Review Article

The food environment in Latin America: a systematic review with a focus on environments relevant to obesity and related chronic diseases

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Abstract

Objective: Food environments may be contributing to the rapid increase in obesity occurring in most Latin American (LA) countries. The present study reviews literature from LA that (i) describes the food environment and policies targeting the food environment (FEP); and (ii) analytic studies that investigate associations between the FEP and dietary behaviours, overweight/obesity and obesity related chronic diseases. We focus on six dimensions of the FEP: food retail, provision, labelling, marketing, pricing and composition.

Design: Systematic literature review. Three databases (Web of Science, SciELO, LILACS) were searched, from 1 January 1999 up to July 2017. Two authors independently selected the studies. A narrative synthesis was used to summarize, integrate and interpret findings.

Setting: Studies conducted in LA countries.

Participants: The search yielded 2695 articles of which eighty-four met inclusion criteria.

Results: Most studies were descriptive and came from Brazil (61%), followed by Mexico (18%) and Guatemala (6%). Studies were focused primarily on retail/provision (n 27), marketing (n 16) and labelling (n 15). Consistent associations between availability of fruit and vegetable markets and higher consumption of fruits and vegetables were found in cross-sectional studies. Health claims in food packaging were prevalent and mostly misleading. There was widespread use of marketing strategies for unhealthy foods aimed at children. Food prices were lower for processed relative to fresh foods. Some studies documented high sodium in industrially processed foods.

Conclusions: Gaps in knowledge remain regarding policy evaluations, longitudinal food retail studies, impacts of food price on diet and effects of digital marketing on diet/health.

Keywords
Food environment
Latin America
Food retail
Food labelling
Food promotion
Food price
Systematic literature review

Food environments are the collective physical, economic and policy conditions that influence people’s food and beverage choices and nutritional status(1). They work as a bridge between the macro food system – food supply chains, processing, wholesale and logistics(2) – and people’s dietary choices. The International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Support (INFORMAS) has provided a comprehensive framework to study the food environment, operationalizing it into seven distinct dimensions: food retail, provision, labelling, marketing/promotion, prices, composition, and trade and investment (Fig. 1)(1). These dimensions independently

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influence dietary behaviours, body weight and related health outcomes(3–9) and are amenable to intervention through health promotion policies. Examples of policies that modify the food environment include effective food labeling systems, regulation on the type and number of food outlets around schools, regulation of advertising of unhealthy foods to children, taxation of sugar-sweetened beverages (SSB) and reformulation of food products(10).

The Latin American region is comprised of thirty-three countries, home to 650 million people. Most Latin American countries are well underway in the nutrition transition(11) and face a large public health burden due to obesity and related chronic diseases(12). There is a growing body of literature on the food environment arising from Latin American countries which has not been summarized to date.

The objective of the current systematic review was to summarize the scientific literature on the food environment in Latin America. We focused on the following INFORMAS dimensions of the food environment: food retail, food provision, food labelling, food marketing, food price and food composition (Fig. 1). The INFORMAS framework is a fairly new framework (2013) and only in recent years have studies adopted it for monitoring the food environment(13,14). This framework is useful to examine and characterize the peer-reviewed literature on the food environment in Latin America because dimensions are clearly defined and strongly relate to policy options to prevent obesity and obesity-related chronic diseases. The current review includes: (i) descriptive studies of the food environment and policies targeting the food environment; and (ii) associations identified between one or more dimensions and dietary behaviours, BMI, obesity and obesity-related chronic diseases. We identify whether some of the work to date can be used to inform public health policy and areas where more research is needed.

Methods

We followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines for systematic reviews(15). We searched the literature published from 1 January 1999 up to July 2017 using Web of Science (which includes the indexes in PubMed), LILACS and SciELO. The search strategy and comprehensive list of search terms were developed with input from all members of the writing group (see Supplemental File S1 for keywords and example syntax). Our search strategy was broad in order to identify descriptive studies of the food environment and those which investigated the association between the food environment and a health outcome or policy. In brief, the search strategy was designed to include (diet-food AND spatial) OR food retail OR food composition OR food marketing OR food labelling OR food price

Fig. 1 Conceptual food environment framework adapted from INFORMAS (International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Support) for the current systematic review of food environments relevant to obesity and related chronic diseases in Latin America(1,18,20,67,125)
AND Latin America. Keywords were translated into Portuguese and Spanish by native Portuguese/Spanish speakers and used for the SciELO and LILACS databases. After refining the search, 2688 records were retrieved and the writing group identified seven more after consulting with food environment experts participating in a regional meeting in Antigua, Guatemala in May 2018. Titles were screened by the first author taking a conservative approach: only titles that were clearly unrelated to food, human nutrition or Latin America were excluded at this stage (1602 records). Two independent reviewers fluent in English and Spanish (C.P.-F., M.F.K.-L.) then screened the abstracts in English and Spanish. Abstracts in Portuguese were reviewed by two native Portuguese speakers (M.C.M., L.O.C.). In total, 1093 abstracts were reviewed. Upon disagreement, a third reviewer (A.H.A.) read the abstracts and decided whether to include them or not. Reasons for exclusion at each stage are presented in Fig. 2. One hundred and ten full texts were screened, and eighty-four studies met inclusion criteria. See Supplemental File S1 for the list of exclusion criteria and Supplemental File S2 for the full list of included studies.

Using an Excel template, we extracted study information including: country; sample size; study setting; study design; data collection methods; INFORMAS dimension; key variables; main findings; whether findings were stratified by a variable of socio-economic position; funding sources; and language. For each INFORMAS dimension we identified key aspects of the studies using as a guideline the extraction fields used for INFORMAS systematic reviews\(^{16-20}\). See Supplemental File S1 for details on extraction. The retail and provision dimensions were combined because there was much overlap between them (e.g. sale of foods in schools would classify in both food retail and provision).

Narrative synthesis was used to summarize, integrate and interpret findings. Narrative synthesis was chosen because our review included a wide range of research designs, types of data and measures, which could not be summarized using quantitative methods. Narrative synthesis involved two steps\(^{21}\). First, we classified studies according to INFORMAS dimension, country, study design and other general characteristics as detailed in Tables 1 and 2, then conducted a preliminary synthesis of findings. Second, we further classified studies within each INFORMAS dimension (see sub-headings in Tables 3, 4 and 5 and Supplemental Tables S1 and S2).

For descriptive studies, we looked for consistency of findings by INFORMAS domain. In analytic studies, we looked for consistency in the direction and strength of associations.
Our summary of analytic studies was limited to the food retail dimension because other dimensions had too few analytic studies to attempt summarizing associations. We evaluated the direction and strength of each association and classified according to whether the association was in the expected direction (i.e. in agreement with hypothesis), null or in an unexpected direction (see Supplemental File S1 for details).

Results

Over 60 % of the eighty-four eligible studies were conducted in Brazil, followed by Mexico (18 %) and Guatemala (6 %). Other countries in Latin America contributed between one and three papers to the review (Table 1 and Supplemental Fig. S1). The number of papers published on this topic has increased gradually over time; more than half (n 47) of the studies identified were published between 2014 and 2017. Most studies (77·4 %) focused on urban areas (Table 2). Seventy-one per cent of included studies were descriptive. Seventy-five per cent of association studies (eighteen out of twenty-four) utilized a cross-sectional or ecological design to study associations between the food environment and health or nutrition outcomes/behaviours (Tables 1 and 2). Out of the twenty-four association studies, sixteen investigated the retail food environment.

In terms of INFORMAS dimensions, food provision/retail was the dominant topic (32 %) followed by promotion (19 %), labelling (18 %) and composition (14 %). Price was the least explored (10 %). Forty-three per cent of studies investigated the consumer food environment, 20 % the community food environment and a further 17 % the school food environment. Most studies (67 %) collected primary data. The following sections present more detail on the design and results of studies within each food environment dimension.

### Food retail/provision

Twenty-seven studies related to the food retail/provision dimension. Descriptive studies of the community food environment mainly investigated the availability of healthy and
The food environment in Latin America

unhealthy foods by area-level socio-economic position and consistently showed higher availability of healthy foods in more affluent neighbourhoods. Results were fairly consistent across diverse contexts in Brazil (three cities: São Paulo, Florianópolis and Belo Horizonte) and Mexico (four cities: Mazatlán, Guadalajara, Mexico City and Puerto Vallarta). There were mixed results regarding the availability of unhealthy foods in more disadvantaged neighbourhoods. Relative to more advantaged neighbourhoods, higher availability of unhealthy foods was found in more disadvantaged neighbourhoods in four Mexican cities (as listed above) and in one Brazilian city (São Paulo), but two other studies in Brazil found fewer food stores (both healthy and unhealthy) in more disadvantaged neighbourhoods (Belo Horizonte and Florianópolis). The descriptive studies of the consumer food environment focused on evaluating and classifying food stores as healthy or unhealthy according to types of foods found in the stores. As can be seen in Supplemental Table S1, consumer food environment studies used a mix of instruments to evaluate food stores. Several studies adapted and validated the Nutrition Environment Measures Survey in Stores (NEMS-S) while others used locally developed and validated instruments, for example the auditing tool for markets, supermarkets and grocery stores (ESAO).

Table 3 shows results for the analytic, observational food retail studies with a health or nutrition outcome/behaviour (n = 10). All but one study were carried out in Brazil and all studies had a cross-sectional design except for one which was ecological. There were consistent results regarding the association of healthier food environments, specifically those with a higher density of fruit and vegetable shops (measured or perceived), with higher consumption of fruits and vegetables (Table 3; column A). There were mostly null findings for the association between healthier food environments and unfavourable health outcomes/behaviours such as overweight, obesity or SSB consumption (Table 3; column B). However, a couple of studies found expected associations. Azeredo et al. found selling fruit and natural fruit juice in private schools was associated with lower consumption of SSB and ultra-processed foods. Vedovato et al. found that perceiving higher variety of fruits and vegetables (but not perceived availability of fruit and vegetables) was associated with higher consumption of fruits and vegetables. Perception measures of distance to shops were not associated with nutrition or health outcomes/behaviours in two studies.

Food labelling

Nineteen out of twenty-one studies in this dimension (labelling, and composition and labelling together) were carried out in Brazil (Table 4). All food labelling studies were descriptive. In most studies, processed or packaged products from one supermarket were either selected for a sample (n = 3 random; n = 8 convenience) or inventoried (n = 10). Studies ranged considerably in size from 100 to 5620 products. The most common themes studied were the presence of food labels and whether labels correctly reflected the nutrient composition of products, the nutrition quality of products with or without health or nutrition claims, nutrient adequacy, and serving size. An overarching theme was to evaluate compliance of food labelling with current legislation on these aspects. Labelling regulations in Brazil, Chile and Costa Rica require a nutrition facts table with at least five nutrients (total fat, saturated fat, carbohydrates, protein and sodium) and total energy declared on the label. Nutrient claims...
Table 3: Retail studies* included in the current systematic review of food environments relevant to obesity and related chronic diseases in Latin America

<table>
<thead>
<tr>
<th>First author, year, reference</th>
<th>Study design, sample size</th>
<th>Population</th>
<th>Perception or objective measure</th>
<th>Adjustment variables</th>
<th>Healthier food environment</th>
<th>Unhealthier food environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary of associations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Favourable health outcome (A)</td>
<td>Unfavourable health outcome (B)</td>
</tr>
<tr>
<td>Azeredo, 2016 (37)</td>
<td>Cross-sectional, n 109 104</td>
<td>9th grade children, PeNSE 2012; Brazil</td>
<td>Perception</td>
<td>Sociodemographic characteristics, regular intake of a specific unhealthy food (e.g. soft drinks), sale of the same unhealthy food in the cafeteria and in an alternative outlet, student consumption of food provided by the school food programme</td>
<td>[+] [+] [+] [+] [+] [-] [-]</td>
<td>[+] [-] [+] [-] [-] [-] [-] [-]</td>
</tr>
<tr>
<td>Chor, 2016 (31)</td>
<td>Cross-sectional, n 14 749</td>
<td>35–74-year-olds, ELSA 2008–2011; Brazil</td>
<td>Perception</td>
<td>Age, gender, education, income</td>
<td>[+] Perceived availability of healthy food (neighbourhood) assoc. with higher F&amp;V consumption</td>
<td>[+] Soft drinks and fried salty snacks sold at school (school, public or private) assoc. with higher consumption of UPF and SSB (and bagged snacks assoc. with UPF at private but not public)</td>
</tr>
<tr>
<td>Duran, 2016 (32)</td>
<td>Cross-sectional, n 1842</td>
<td>20–59-year-olds, VIGITEL 2011; Brazil</td>
<td>Objective (GIS)</td>
<td>Individual-level variables (age, sex, education and income) + neighbourhood-level income + community (proximity to supermarkets and fresh produce markets) and consumer FE variables</td>
<td>[+] Mostly found healthier foods in neighbourhood (fresh produce market distance and density, and availability at other stores) assoc. with more F&amp;V consumption</td>
<td>[-] Did not find density of healthier foods in neighbourhood or lower prices for F&amp;V assoc. with less SSB consumption</td>
</tr>
<tr>
<td>Barrera, 2016 (30)</td>
<td>Cross-sectional, n 725</td>
<td>9–11-year-old children, 2012/2013; Mexico</td>
<td>Objective (GIS)</td>
<td>Age, sex, type of school (i.e. public or private) as a proxy of SES, and whether the school complies with federal food-in-school regulations</td>
<td>[+] [+] [+] [+] [+] [-] [-] [-]</td>
<td>[+] [-] [+] [-] [-] [-] [-] [-] [-]</td>
</tr>
<tr>
<td>First author, year, reference</td>
<td>Study design, sample size</td>
<td>Population</td>
<td>Perception or objective measure</td>
<td>Adjustment variables</td>
<td>Healthier food environment</td>
<td>Unhealthier food environment</td>
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</tr>
<tr>
<td>Jaime, 2011 (23)</td>
<td>Ecological, n 2122</td>
<td>Adults ≥18 years old, VIGITEL 2003 (only São Paulo), Brazil</td>
<td>Objective</td>
<td>Only area-level SES</td>
<td>[+] Density of F&amp;V markets (including F&amp;V street markets and public food markets) assoc. with more F&amp;V consumption. But all other results were null</td>
<td>[-] Large supermarkets, grocery stores, total retail food stores (excluding fast-food restaurants) not assoc. with overweight/obesity, or SSB consumption</td>
</tr>
<tr>
<td>Mendes, 2013 (35)</td>
<td>Cross-sectional, n 3404</td>
<td>Adults ≥18 years old, VIGITEL 2008–2009; Brazil</td>
<td>Objective (GIS)</td>
<td>Unclear from paper</td>
<td>[-] Presence of F&amp;V markets or supermarkets not assoc. with overweight/obesity</td>
<td>[-] Distance to fresh produce stores, supermarkets or other small specialty stores (butcher or bakery) not assoc. with overweight or obesity</td>
</tr>
<tr>
<td>Motter, 2015 (36)</td>
<td>Cross-sectional, n 2506</td>
<td>7–14-year-old children; Florianopolis City, Brazil</td>
<td>Perception</td>
<td>Sex, age, whether interviewee is head of household, education</td>
<td>[-] Distance to convenience store not assoc. with overweight or obesity</td>
<td>[-] Distance to convenience store not assoc. with overweight or obesity</td>
</tr>
<tr>
<td>Pessoa, 2015 (33)</td>
<td>Cross-sectional, n 5611</td>
<td>Adults ≥18 years old, VIGITEL 2010; Brazil</td>
<td>Objective</td>
<td>Age, sex, education, smoking, SSB intake, neighbourhood income, density of the other type of food store</td>
<td>[+/-] Combined density of F&amp;V stores and F&amp;V open-air markets assoc. with higher F&amp;V consumption</td>
<td>[-] Combined density of bars, snack bars, food trucks assoc. with lower F&amp;V consumption</td>
</tr>
<tr>
<td>Vedovato, 2015 (34)</td>
<td>Cross-sectional, n 538</td>
<td>Mothers of young children; Santos City, Brazil</td>
<td>Perceived</td>
<td>SES and mother’s education</td>
<td>[+/-] Perception of F&amp;V availability in neighbourhood assoc. with higher household purchases of minimally processed foods</td>
<td>[-] Perception of higher variety of F&amp;V assoc. with lower acquisition of UPF, but perception of overall availability of ‘healthy food’ – or F&amp;V in particular – not assoc. with household purchases of UPF</td>
</tr>
</tbody>
</table>
are allowed and, if present, the nutrition facts table must include the nutrient mentioned in the claim. Nine studies evaluated the presence of food labels and their reliability. Of them, three studies analysed labelling across all types of food in Chile, Brazil, Colombia and Argentina, finding that those with mandatory labelling were more likely to comply with the Codex Alimentarius Commission Guidelines(67); Brazil had the most comprehensive labels (6·4/7 nutrients required by CODEX and most readable), while Colombia had the least (4·6/7 nutrients required by CODEX)(51). In terms of reliability of labels, three Brazilian studies suggested inaccuracy in label contents compared with measured composition specifically for saturated fat, trans fat and sodium content(43–45) while one Costa Rican study reported accuracy in labels specifically for sodium content in breads(47). Four studies showed that the nutritional quality of foods with and without nutrition- and health-related claims was not different(52–55). Claims were used as a persuasive marketing technique for foods targeted to children, for example highlighting vitamin and mineral content in products that were high in sugar(52–55). Four studies from Brazil evaluated serving size reported in labels v. labelling law or the average serving size consumed by the population, finding that compliance with regulations was above 75 % of products but large differences were observed when compared with average serving sizes consumed by the population(60–63).

Food marketing/promotion

Table 5 shows the sixteen food promotion studies conducted in seven countries, their characteristics and findings. Except for one study(68), all were descriptive. Nine out of sixteen studies monitored food and beverage advertisements on television (TV) by recording TV programming, counting and classifying advertisements(69–77); four focused on food package design(78–81); and the rest evaluated advertisements on billboards and shops(78,82,83). The proportion of TV advertisements relating to foods and beverages ranged from 5·6 to 22 % depending on the channel and country (studies came from Brazil, Mexico and Honduras). Between 55 and 79 % of all food advertisements were for ultra-processed foods or foods considered unhealthy by the system used in the study(70,71,73,74,76,77). Advertisements shown during children’s TV programming tended to be longer and show more unhealthy products compared with those in adult programming. Between 55 and 79 % of all food advertisements were for ultra-processed foods or foods considered unhealthy by the system used in the study(70,71,73,74,76,77).

C Pérez-Ferrer et al.

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<table>
<thead>
<tr>
<th>Labelling aspect</th>
<th>Country</th>
<th>Retail outlets</th>
<th>No. of products</th>
<th>Sample design</th>
<th>Compliance with legislation?†‡</th>
<th>Main findings</th>
<th>First author, year, reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of food labels and food label reliability</td>
<td>Costa Rica</td>
<td>1 (supermarket)</td>
<td>2910</td>
<td>Inventory</td>
<td>N</td>
<td>58% of products had nutrition information. More than 100 different nutrition and health claims identified</td>
<td>Blanco-Metzler, 2011 (48)</td>
</tr>
<tr>
<td></td>
<td>Chile</td>
<td>1 (supermarket)</td>
<td>1020</td>
<td>Random sample</td>
<td>Y</td>
<td>9-6% of nutrition labelling had some type of error, the groups with most errors were packaged vegetables</td>
<td>Urquiaga, 2014 (46)</td>
</tr>
<tr>
<td></td>
<td>Brazil</td>
<td>NS</td>
<td>153</td>
<td>Convenience</td>
<td>N</td>
<td>Low reliability of food labels (label vs. measured composition), e.g. under-report of saturated fat. Could be due to composition methods used</td>
<td>Lobanco, 2009 (44)</td>
</tr>
<tr>
<td>Overall</td>
<td>Colombia, Brazil, Chile, &amp; Argentina</td>
<td>Food shops (n NS)</td>
<td>40 per country</td>
<td>Convenience</td>
<td>Y</td>
<td>Labels in countries with mandatory labelling more likely to comply with CODEX, Brazil most comprehensive labels and more frequent, Colombia least. Health claims most common in Brazil and Argentina</td>
<td>Mayhew, 2015 (51)</td>
</tr>
<tr>
<td>Sodium</td>
<td>Costa Rica</td>
<td>Supermarkets and bakeries</td>
<td>183</td>
<td>Sample</td>
<td>Y</td>
<td>High compliance of bread labels with regulation regarding Na content. Lower compliance for snacks; 43% labels report less Na than measured</td>
<td>Montero-Campos, 2015 (47)</td>
</tr>
<tr>
<td></td>
<td>Brazil</td>
<td>NS</td>
<td>17</td>
<td>Convenience</td>
<td>Y</td>
<td>In 8 of 17 samples Na content higher compared with label. Most labels did not comply with legislation</td>
<td>Ribeiro, 2013 (45)</td>
</tr>
<tr>
<td>Trans fat</td>
<td>Brazil</td>
<td>1 (supermarket)</td>
<td>2327</td>
<td>Inventory</td>
<td>N</td>
<td>50% of products may have trans fats according to ingredients, only a small proportion of products declared trans fats on label</td>
<td>Silveira, 2013 (43)</td>
</tr>
<tr>
<td></td>
<td>Brazil</td>
<td>Supermarkets (n NS)</td>
<td>150</td>
<td>Convenience</td>
<td>Y</td>
<td>55% of food labels did not comply with trans fat labelling legislation</td>
<td>Dias, 2009 (49)</td>
</tr>
<tr>
<td>Presence of restaurant food labels</td>
<td>Brazil</td>
<td>N/A (restaurants)</td>
<td>114</td>
<td>Stratified random sample</td>
<td>N</td>
<td>25% of restaurants provided nutritional information. More common in fast-food chains than full-service restaurants</td>
<td>Maestro, 2008 (50)</td>
</tr>
</tbody>
</table>

Table 4 Labelling studies (including labelling and composition)* included in the current systematic review of food environments relevant to obesity and related chronic diseases in Latin America.

*Excluding restaurant food labels.
### Table 4 Continued

<table>
<thead>
<tr>
<th>Labelling aspect</th>
<th>Country</th>
<th>Retail outlets</th>
<th>No. of products</th>
<th>Sample design</th>
<th>Compliance with legislation?†,‡</th>
<th>Main findings</th>
<th>First author, year, reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrient/health food claims and other categories</td>
<td>Brazil</td>
<td>1 (supermarket)</td>
<td>3449</td>
<td>Inventory</td>
<td>N</td>
<td>Food products with nutrition claims have higher median Na contents than the corresponding conventional products</td>
<td>Nishida, 2016[54]</td>
</tr>
<tr>
<td>Claims &amp; composition</td>
<td>Brazil</td>
<td>1 (supermarket)</td>
<td>535</td>
<td>Inventory</td>
<td>N</td>
<td>Foods with nutrient claims less healthy than those without according to NOVA and similar according to Ofcom</td>
<td>Rodrigues, 2017[52]</td>
</tr>
<tr>
<td>Claims &amp; marketing to children</td>
<td>Brazil</td>
<td>1 (supermarket)</td>
<td>5620</td>
<td>Inventory</td>
<td>Y</td>
<td>9.5% of products targeted children (n=535), products with nutrient claims were less healthy than or similar to those without</td>
<td>Rodrigues, 2016[53]</td>
</tr>
<tr>
<td>Nutrient adequacy</td>
<td>Brazil</td>
<td>1 (supermarket)</td>
<td>2945</td>
<td>Inventory</td>
<td>Y</td>
<td>88 % of foods targeting children were ultra-processed, 47 % had nutrient claim mostly about higher quantity of vitamins and minerals</td>
<td>Zucchi, 2016[55]</td>
</tr>
<tr>
<td>Sodium &amp; serving size</td>
<td>Brazil</td>
<td>1 (supermarket)</td>
<td>100</td>
<td>Convenience</td>
<td>N</td>
<td>14 % of foods did not comply with serving sizes, 37 % had Na ≥ 5 mg/g (considered high)</td>
<td>Kraemer, 2016[56]</td>
</tr>
<tr>
<td>Sodium</td>
<td>Brazil</td>
<td>1 (supermarket)</td>
<td>1416</td>
<td>Inventory</td>
<td>N</td>
<td>58.8 % classified as high Na content, highest content in sauces, seasonings, broths, soups and prepared dishes</td>
<td>Longo-Silva, 2010[58]</td>
</tr>
<tr>
<td>Sodium, fat, fibre</td>
<td>Brazil</td>
<td>1 (supermarket)</td>
<td>100</td>
<td>Convenience</td>
<td>N</td>
<td>Labelling using traffic light criteria, 2/3 of products would be red for fibre and Na and 1/4 for fat</td>
<td>Gagliardi, 2009[57]</td>
</tr>
<tr>
<td>Saturated fat</td>
<td>Brazil</td>
<td>NS</td>
<td>9</td>
<td>Convenience</td>
<td>N</td>
<td>Large concentration of saturated fats found in products and n-6:n-3 above recommended levels</td>
<td>Kliemann, 2014[53]</td>
</tr>
<tr>
<td>Serving size</td>
<td>Brazil</td>
<td>1 (supermarket)</td>
<td>2072</td>
<td>Inventory</td>
<td>Y</td>
<td>Differences identified between Food Guide for the Brazilian Population and labelling law with respect to recommended serving sizes</td>
<td>Kliemann, 2016[53]</td>
</tr>
<tr>
<td>Serving size</td>
<td>Brazil</td>
<td>1 (supermarket)</td>
<td>1071</td>
<td>Convenience</td>
<td>N</td>
<td>Declared serving size in most products complied with regulation. Only 4.1 % of foods had larger than recommended serving sizes</td>
<td>Kraemer, 2015[60]</td>
</tr>
<tr>
<td>Serving size</td>
<td>Brazil</td>
<td>1 (supermarket)</td>
<td>451</td>
<td>Inventory</td>
<td>Y</td>
<td>In 88 % of food groups the average serving size consumed by the Brazilian population was larger than the declared serving size</td>
<td>Machado, 2016[61]</td>
</tr>
</tbody>
</table>

NS, not stated; N/A, not applicable; N, no; Y, yes.

*All studies included were descriptive.

†Study evaluates compliance of food labels with law or regulation on food labels.

‡Brazilian labelling regulation: the following nutrients must be declared in packaged products per portion; energy, carbohydrates, protein, total fat, saturated fat, trans fat and sodium. Additionally, if a nutrition claim is present in the label, nutrition information must report the quantity of the nutrient the nutrition claim refers to[64]. Centro American (Nicaragua, Guatemala, El Salvador, Honduras and Costa Rica) nutrition labelling regulation: the following nutrients must be declared in food products per portion or 100 g or 100 mL: total energy, total fat, saturated fat, carbohydrates, sodium and protein. If a nutrition claim is present, the nutrient in question must be included. Nutrition claims definitions for different nutrients included in regulation[65,66]. Former Chilean labelling law required nutrition facts table[129].
### Table 5: Promotion studies* included in the current systematic review of food environments relevant to obesity and related chronic diseases in Latin America

<table>
<thead>
<tr>
<th>Media platform</th>
<th>Country</th>
<th>No. of ads/products</th>
<th>Length of time recorded/other</th>
<th>Promotion element(s) identified†</th>
<th>System for defining healthy/unhealthy Monitoring of codes/laws</th>
<th>Key findings</th>
<th>First author, year, reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV</td>
<td>Brazil</td>
<td>1618 (TV ads)</td>
<td>162 h/6 channels</td>
<td>Prom char, Health claims, Offers, Appeal</td>
<td>FB</td>
<td>Y</td>
<td>Britto, 2016(69)</td>
</tr>
<tr>
<td></td>
<td>Brazil</td>
<td>4127 (TV ads)</td>
<td>h NS/3 channels</td>
<td></td>
<td>FB</td>
<td>N</td>
<td>Kelly, 2010(70)</td>
</tr>
<tr>
<td></td>
<td>Chile</td>
<td>83 (food TV ads)</td>
<td>350 h/5 channels</td>
<td>Appeal</td>
<td>NP</td>
<td>N</td>
<td>Castillo-Lancellotti, 2010(71)</td>
</tr>
<tr>
<td></td>
<td>Mexico</td>
<td>9178 (TV ads)</td>
<td>336 h/10 channels</td>
<td>Health claims, Appeal</td>
<td>NP</td>
<td>N</td>
<td>Perez-Salgado, 2010(72)</td>
</tr>
<tr>
<td></td>
<td>Mexico</td>
<td>8299 (TV ads)</td>
<td>235 h/5 channels</td>
<td>Prom char, Appeal</td>
<td>FB</td>
<td>N</td>
<td>Ramirez-Ley, 2009(73)</td>
</tr>
<tr>
<td></td>
<td>Brazil</td>
<td>2732 (TV ads)</td>
<td>132 h/4 channels</td>
<td>Prom char, Health claims, Offers, Appeal</td>
<td>FB</td>
<td>N</td>
<td>Maia, 2017(74)</td>
</tr>
<tr>
<td></td>
<td>Mexico</td>
<td>2544 (TV ads)</td>
<td>600 h/4 channels</td>
<td>Appeal</td>
<td>NP</td>
<td>N</td>
<td>Patino, 2016(75)</td>
</tr>
<tr>
<td></td>
<td>Honduras</td>
<td>2272 (TV ads)</td>
<td>80 h/4 channels</td>
<td>Prom char, Appeal</td>
<td>FB</td>
<td>N</td>
<td>Gunderson, 2014(76)</td>
</tr>
<tr>
<td></td>
<td>Brazil</td>
<td>3972 (TV ads)</td>
<td>432 h/3 channels</td>
<td>Appeal</td>
<td>FB</td>
<td>N</td>
<td>Almeida, 2002(77)</td>
</tr>
<tr>
<td>Food packages</td>
<td>Guatemala</td>
<td>106 (cereal boxes)</td>
<td>1 supermarket</td>
<td>Health claims, Appeal</td>
<td>NP</td>
<td>N</td>
<td>Soo, 2016(79)</td>
</tr>
<tr>
<td></td>
<td>Guatemala</td>
<td>106 ('child oriented' snacks)</td>
<td>55 shops around 4 schools</td>
<td>Prom char, Offers, Appeal</td>
<td>NP</td>
<td>N</td>
<td>Chacon, 2013(80)</td>
</tr>
<tr>
<td></td>
<td>Uruguay</td>
<td>180 (products)</td>
<td>2 supermarkets</td>
<td>Prom char, Health claims, Appeal</td>
<td>NP</td>
<td>N</td>
<td>Gimenez, 2017(84)</td>
</tr>
<tr>
<td>Fast-food combo meals</td>
<td>Guatemala</td>
<td>116 (combo meals)</td>
<td>6 fast-food chain restaurants</td>
<td>Prom char, Offers, Appeal, Price, Time to delivery</td>
<td>NP</td>
<td>N</td>
<td>Mazariégos, 2016(85)</td>
</tr>
</tbody>
</table>
The only analytic study in this dimension reported results from a social marketing intervention in four schools that aimed to increase water consumption. Water consumption was higher in intervention schools (vs. control schools) but differences were not statistically significant (68).

Ten studies explored price (or price and composition of foods) of which six were from Brazil, three from Mexico and one from Guatemala. Seven out of ten studies were descriptive. Out of these, five focused on the price of food relative to its nutritional quality (85–89); with findings mostly consistent. Two studies suggested a higher relative price of processed and ultra-processed foods compared with healthier dry goods (e.g. beans, rice) (86); however, fresh foods (e.g. fruits, vegetables and meat) were more expensive than processed foods (86,88) and prepared foods made with processed ingredients were cheaper than similar items made from unprocessed ingredients (85). Furthermore, analyses of price trends over 60 years found a relative increase in the prices of fresh fruits and vegetables and a relative decrease in the prices of sugars/sweets and processed foods (89).

The three analytic studies in this dimension were from Mexico and explored the effect of the Mexico SSB tax (90–92). They found the tax (excise tax of 1 peso ($US 0.05) per litre) was fully passed on to consumers and that it had the expected effect on sales: a reduction of between 6.2 and 8.7% (90–92).

Discussion

We aimed to systematically review and summarize the literature about the food environment in Latin America that relates to risk factors for obesity and associated chronic diseases. We identified eighty-four studies analysing six out of seven dimensions proposed by INFORMAS: food retail provision, labelling, promotion, price, composition and health claims. Our systematic review is the first to explore all dimensions together and to systematically assess evidence quality.

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The food environment in Latin America

The most studied areas were food retail/provision followed by promotion and labelling. Cross-sectional results consistently found associations between healthy food retail environments and better diet; and descriptive studies consistently reported a high prevalence of health claims and marketing strategies that aimed to promote unhealthy products to children. Notable gaps in research were in longitudinal studies and analytic studies more generally along all dimensions of the food environment.

The current review consistently found a positive association between the availability of healthy foods or healthy food outlets (such as specialty fruit and vegetable shops and markets) and better diet quality; these studies were cross-sectional. Although more robust study designs are needed to confirm this association (i.e. longitudinal studies), these findings could potentially represent an opportunity for health promotion. Policies that support the continued presence of specialty fruit and vegetable shops and markets may support dietary quality. The retail food environment in Latin America is similar to North America and Europe in that there is a strong presence and growth of large supermarket chains and convenience stores at the expense of traditional retail channels such as local markets\(^{99}\). However, in contrast to more developed countries, the traditional non-chain channels remain an important source of food in Latin America\(^{2,32,36}\).

Studies investigating the food environment in developed countries tend to focus on fast-food restaurants and convenience stores but rarely explore the effect of healthy food shops other than supermarkets\(^{40}\). Consistent with findings from systematic reviews from the USA, our findings were inconclusive on whether convenience stores and fast-food restaurants are associated with low quality diet or BMI in Latin America\(^{4,100}\). Further, there was no evidence that density of supermarkets was associated with weight (overweight or obesity)\(^{101}\). In Latin America, store type alone may be a poor indicator for healthfulness\(^{3}\) given that there is great heterogeneity within categories such as supermarkets, grocery stores or even fast-food restaurants.

Food marketing studies included in the current review consistently found that regardless of country or TV channel, unhealthy food products were more likely to be advertised than healthy food products. Further, marketing of unhealthy products to children via advertisements in children’s TV programmes, food packages and stores near to schools, using a series of persuasive marketing techniques, was common practice in the countries studied. These findings are salient since there is a large body of literature that has demonstrated associations between aggressive food marketing and food preferences, especially among children\(^{9,102}\). The channels and strategies used in Latin America are very similar to those in developed countries (i.e. TV, food package design, use of promotional characters, premium offers and health claims). For example, widely used licensed characters are associated with taste preferences and food selection\(^{103}\) and exposure to TV food advertisements is associated with food intake in children\(^{104}\). Health claims are often used to market unhealthy food to mothers and as the current review has found, foods with nutrition- or health-related claims are often less healthy than those without them. Ten of the sixteen promotion studies included in our review were carried out after the adoption of the WHO’s Resolution WHA63.14 that aims to restrict the marketing of unhealthy food products to children and adolescents\(^{105}\). This resolution was accompanied by a set of twelve recommendations for national governments\(^{105,106}\). Our findings suggest that governments in the region have not taken the necessary actions to protect children from the harmful impact of unhealthy food marketing and that voluntary codes adopted by the food industry have not been effective.

Brazil was the first country in the region to introduce mandatory labelling in 2001\(^{107}\). Other Mercosur countries (Argentina, Chile, Colombia, Ecuador, Paraguay and Uruguay) followed suit with slightly different labelling requirements\(^{107,108}\). Studies identified in the current systematic review show that when food labelling is mandatory, food products are more likely to have labels and comply with the basic Codex Alimentarius Commission guidelines\(^{51,67,107}\). However, in some contexts, compliance with labelling laws was low or mediocre (in Brazil, studies reported less than half of products complying on some aspect of the label\(^{45,49}\)). Further, even when compliance is high\(^{10,46}\), the impact of labels on food choices depends on the design and interpretability of the label\(^{46,109,110}\). In order to have a larger impact on food choice, some countries have converted traditional nutrition facts tables into graphical nutrition labels that may be better understood\(^{10,111}\). In the future it will be crucial to monitor compliance with labelling regulations, consumer understanding of the labels and their effect on food choices.

We identified five key areas of opportunity where more research is warranted to better inform public health policy in the region. The first is to carry out more policy evaluations. Policy evaluations were largely absent from the literature, with the exception of evaluations of the soda tax in Mexico\(^{90-92}\). Upcoming policy evaluations of the Chilean and Peruvian labelling laws, the regulation of school food in Mexico and the banning of trans fats in Argentina, for example, will enhance the literature. Further on this point, research should also monitor existing regulations so that governments and industry can be held accountable. The second area of opportunity identified is to strengthen the design of studies in the food retail dimension in order to improve causal inference; this will increase their relevance to policy makers. This could be done by designing cohort/panel studies and experiments rather than cross-sectional and ecological studies\(^{112}\). The two experiments identified in the present review suggested that a change in the food environment had the expected effect on diet; however, both studies were small and at a local level\(^{39,41}\). Causal inference can also be improved by better measurement.
of the neighbourhood food environment; for example, by using standardized instruments to measure and characterize the consumer food environment. Further research on the retail food environment could also assess whether it is availability or accessibility through which healthy food outlets or traditional retail channels affect diet and ultimately health. Only one study assessed accessibility objectively (distance using a geographic information system)\(^{32}\).

A third area of opportunity for research is to better explore the role of food price. We found few studies investigating price and relative price of healthy vs. unhealthy foods. Controversy exists on whether the price of healthy foods is a determinant of obesity and obesity inequalities in Latin American countries. While this has been demonstrated in the USA\(^{114,115}\), the price of the traditional diet composed of staple foods and seasonal fruits and vegetables in Latin American countries may be cheaper than packaged ultra-processed foods. The fourth area of opportunity is regarding marketing and advertising on other media platforms not only TV and printed media. We do not yet know the reach of food marketing in digital media, i.e. through online video platforms, advergames, popular websites and apps, or its effects on food choices. Emerging evidence from other countries suggests that it has the same persuasive effect as marketing through traditional channels\(^{116,117}\).

Finally, a fifth area of opportunity for research is investigating the role of worksite food environments for health. Only one study on the worksite environment was found in the current literature review\(^{98}\).

It is important to acknowledge that in order to conduct more and better research on the food environment in Latin America, funding for these types of studies is necessary. Research funding in Mexico and Brazil has traditionally supported basic science, infections and parasitic diseases, and health services\(^{118,119}\). Health research funding priorities are not in line with the most pressing public health problems\(^{118}\) which in these countries are poor diets, obesity and non-communicable diseases\(^{12}\). Research funding for food environment studies must also be independent of conflict of interest. Evidence suggests that research funded by the food industry tends to be biased in favour of the industry\(^{120,121}\). At minimum, the field would benefit from more transparency\(^{122}\). In the current review of the literature, a third of studies did not declare the source of funding. Out of those that declared it, one was funded by the food industry\(^{122}\).

Now we weigh the evidence thus far and comment on potential policy options. The research on the food labelling and food marketing dimensions in Latin America highlights the need for policy interventions in these two areas. Some policy options include stricter regulation of health and nutrition claims, graphical food labels such as the ones introduced by Chile and Ecuador, and mandatory (as opposed to industry-led) regulations on food marketing that comply with WHO recommendations\(^{10,14}\). Further context-specific research should inform the finer details of marketing and labelling regulations (i.e. what to regulate: type of product, content of advertisements) and their effectiveness\(^{70}\). Policy options in the food price dimension relate to food taxes and subsidies. The evidence for Mexico shows that taxes are viable and effective to reduce the consumption of SSB. Alternative pricing strategies such as subsidies were not studied and could be evaluated in future. In terms of food composition, reformulation as a policy option was understudied but could be promising\(^{124}\). Finally, if associations between healthier food retail environments and diet are confirmed with more robust research designs, protecting and promoting local fruit and vegetable stores could be tested as a retail policy option. In addition to new policies it is of utmost importance to monitor existing codes and regulations around labelling, marketing, price/ taxes and provision of foods in schools, among others, to ensure compliance and to determine whether the regulation is beneficial or not.

A limitation of the current review is that it does not include the trade and investment dimension because most studies in this area were reviews or qualitative studies that did not meet inclusion criteria. Trade and investment studies are crucial to understand recent changes in the food system and the food environment in Latin America. For example, in Mexico, the North American Free Trade Agreement led to a twenty-five-fold increase in foreign direct investment in the food processing industry in the 1990s, as well as exponential growth of multinational retailers\(^{4,99}\). Another limitation relates to the representativeness of studies. Most studies were representative of neighbourhoods or cities but not entire countries or regions. There were very few multi-city or multi-country studies; these could have given a better picture of differences and similarities in the food environment within the region. Because most studies were descriptive, we did not conduct a detailed assessment of study rigour besides providing information about sample size and sampling design. Even among the analytic studies, we did not conduct meta-analyses due to high heterogeneity in epidemiological design, measures and food environment dimensions. Nevertheless, we were able to provide a narrative summary of the direction of associations.

**Conclusion**

In conclusion, the literature on the food environment in Latin American countries has grown in size over the past few years, probably as a result of the rising obesity prevalence and increasing recognition of the food environment’s role. This body of literature had not been systematically summarized to date. Our literature review contributes to the literature in two ways. First, it highlights areas where evidence is consistent enough to inform policy making; for example, evidence on marketing of unhealthy food to children and inadequate use of health claims. Second,
The food environment in Latin America

...it identifies knowledge gaps which should be addressed by future research: evaluations of policies which aim to modify some aspect of the food environment; monitoring of existing regulations; improving causal inference of food retail studies; further investigating the relative cost of healthy v. unhealthy foods; exploring other marketing and advertising channels such as digital marketing; and investigating the role of worksite food environments.

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Supplementary material

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The food environment in Latin America


