign (e.g. Nestlé, the largest food manufacturer in the world, which has FDI operations in nearly all LAC countries, and PepsiCo's Mexican company Sabritas) and large domestic-based multinationals (e.g. Bimbo in Mexico and Nutresa in Colombia).

The early role of multinational firms was fundamental in this third phase. Cook (209) analyses the entrance into Mexico in the 1980s of key companies in the very competitive and rapidly consolidating packaged foods industry, including Nestlé, Carnation (before Nestlé acquired it), General Foods and Anderson-Clayton (before Quaker Oats acquired it and PepsiCo subsequently acquired Quaker Oats). These firms mounted advertising campaigns to change Mexican food preferences towards their (US and European) products. They shifted from direct distribution to specialized wholesalers-cum-stockists to deliver to fledgling supermarkets and to small shops. At that time, Cook notes, food manufactures were rapidly consolidating (pushing out small Mexican processors), and wholesale and retail were still relatively fragmented. Large multinational processors also provided volume discounts and promotions to induce retailers to shift to their products, save costs and win consumers with lower product prices.

But a number of domestic firms developed fast and became large second-stage processors. They often inherited organizational and food processing technologies from the international sector. Two examples from Mexico, Bimbo and Sabritas, and one from Colombia, Nutresa, fascinatingly show the path of processed foods from local, traditional and labour intensive to large scale, capital intensive and diverse.

Bimbo started as a small company in Mexico City, building from small bakeries as in the aforementioned first phase. It established bakeries and factories in other large Mexican cities and then in other LAC countries and then in the USA, Europe and China. Beginning as a bread bakery, it diversified into other baked and snack products and ventured into restaurant chains. The Bimbo Group is now a multinational company with processing operations in Mexico, a number of other LAC countries, the USA, Canada, Chile, Spain and China. It distributes products all over LAC, Europe, the USA and Asia. It makes bread, cookies, doughnuts, potato chips, corn chips and other baked goods. Bimbo also operates a chain of bakeries and coffee shops. Its factories are in cities, but it delivers its products to large and small retailers in large cities, small cities, rural towns and villages via its own distribution network of vans and trucks. This network is an important way processed food has penetrated beyond cities into villages. In the process, Bimbo and similar large urban-based processors have displaced small local firms, e.g. local bakeries and *tortillerias* (210).

Sabritas was founded in Mexico City in the 1940s as a small firm that delivered to small shops with a bicycle network. Later it expanded to other cities and formed truck distribution networks. In the 1960s, PepsiCo purchased Sabritas, which produces cheese puffs, potato chips and similar items for city and rural markets. It has an extensive direct distribution system of warehouses and trucks that deliver to retailers.

Nutresa started in Colombia in 1920 as a chocolate company and acquired or started coffee, cookie and meat firms and flour mills through the 1990s. In the 2000s, it established distribution companies in Mexico, Ecuador, Puerto Rico, the USA, Panama, Nicaragua, Guatemala, El Salvador, Honduras and Venezuela and bought Nestlé's cookie and chocolate factory in Costa Rica, the French Danone's share in Galletas Noel (Nutresa's large cookie company), a Guatemalan cookie company, a large Panamanian meat company, a Colombian pasta and ice cream company, a Peruvian confections company and a Mexican chocolate company. The point of this detail is to demonstrate that in many ways Nutresa followed the path of other global multinationals, starting from a single processed product and over decades acquiring companies in its home and regional markets to become a regional multinational. In the process, it injected technology and capital into a series of medium-size domestic processors and developed a home market share of 60% of the processed food.

Logistics and wholesale sector investments have been crucial to the rapid and deep penetration of second-stage processed products. This has included both the proliferation of traditional stockists and the spread of modern logistics, cold chains and warehousing companies. As noted above, the largest firms typically have fleets of vans or trucks distributing their products in cities and rural areas (as we illustrated for Bimbo).

Moreover, imports of processed foods have played an important role, particularly in the smaller countries with less developed domestic processing sectors. Loza and Beillard (160) note that Peru imports 10% of the consumer products in its modern retail. Brazil imports 2%, but Costa Rica imports 50% (165). In some cases, imports of snacks are rising quickly. For example, in the Dominican Republic, imports of snacks from the USA rose 300% between 2009 and 2014 (157).

By contrast, in larger countries and some smaller countries, exports of processed foods to other LAC countries have become important to their industries as well as to imports in the receiving LAC countries. For example, since 2008, with the Dominican Republic–Central America Free Trade Agreement, there imports of processed foods have increased substantially among Central American countries, as have imports of Central American products in the Dominican Republic and US products in both. Mexico's proximity and huge processed food sector ensures strong processed food exports to Central America. For Honduras, Pavon (169) shows the shares of competing exporters (for imports of 136 million USD) to the snack market (where local processed food is plantain chips and potato chips): 39% from Guatemala, 30% from El Salvador, 12% from Mexico and 7% from the USA. For Guatemala, Vasquez (168) reports that consumer agri-food imports are 29% from the USA, 17% from Mexico and 33% from other Central American countries. Of Peru's snack imports of 81 million USD, 47% is from Colombia, 10% from Brazil, 6% from China, 6% from the USA and 4% from Argentina. The integration of the LAC snack market has proceeded apace.

Link between food system transformation and diet change

Earlier, we documented the food system transformation in LAC in the past several decades. That transformation altered the food environment for tens and then hundreds of millions of LAC consumers. It also altered their behaviours as food consumers, and that changed behaviour sent a signal to the private sector to invest further in the food transformation, so that the process was iterative, a snowball. The food system transformation led to obesity by changing the food LAC consumers have access to and the way consumers relate to food. This occurred at a time when technology significantly reduced physical activity in all daily behaviours (9).

Policy implications

We have described the shifts in LAC towards overweight and obesity and provoked by changes in diets. While declines in physical activity have been an important causal component of obesity, we cannot return to labour-intensive market and home production or transportation where most of the energy expenditure decline occurred (9) nor replace this fully with new modes of physical activity, so our focus is on the food sector. This is where diet, obesity and the related NCDs must be addressed. The complexities of so doing are immense because of the changes in foods and food service technology, marketing and distribution. At the same time, urbanization and income increases have accelerated the trend towards a diet dominated throughout the Americas towards highly processed or ultra-processed foods and beverages. The levers of change have also moved, as governments no longer have direct control over the food supply or demand. As noted earlier, the transformation in the food system happened when many governments in LAC were liberalizing and dismantling policies and privatizing state functions, so there was little to no public governance of this process or of its 'externalities', e.g. the impacts on health. That liberalization had at first its main impact in allowing, in a context of increasing market opportunities brought by other meta-conditioners e.g. income increases in rural and urban areas, and urbanization, the ingress of extra-LAC multinational firms that were important in

the initiation in the region of supermarketization, fast food chain diffusion and the rise of large processors. Eventually, domestic firms also expanded to very-large-scale and regionalized presences in the liberalized and market-opportune region and accelerated food system change. Only now are LAC countries attempting to address some of the adverse health consequences of one aspect of this enormous food system change, the increase in consumer access to ultra-processed foods (75,76,120).

With control of food systems moving away from governments towards a small number of large, powerful domestic and international companies and given the complexity of focusing agricultural research and country subsidies on redirecting prices from less healthy to more healthy products, countries have tried fiscal and other regulatory approaches. Moreover, the culture and norms surrounding food, the time expended in food preparation (9,137) and their roles in the process of consumption have been transformed.

Many in the Americas are trying to direct their countries back to a traditional diet dominated by unprocessed and moderately processed foods and ingredients, but it is clear they have and will continue to clash with the modern food sector (108,211). There is a push led by Monteiro and many others in Latin America and food writers in the USA and around the world to eat wholesome food in traditional ways (75,92,108,172,212–214).

However, to turn away from convenience food is to do battle against a strong food industry and to go against the grain of demand by the mass of consumers for convenience amid increasing opportunity costs of time with the trends noted earlier. Moreover, this clashes with a culture of eating, which has changed drastically as evinced by increased snacking between meals and by the ready-to-eat and ready-to-heat convenience revolution (90,97,101).

This article highlights the modern food system supplying the bulk of ultra-processed foods, a large component of the diet available from the fast food sector and modern retailers. In a sense, the modern food system revolution merely accelerated, intensified and made more efficient the shift to processed foods that had already started in traditional shops in response to consumer demand and lifestyle changes. Even before modern processed foods were sold in small shops, traditional highly processed, salty, sugary, refined and fatty snacks, like churros, were common and were consumed as much as incomes allowed. That the consumption of these products soared with income increases and that convenience products were sought as lifestyles changed is basic economics of consumer choice. In its fundamental form, this has happened in all the urbanizing industrializing societies in more or less the same ways for the same reasons. These basic economic reasons for the shift will not go away but will intensify.

As incomes rise, as health concerns arise and importantly as the economics and technologies develop for processing and packaging healthy foods, e.g. whole grain snacks and those with healthy oils, consumers will have affordable and accessible alternatives. The evidence is that consumers turn to these alternatives as incomes rise. We think the movement to traditional food styles and delivery is currently a small niche that will not become mainstream without fully implemented regulatory changes. It is not possible to show that this can be performed

to such an extent that the lower-education and income groups and those trying to find cost-saving ways to eat can attain it.

At the same time, the industrialization of healthy alternatives will be the third phase of eating in Latin America. The process started years ago with traditional foods (not unlike in other regions) and then moved to industrialized, commoditized unhealthy processed foods (along with cheaper nutritious processed food, like dairy). In the third stage, the differentiated processed healthy products will become viable commodities. In the nutrition transition, this is termed the final phase of shifting to a mode of healthy eating and healthy activity, but to date, this approach serves a small niche market in a number of countries (138,215). When the market expands, diets will change. Hence the policies we discuss here attempt to accelerate this transition period and prepare for the third phase rather than eschew understanding of the basic economics of the food transition. The clock will not be turned back to traditional food, which includes handmade but unhealthy churros, traditional tortillas packed with lard and so on.

It is unclear whether the bulk of Latin America can return to a different way of eating that is much healthier, but policies in place are attempting to limit unhealthier foods and beverages in several countries as a first step. And it is not clear from any literature that the traditional diet in any country, e.g. Brazil or Mexico, was healthy, as the diets contained generous sugars, heavy creams and fatty animal source foods rather than whole grain tortillas, beans and vegetables, except amid the rural poor. And if these countries today went back to traditional foods and cooking methods, there is no sense that Mexicans would not use highly refined cornmeal to make their tortillas and excessive sugar in their *agua frescas* and coffees or that Brazilians or Chileans would not eat excessive amounts of white bread, confectionaries and sugar. Lard would be replaced by healthier vegetable oils, but it would be equally complex to reduce intake of refined carbohydrates, sugar, salt and total fat to create a truly healthy diet and reduce portion sizes and the number of eating events to achieve a total caloric intake that is not excessive.

When the private sector, policymakers and scholars find a way to make healthy eating as we now understand it much less expensive, less time intensive and also tasty, we will see the popularity of this type of diet explode. But this cannot be accomplished by ignoring the unhealthy components of traditional diets. Eating excessive sugar in any form, salt or unhealthy fats will not work. And the traditional diet was consumed at a time of very heavy energy expenditures that no longer exist, so portion sizes must also adapt. The modern food system that we have shown exists in LAC will change only if we can attain these shifts in cost, keep the convenience and retain the taste but provide healthy options.

An array of policies affecting food supply and demand can improve the diets of Latin America, but it remains a global challenge to accomplish a truly healthy diet for all. No country has succeeded to date, but the LAC countries are making a challenging, long-term effort. Some of the actions that countries are initiating and that can be refined and expanded address demand and in the process the reformulation of food. However, this might mean less added sugar, less sodium, healthier saturated fats and possibly in very few cases increased whole grains. But these changes might just shift to new refined carbohydrate-based foods

and not truly lead to a healthy diet. To truly provide healthy packaged processed food requires a revolution and many decades of advocacy and policy initiatives.

However, there is already much evidence of that future in the food supermarkets sell to the middle and upper classes in most countries. An expansion area (that the US exporters also discuss) is health foods, healthy snack foods and alternative processed foods. These are already rolling into the market, and businesses consider them profitable growth areas alongside healthy processed foods, like milk and plain yoghurt, and unhealthy snack foods. Businesses see those three food components as expansion paths and currently feasible, albeit with higher-income consumers, as usual (as when industrial processed food came on the market), the first in line. The change in diets usually occurs top-down, with businesses trying to attract the most profitable markets first, the upper-middle and middle classes. With organic foods in the USA and Europe, e.g. only the educated and elite bought them at first, and subsequently even the lower-middle class considered them mainstream.

It is clear, we should note, that the ideal healthy diet dominated by vegetables, fruits, whole grains and legumes must also increase fish and seafood intake and other low energy-intensive and water-intensive sustainable animal source foods and reduce other animal source foods (particularly beef), so the diet becomes climate friendly and reduces the carbon and water footprint of the Latin American diet (85,105,216). However, the challenges to get there are enormous. As horticulture, aquaculture and aviculture have risen quickly in Latin America, there has in fact been a steep rise in domestic consumption of those products, as well as dairy, in a short time. The faster these foods become cheaper and commoditized, the faster the diet will shift towards them, as has happened in other regions. The shift to whole grains is not a farming investment but a processing investment. It is fully feasible and profitable now in terms of the technology of making and packaging breads and tortillas made with whole grains. It only awaits a stronger and clearer signal from consumers (or government policies that shift relative costs of these foods), just as it did during the transition in Europe and is only recently emerging in the USA.

We will briefly outline some policies currently used to improve diets and then address in our three segments – retail, food service and food processing – additional policies. To consider policies, one should keep two sets of qualifiers in mind.

On the one hand, there are global constraints. First, trade liberalization mandates that countries must tax and control imports and domestic companies and products equally in most cases following the World Trade Organization agreements (the example of the western Pacific Islands provides evidence of this topic, and there are other trade examples (217–220)). Second, many policies that affect free speech and other civil liberties need stronger scientific evidence and the support of the WHO and other global bodies. Latin America is unique in that constitutions in many countries incorporate rights for children that can allow for more marketing and other controls than found in many higher-income countries. Third, all these changes have shifted the entire culture of food from purchasing to preparation to consumption. To shift towards healthier eating norms will not be simple nor quick.

On the other hand, as noted earlier regarding the diffusion of changes in food systems, there is substantial heterogeneity over sub-regions and countries (and zones within countries) in LAC with respect to the meta-conditioners of change (income growth, urbanization, liberalization, infrastructure and rural nonfarm employment). Where these conditioners are most advanced, system change has gone the furthest, and in those places, there is bound to be already a greater diet health challenge to be addressed. In these more urbanized places, the policy need might be more urgent, and the administrative capacity greater for implementation, but also the shift of the governance node to large companies in the food system will have proceeded further. There might then be a paradox of greater incentive for policies but a lower capacity to change or manage the course of the nutrition transition. In any case, a differentiated strategy and policy approach will be needed to fit to heterogeneous situations.

Policies impacting consumer demand

The agriculture sector has a long history of focusing on policies to increase demand for selected cash crops, basic staples and animal source foods by increasing productivity, providing subsidies along the entire chain from production to retailer, and building infrastructure focused on major crops. To date, there have been few attempts to focus policies on creating demand for healthier food and reducing consumption of ultra-processed food. But these two categories should be distinguished.

For example, there are major public investment, diversification, extension and infrastructure programmes (like wholesale markets and cold chains) to spur the fruit and vegetable industry in Latin America. This effort has grown over several decades, partly for export but also for internal consumption. This fact does not usually enter the nutritionist debates, because healthy foods, like dairy, fruits and vegetables, both highly favoured and invested in in Latin America, have been lumped with the consumption of ultra-processed foods. It is true that governments and private entities have made efforts to spur production and marketing of healthy products, like vegetables and milk, but it is also true that there have been minimal policy efforts to make it less profitable to sell and more expensive to buy junk food. Minimal evaluations of this area exist, and only the marketing and taxation areas have major evaluations underway. Mexico and Chile are the regional leaders in institutions heading rigorous evaluations of their policies. This is a major gap needing future research (221).

Fiscal policies impacting retailers and food services

We are in the early stages of learning what will work in the way of taxation and subsidies, and most work has focused on taxation of very limited sets of products to improve diets. The Mexican taxes on sugary beverages (about 10% excise tax) and nonessential foods (about 8% tax) are among the most rigorously studied. Both have been shown to have a negative impact on purchases, but their overall impact on diets and food purchases and their long-term obesity prevention effects are the subjects only of simulation studies to date (55,56,222–227). Other countries, like Chile, have instituted quite small taxes, and their evaluations are not published yet. Other fiscal policies need to be considered as they relate to issues, e.g. using tax funding to subsidize in workable ways purchases of legumes,

vegetables and fruits that focus on the poor. The economic perspective is that the best use of these subsidies and public investments is to remove infrastructural constraints to horticulture and dairy, fish and chicken production. This is fundamentally concerned with roads, electricity, cold chain facilities, wholesale markets and breeding programmes.

Marketing controls

The global focus has been on marketing controls aimed directly at children via schools and TV and has ignored exposure via nonchildren's TV, characters and other product packaging, billboards and social media. The Chilean government has instituted the most comprehensive child marketing control on 35–45% of processed foods and beverages, aiming at foods and beverages high in added sugar, sodium or saturated fat. These guidelines increase, in year 2 and year 4 of the law's implementation, the strictness of the added nutrient and energy density to cover more products unless they were reformulated. A full layout of the law has not been published. Many countries are drafting identical laws, but none has been implemented yet. Several are in Latin America. Another Chilean law expands a ban on marketing during selected TV programmes with audiences that are more than 20% children to a 6 AM to 10 PM total ban on unhealthy designate foods and warning messages on all TV programmes in other hours. The regulations related to implementation of this new total marketing ban law will be instituted in mid-2018. One of the major hopes is that if marketing controls are comprehensive, then larger-scale nutrition education to shift populations towards selecting truly healthier eating may be more effective. Removing or reducing intake of marketing of nonessential or junk food and beverages alone will not create truly healthy eating.

It is critical to add that to date evaluations are underway in Chile, but we expect it to be 2–4 years before major dietary shifts would be seen there, if at all. And other than the research in Chile, there is evidence only from other marketing control literatures like in the tobacco area to suggest marketing controls might shift behaviour. Real evidence on purchasing and dietary intake shifts is lacking to date. There is a voluminous literature on the lack of impact of nutrition facts panels and dietary guidelines and other global and local government initiatives in the education area we do not discuss here.

Front-of-the-package profiling

In Latin America, Chile is a leader in creating the most comprehensive front-of-the-package (FOP) system, which has been described elsewhere (43). The system's cut-offs are identical to those of the marketing law and thereby reinforce it. Furthermore, these laws ban characters on unhealthy food products and keep these foods out of schools. Ecuador uses a variant of the UK traffic lights, and Mexico has a limited government voluntary FOP. PAHO has a recommended system that would essentially ban most ultra-processed food from marketing (228). Many countries are considering a Chilean-style or PAHO-style warning label, but none has implemented it.

Food and marketing at government-controlled institutions

Brazil has been a leader in developing the most comprehensive school meal law that includes, among other things, that 30% of all school food must be purchased from local

farmers and other incentives related to reducing ultra-processed foods (229). This law is being implemented now, and no evaluation of the law exists. Most of the other countries in Latin America have school meal programmes. Only Chile bans marketing and junk food. The others have not implemented major reforms on food quality to the extent desired, so this is an area open for improvements. However, rigorous evaluations are needed to ensure that the changes are implemented and produce positive dietary changes.

Fast food chains—Clearly many changes can improve the quality of fast food chains, ranging from shifting the temperature of cooking French fries to lower the fat content (230), calorie and sodium labelling, and portion-size pricing. One of the most important is to require chains with six or more fast food restaurants to label calories and require pricing such that each calorie of a given food or beverage is charged the exact same amount. This will create incentives to reduce the excessive portion sizes of foods and beverages at fast food restaurants. Nevertheless, there is no research on ways to shift purchases in the formal food service sector towards healthier eating, another huge gap.

Informal food sector

This is the least regulated area and can range from carts, trucks and other types of food vendors to small stands selling packaged processed food in villages. It is an expensive area to address. To date globally, only Singapore has tried to control this sector, improve the quality of its food and provide proper sanitation and quality controls (231). Experimentation is needed to generate some viable policy options.

Policies impacting the supply side

There are three categories of agents to consider – farmers, processors and retailers – and three key premises to keep in mind.

The first and most important premise is that these actors do not have an inherent stake, ideological position, preference or goal with respect to how they affect diets. Their goal is sustaining and growing profitable businesses. If they can do that selling healthy products or unhealthy products (we do not mean toxic products), it is essentially all the same to the business. As has been observed in the USA, Germany and Chile, when organic fruit brings a profit, farmers shift to organic fruit. If the market requires integrated pest management to grow and sell fruit, farmers shift to integrated pest management. If consumers want to buy multigrain bread, bakeries add lines of those products. The economics of the product's attributes and technology decide the choice. If farmers find it unprofitable to grow organic fruit, they switch out of it. When the Chinese, European and Latin American markets wanted to buy massive amounts of soybeans to feed chickens and fish (and beef cattle), Brazilian and Argentine farmers quickly switched to these products without subsidies or help. The markets and profits have dictated the main decisions in Latin American agriculture, not subsidies. Processors can use the ensuing mass of soy to produce miso, tofu or fish feed, all healthy ends; or for cow feed or for milk for children, healthy ends; or for feed for wagyu beef cattle in Japan, arguably a tasty but less healthy end (232).

The second premise is that the retail, processing and even farming sectors of Latin America are commercial businesses and are concentrated or in the process of concentrating. There are many small firms still, but as we have shown, the great bulk of Latin American food is in the hands of medium-size and large actors. The share of LAC food coming from small farmers is small. Hence, governments cannot seek solutions that turn back the clock to fragmented food systems (with high transaction costs, much risk and expensive food). The supply side is concentrated. However, the very concentration and formalization of food processing and food retail have permitted government to apply regulations to food safety, as implementation of such regulations is difficult in a fragmented, traditional and informal food system. This in itself provides some hope that regulations constraining equivalently harmful excesses and formulations can also be implemented in the nutritional realm.

However, consider how much more the demand side is concentrated in Latin America. It is not a rural society but one with 75% urbanization. The most important goal facing policymakers is ensuring no food shortfall in the cities and that farmers, processors and even retailers are productive and efficient. Thus, it may not be politically or economically practical to turn back the clock to traditional food systems. In all industrializing and industrialized societies, one sees the push towards eating wholesome food, usually from local farmers, among those with higher educations and incomes. Rarely are attempts made to reach lower-income populations, and those usually require extensive subsidies. There is a strong movement in many countries among select farmers to serve the high-end food service sector, households and retailers, but this is a relatively small niche market.

The third premise is that the policy goals for primary production can be to lower risk and transaction costs to produce more healthy foods, given the aforementioned two points and the fact that there is already a massive amount of private investment and government support for the production of healthy foods in Latin America. Supporting agricultural diversification towards horticulture and fish, dairy and chicken production is already a goal of most LAC governments.

That leaves the demand side policy lever. We see that as the most practical way to influence processors. As noted earlier, 65% of what supermarkets sell and consumption baskets in Latin America show are processed foods. What they are and how they are processed are crucial. It makes minimal economic sense to subsidize or tax medium-size and large processors, as they are at ease with and adept at ingredient substitution. Rather, if their consumers prefer less of this and more of that, the processors will quickly follow. This is in fact the real reason the policies described earlier work mainly in rich or upper-middle-class countries, as that is where consumers have become aware of the health consequences of trans-fats, sugar, chemicals and other unhealthy ingredients and are willing to support taxes or other regulations on consumption of them. The same happened with cigarettes. Once the profits favour whole grain pasta, brown rice and low trans-fat foods, processors will run towards them, as has been demonstrated elsewhere. Where they see that the mass of consumers still want white bread and snacks laden with highly processed fat, sugar and sodium, they will keep selling those. Demand decides the supply.

Retailers represent an area where innovation is potentially possible. They do not have a stake in selling healthy versus unhealthy food, and many differentiate themselves by trying to support healthier food purchases. In the LMICs of Latin America, this is an area where no major research or experimentation has been systematically carried out, and there is room for experimentation and innovation.

In summary, the LAC region faces a major diet-related health problem accompanied by enormous economic and social costs. Obesity and many nutrition-related NCDs are linked with both excessive intake of unhealthy ultra-processed food and excessive intake of unhealthy traditional foods, be they deep-fried items, highly refined white bread or confectionaries made in traditional fashions. Most of the way to shift the food system, as we have noted, relates to shifting demand. When consumers demand healthier foods and beverages, we will begin to see these changes for an array of fiscal and regulatory reasons. As noted, we are seeing the beginning of such actions in Chile and Mexico and Brazil, but the road ahead is very long and not simple to achieve.

An essential contribution of this piece is to marry and integrate the nutrition transition literature with the literature on the economics of food system transformation. These two literatures and debates have been to date largely 'two ships passing in the night'. On the one hand, the nutrition transition debate has rightly, but somewhat narrowly, emphasized the health problems emerging from the nutrition transition that has included obesity. Many who write on this topic have largely regarded the food system as unrooted, malleable, superficial, easily changed and reversed as merely a creature of choices and politics and profits. On the other hand, the food system transformation literature has largely sidestepped issues of nutritional consequences and has instead focused mainly on distributional consequences (who is excluded from participating in new markets), and on signalling the positive consequences of the transformation (cheaper food for the poor, food system employment for rural areas, more processed/convenient food to liberate women from drudgery, less sharp seasonality of food availability, safer food, feeding huge growing cities to an extent traditional food systems could not have). This literature tends to see the food system as the opposite in nature to the vision from the nutrition debate: as rooted in inevitable economic and social logic and trends of urbanization, women working outside the home, of a world where transfer of goods, services and technology is increasingly unfettered, and of the growing ability of firms enjoying economies of scale and scope and new technology to deliver a vastly expanded and more efficient food system.

We have taken the position that these two broad literatures can and should be integrated and reconciled. We feel it will change both debates. To frame the debate in that holistic way will help the nutrition/obesity debate in the longer run, as it is clear that convenience/industrialization is here to stay and serves a key purpose demanded by consumers, including the poor (cheap food including protein and calories, convenient food to liberate women from time-consuming food preparation at a time where their involvement in the economic marketplace and their opportunity costs of time have risen greatly). The new food system has taken traditional food system luxury and dream foods (e.g. churros) and made them plentiful and cheap, while doing the same for many good foods. We conclude that the food system transformation is driven by such basic consumer side demands (of the large majority

of the populations of emerging markets) and demographic logic (urbanization and women working outside the home and men and women commuting) that trying to correct the health externalities by striving to turn back the clock and reinstate a traditional fragmented food system will be very difficult at a minimum and most likely will not happen, except at the margins for unique subpopulations that can afford the time and money to return to traditional foods and food preparation. Turning back to the traditional would then have its own negative externalities, women being pushed to spend scarce time in food preparation, food more expensive for the poor and still the growing need to feed the majority of the population who are increasingly living in urban areas.

The nutrition debate and action will need to work – with – the transforming food system and with regulation and education manage as much as possible its path, including making it more profitable, through demand increase, for the food industry to serve up health foods. Bad foods will thus become less profitable and drop off the food shelves. We showed that the food system transformation is not just existential choices that can turn on a dime but a long strong logic that of course creates its own challenges. But at the same time, we use the essence of the current nutrition debate to argue that it is important to redouble the regulatory and policy effort to address those challenges. We must be cognizant that ultimately the public consumers must be incentivized to market the components of healthy diets. But this does not address portion sizing. We must also find ways to reduce norms of food consumption towards healthy outcomes. Again, there are price policies that could help. The challenge is to reach the subpopulations with lower educations and incomes in addition to those with higher socioeconomic status.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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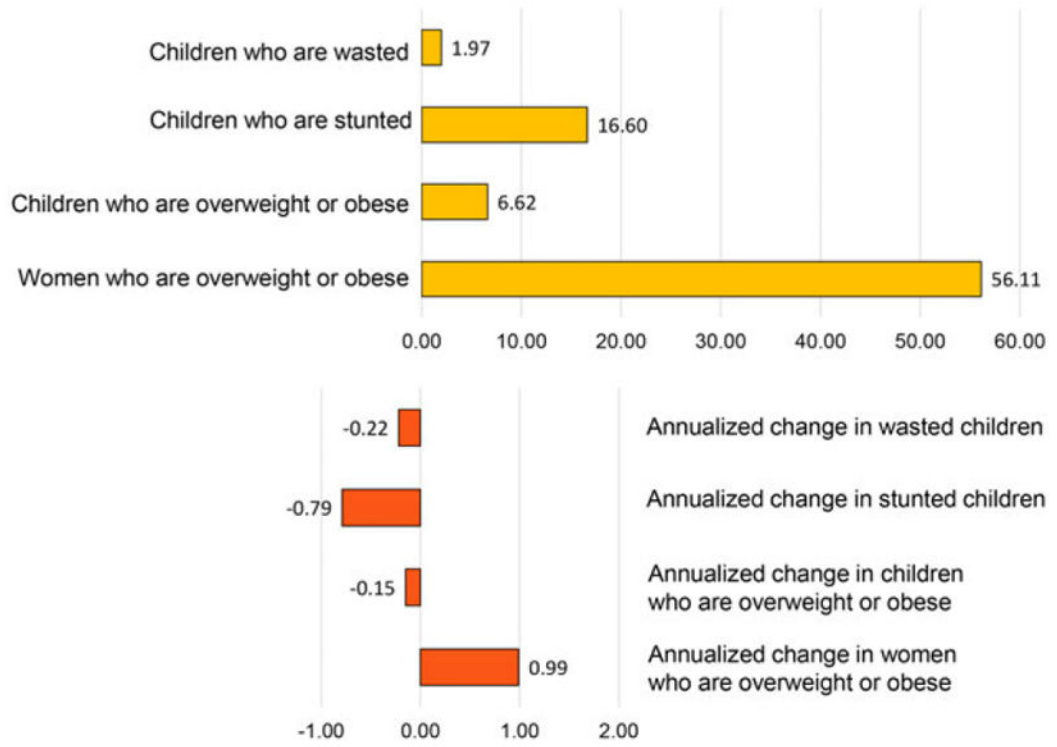


Figure 1. Latin America and the Caribbean: prevalence and annualized change of undernutrition and overweight burden (percentage point prevalence change per year).

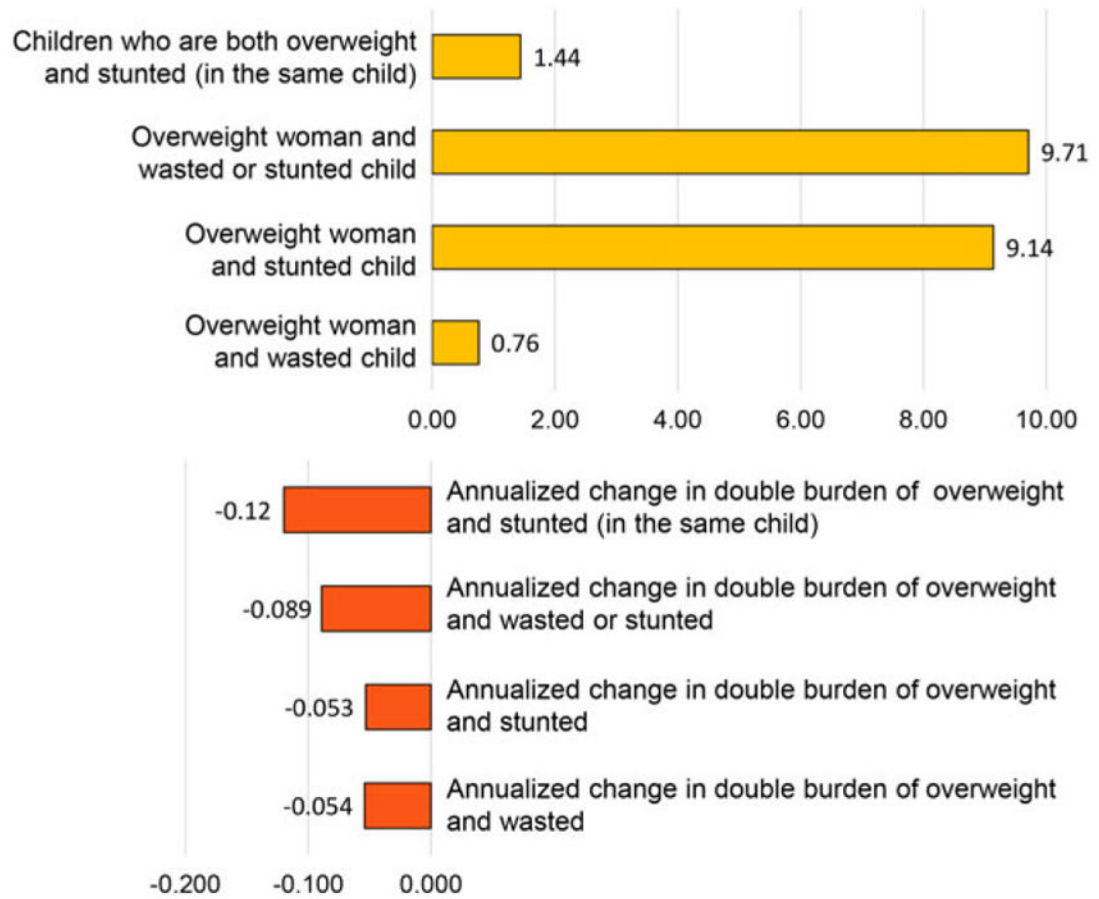


Figure 2. Latin America and the Caribbean: double burden of undernutrition and overweight and annualized change (percentage point prevalence change per year).

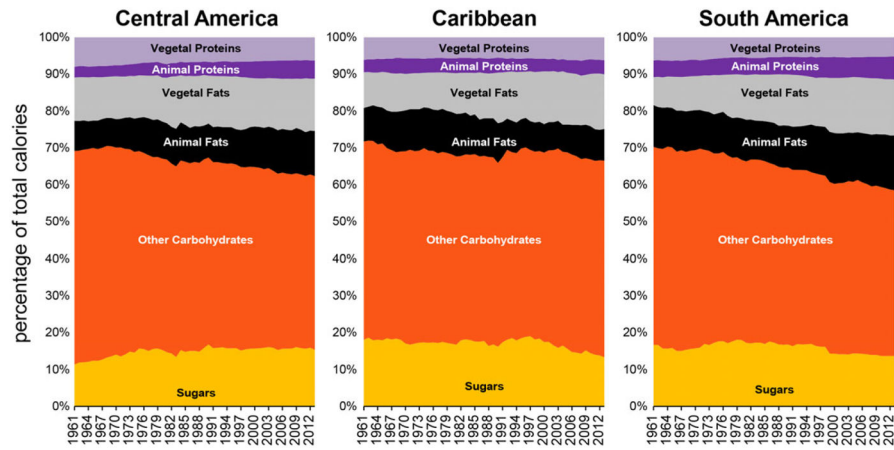


Figure 3. Change in macronutrient percentages of total daily per capita kilocalorie food balance by source, 1961–2013. Source: FAOSTAT.

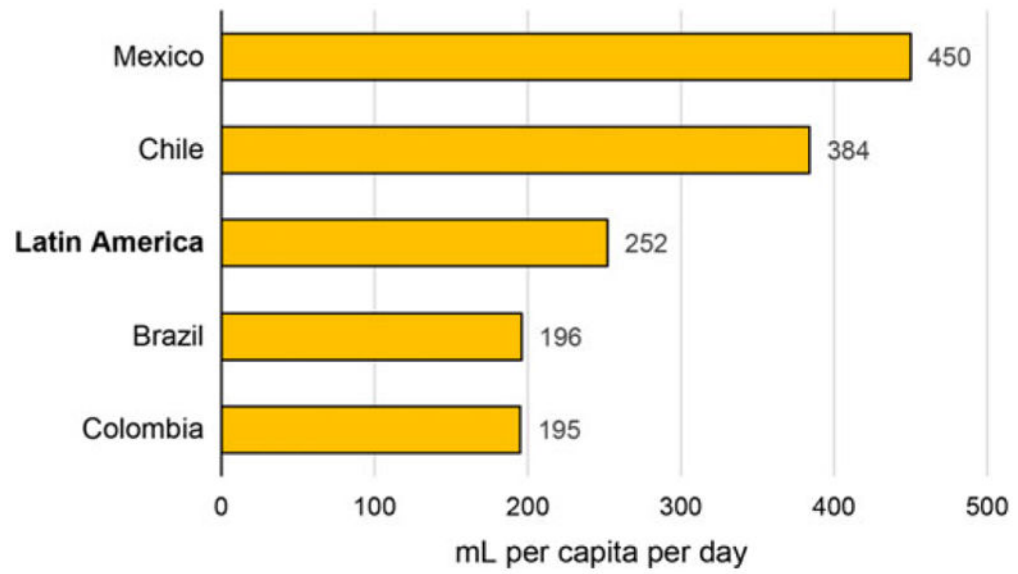


Figure 4. Total daily per capita sales of sugar-sweetened beverages in Latin America and select countries, 2017. Source: Euromonitor International Limited 2018© All rights reserved.

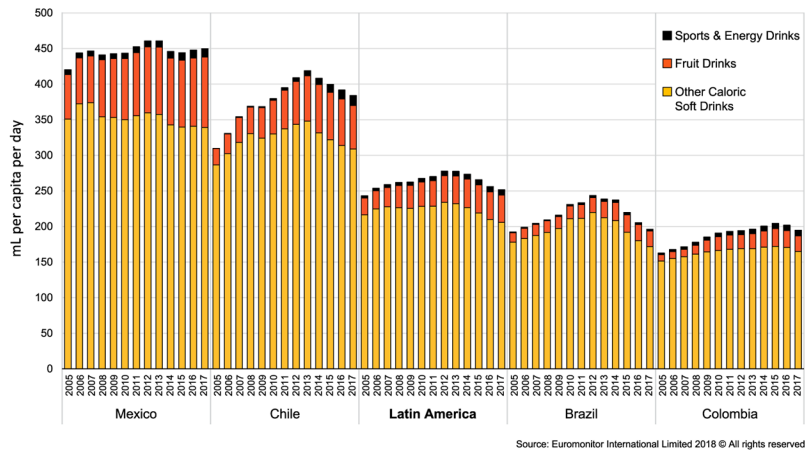


Figure 5. Trends in daily per capita sugar-sweetened beverage sales by category in Latin America and select countries, 2005–2017. Source: Euromonitor International Limited 2018© All rights reserved.

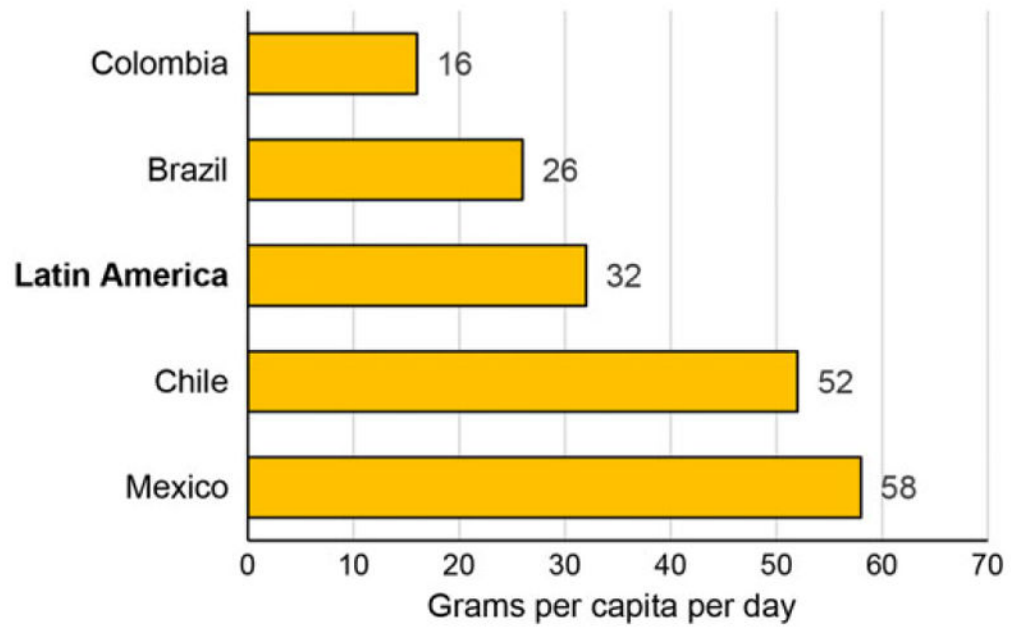


Figure 6. Total daily per capita junk food sales in Latin America and select countries, 2017. Source: Euromonitor International Limited 2018© All rights reserved.

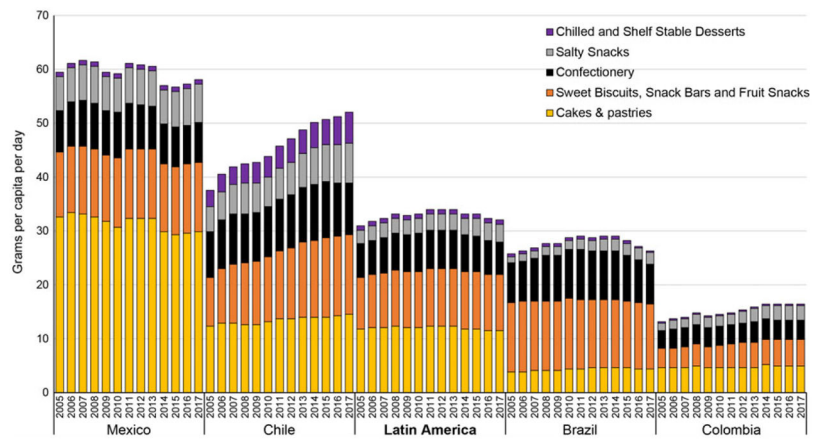


Figure 7. Trends in per capita daily junk food sales by category in Latin American countries, 2005–2017. Source: Euromonitor International Limited 2018© All rights reserved.

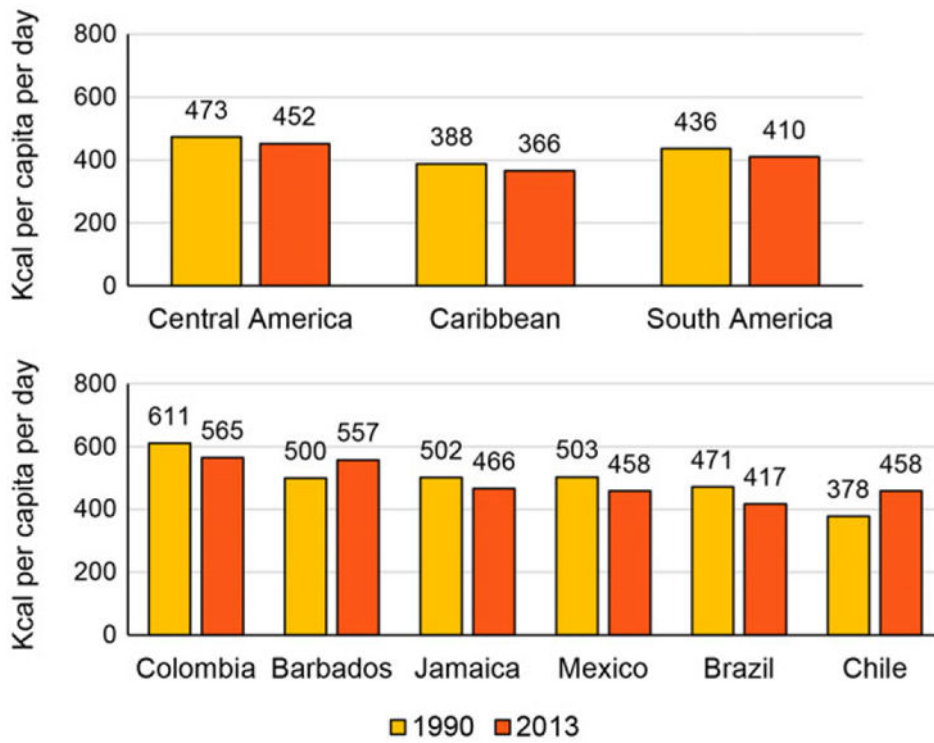


Figure 8. Sugar and sweetener food balance, 1990 and 2013 (kcal/capita/day). Source: 7 FAOSTAT.

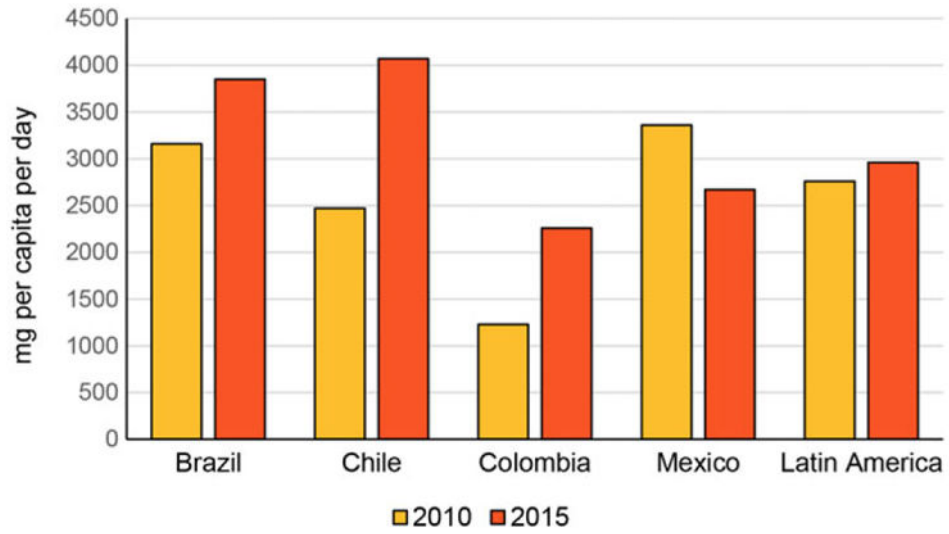


Figure 9. Combined retail and food service daily per capita sodium sales, 2010 and 2015. Source: Euromonitor International Limited 2018© All rights reserved.

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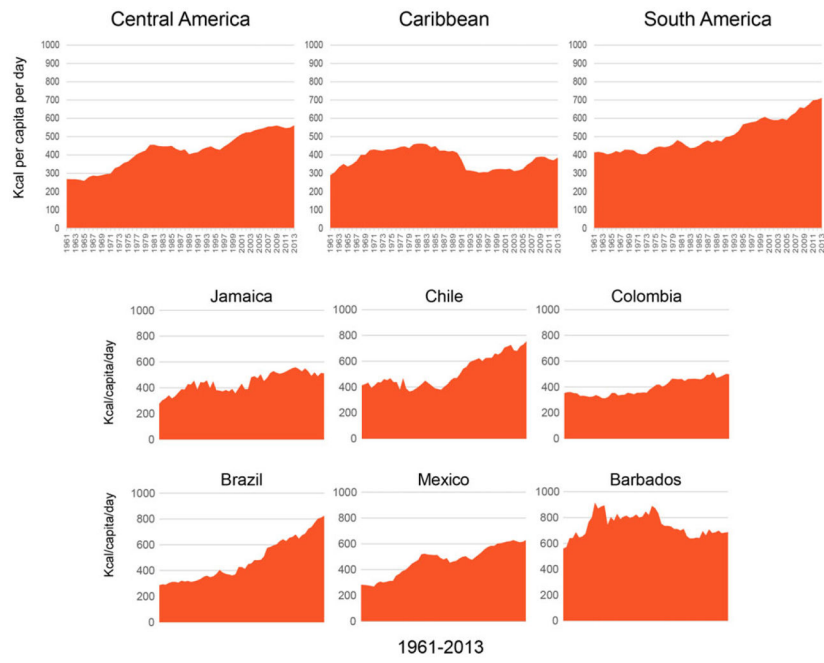


Figure 10. Trends in animal product food balance, 1961–2013. Source FAOSTAT.

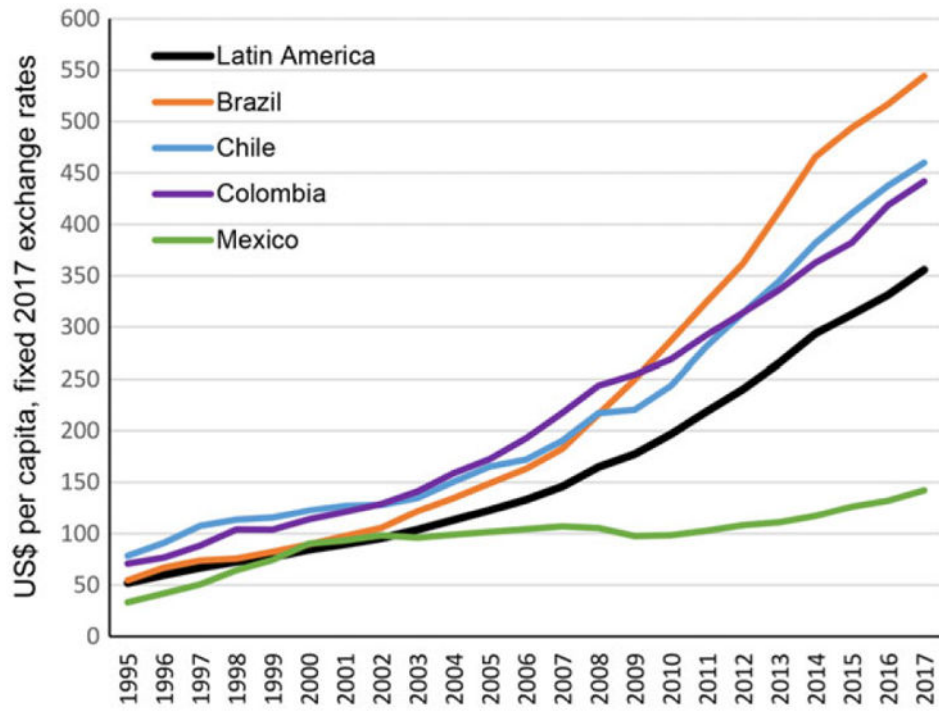


Figure 11. Per capita away-from-home food and nonalcoholic beverage yearly expenditures, 1995–2017. Source: Euromonitor International Limited 2018© All rights reserved.

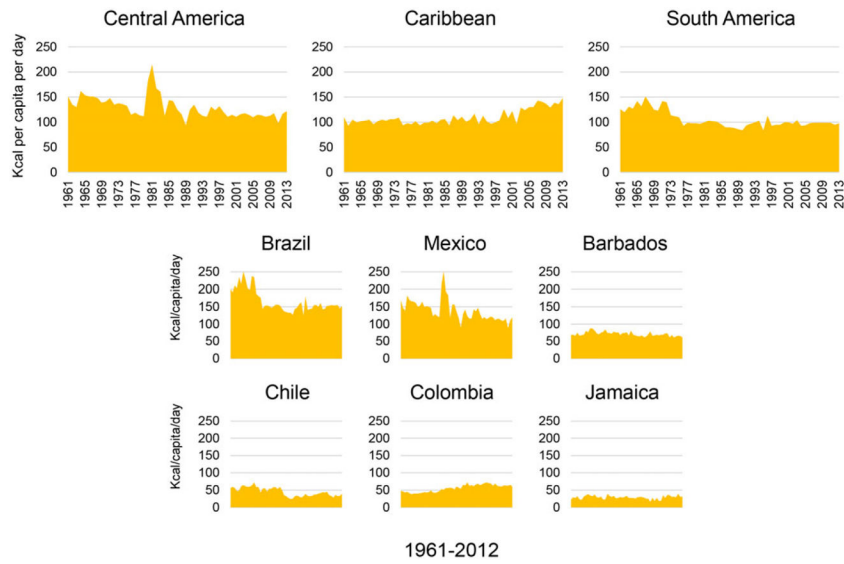


Figure 12. Trends in bean, pea and other legume food balance, 1961–2013 (kcal/capita/day). Source: FAOSTAT.

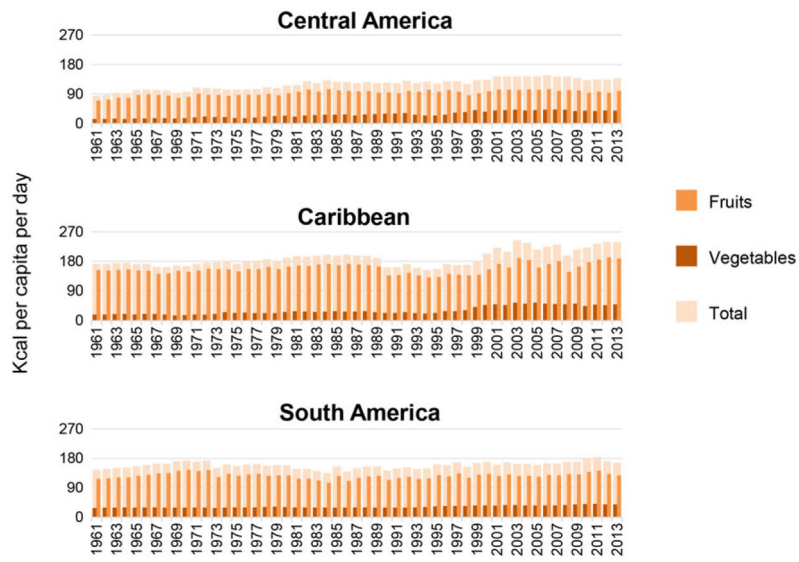


Figure 13. Trends in fruit and vegetable food balance in Latin America and the Caribbean, 1961–2013 (kcal/capita/day). Source: FAOSTAT.

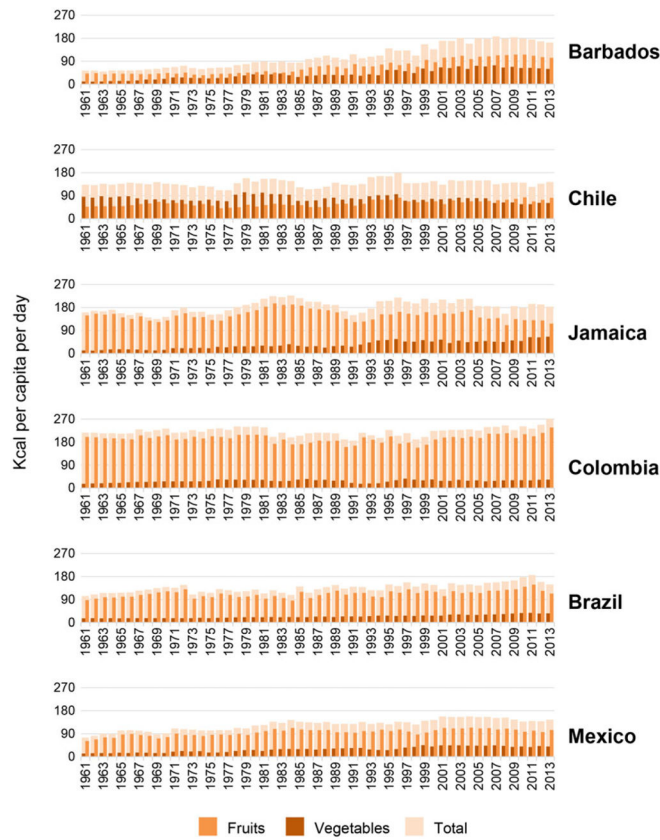


Figure 14. Trends in fruit and vegetable food balance in select countries, 1961–2013(kcal/capita/day). Source: FAOSTAT.

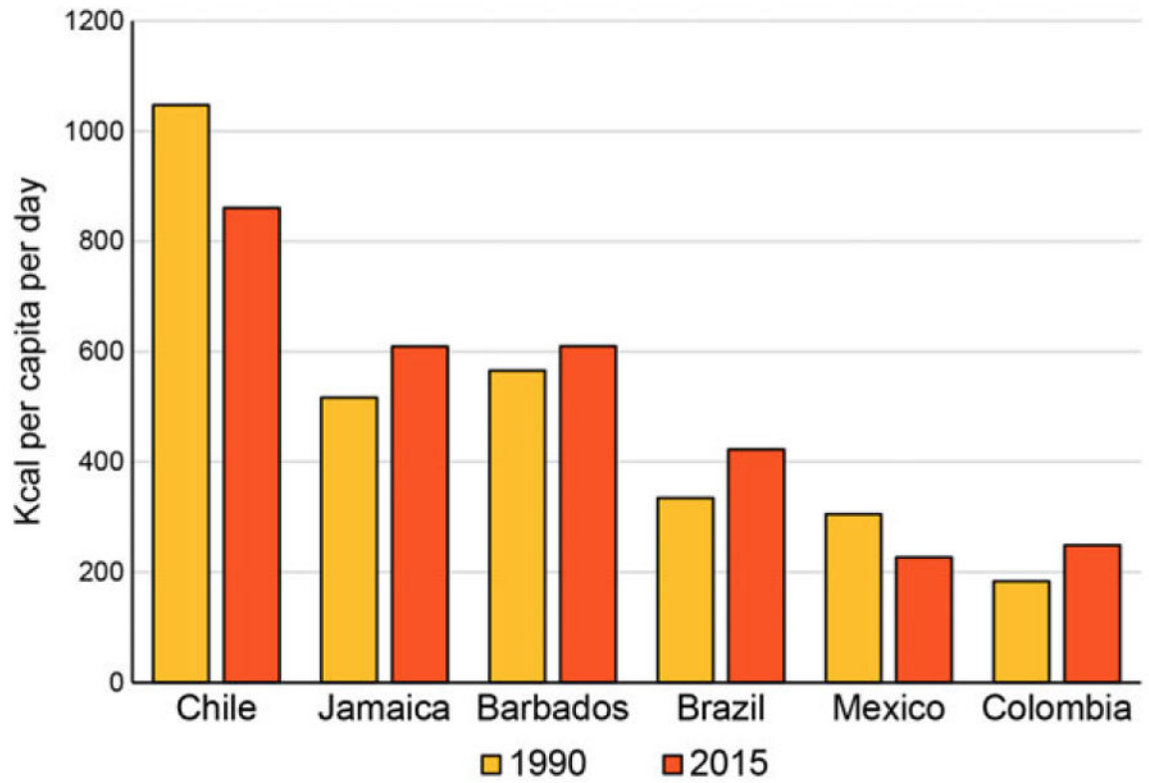


Figure 15. Daily per capita whole grain consumption in select countries, 1990 and 2015 (kcal/capita/day). Source: Institute for Health Metrics and Evaluation.

Table 1

Edible grocery sales of leading modern retail chains and gross domestic product (GDP) growth in selected Latin American countries (2002–16) in nominal millions of USD

Waves	Sales 2002	Sales 2006	Compound sales growth 2001–2006 (%)	Compound real GDP growth 2002–2006 (%)	Sales 2011	Compound sales growth 2006–2011 (%)	Compound real GDP growth 2006–2011 (%)	Sales 2016	Compound sales growth 2011–2016 (%)	Compound real GDP growth 2011–2016 (%)
First wave										
Argentina	3,057	5,036	13	9	12,207	19	4	13,656	2	-0.2
Brazil	19,110	36,853	18	4	92,039	20	4	72,019	-5	-0.4
Uruguay	344	504	10	4	1,253	20	6	1,450	3	3
Second wave										
Costa Rica	563	1,059	17	5	2,058	14	4	2,711	6	4
Chile	2,101	4,778	23	6	11,300	19	4	11,536	0.4	3
Colombia	2,032	3,099	11	5	5,892	14	5	6,038	0.5	4
Ecuador	566	853	11	5	1,576	13	4	2,251	7	2
Guatemala	377	512	8	4	1,055	16	3	1,036	-0.4	4
Mexico	11,368	17,155	11	3	24,331	7	2	22,027	1	3
Third wave										
Bolivia	28	43	11	4	92	17	5	179	14	5
Nicaragua	46	128	29	4	290	18	3	563	14	5
Peru	251	365	10	6	2,251	44	7	2,856	5	4

Source: Authors' analysis of raw data in www.Planetretail.net. The sales figures are for the food retail chains Planet Retail followed per country. Planet Retail follows the leading national chains, not smaller chains, independents or regional chains in a country. The total sales for a given country are thus an underestimate of all modern food retail sales. There are no official data with which to compare. In Argentina, Planet Retail followed 11–13 chains in this period, in Brazil 22–23, in Uruguay 3, in Costa Rica 4–5, Chile 8 in 2002 and 5–6 thereafter, in Colombia 7–8 in 2008 and 10–12 thereafter, in Ecuador 3–4, in Guatemala 2, in Mexico 13–14 in 2002 and 10–11 thereafter, in Bolivia 1, in Nicaragua 1–2, and in Peru 3 in 2002 and 5 thereafter. Any major shifts were due to companies being acquired or exiting or major firms coming in. For example, the fall in the number of retailers in Chile between 2002 and 2006 can be attributed to a number of mergers (Falabella bought Supermercados San Francisco in 2004, and D&S bought Carrefour in 2003) and to Ahold Delhaize leaving the region in 2003. Brazil's fall in sales from 2011 to 2016 can be explained by the 2015–2016 crisis, when GDP fell and a number of the major retailers (Casino, Carrefour and Walmart) reported a decrease in their sales.

Table 2A

Total banner sales of leading fast food chains, café chains and restaurant retailers and gross domestic product (GDP) growth in selected Latin American countries (2008–2016) in nominal millions of USD

Waves	Sales 2008	Sales 2011	Compound sales growth 2008–2011 (%)	Real GDP growth 2008–2011 (%)	Sales 2014	Compound sales growth 2011–2014 (%)	Real GDP growth 2011–2014 (%)	Sales 2016	Compound sales growth 2014–2016 (%)	Real GDP growth 2014–2016 (%)
First wave										
Argentina	475	606	8	3	617	1	0	631	1	0
Brazil	3,784	6,313	19	4	5,969	-2	2	9,153	24	-4
Uruguay	60	67	4	6	69	1	4	63	-4	1
Second wave										
Costa Rica	200	233	5	3	312	10	4	283	-5	5
Chile	306	352	5	3	456	9	4	458	0	2
Colombia	151	275	22	4	458	19	4	696	23	3
Ecuador	207	234	4	4	287	7	5	334	8	-1
Guatemala*	446	611	11	3	368	-16	4	372	1	4
Mexico [†]	2,939	3,009	1	1	3,669	7	3	3,808	2	2
Third wave										
Bolivia [‡]	25	28	5	4	29	62	6	43	21	4
Nicaragua	43	54	8	2	41	-9	5	45	4	5
Peru	170	227	10	5	389	20	5	381	-1	4

* Guatemala's fall in sales can be attributed to a fall in McDonald's sales (which had reported a fall in sales in Latin America). If McDonald's is taken away, the growth in sales would have been 5%.

[†] Mexico's data from 2014 to 2016 are approximate, as Planet Retail did not provide sales information on VIPS. Given that it is an important chain restaurant, we generated our own projections of its growth yet maintained the number of outlets.

[‡] We had to use 2010 data from Bolivia instead of 2011, as there seems to be an inconsistency with this year. Planet Retail reported 13 locations in 2011, whereas in 2010, it reported 26 locations, and in 2012, it reported 22.

Total banner sales and number of outlets of leading fast food chains in selected Latin American countries (2008–2016) in nominal millions of USD

Table 2B

Waves	2008		2011		2014		2016	
	Sales	Outlets	Sales	Outlets	Sales	Outlets	Sales	Outlets
First wave								
Argentina	459	234	576	318	542	456	526	516
Brazil	3,737	2,156	6,232	3,636	5,746	6,490	8,889	8,292
Uruguay	60	29	67	34	69	59	63	54
Second wave								
Costa Rica	200	204	231	247	301	324	265	255
Chile	292	213	320	236	375	289	347	354
Colombia	134	134	250	255	423	568	656	738
Ecuador	196	169	218	198	255	275	302	323
Guatemala	441	259	599	295	349	330	346	345
Mexico	2,095	2,462	2,145	2,662	2,669	3,339	2,566	3,320
Third wave								
Bolivia	25	24	28	26	29	39	39	52
Nicaragua	43	37	54	32	41	46	45	56
Peru	163	138	207	177	313	306	280	288