

**Why do some local food availability interventions fail to modify diet quality? A realist review and synthesis and proposed systemic theory of change**

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## **Abstract**

**Background:** Despite promising observational evidence, evaluations of interventions and policies to improve local food availability, diet and obesity report a lack of effectiveness. Often implemented without an explicit theory of change, understanding failure is limited. This study aimed to develop a theory of change (ToC) and map existing local food availability evaluation related literature.

**Methods:** An expert panel participated in a concept mapping and consensus workshop to develop an initial ToC. A systematic search of evaluation literature and synthesis guided by the Realist And Meta-narrative Evidence Syntheses publication standards was done. Content from evaluation literature was mapped onto the ToC based on identified context, mechanism, and outcome (CMO) configurations to determine tested and hypothesized pathways.

**Results:** The workshop resulted in a realist informed ToC that made explicit the ‘system’ in which food availability interventions are implemented. A process of sequential interactions across both space and time was articulate. The ToC included long causal chains across multiple levels of context converging on several theorised mechanisms to explain food choice and dietary patterns.

**Conclusions:** The resulting ToC suggests that reductionist approaches to local food availability interventions may result in limited generalisable insights between varying contexts, possible unintended consequences, or incomplete conclusions.

## Introduction

Obesity is considered a global epidemic with a doubling of prevalence worldwide since 1980, reaching approximately 600 million adults as of 2014.<sup>1</sup> Dietary risk factors account for the highest proportion of chronic disease burden, with poor diet quality associated with an increased risk of cardiovascular disease<sup>2-4</sup>, diabetes<sup>5</sup>, certain types of cancer<sup>6</sup> and conditions such as overweight and obesity.<sup>7-9</sup> However, translating this knowledge into policy actions that can modify food choice to improve diet quality at the population level has yet to be achieved.<sup>10</sup>

### *Local food availability and shifting the distribution of dietary risk for disease*

A public health approach that seeks to ‘shift the curve’ of dietary risk for everyone, rather than focusing on specific high-risk groups<sup>11</sup> requires understanding how physical environments might shape behaviour.<sup>12,13</sup> Local food availability is a dimension of food access reflecting what is available for purchase through the presence, amount and/or density of foods and food sources.<sup>14</sup> At the community level this often includes the location and type of retail food sources (i.e. supermarkets, convenience stores, fast food outlets, restaurants and cafés); at the consumer level it includes food provision within a food outlet often shaped by the customer market that frequents that outlet<sup>15,16</sup>.

### *Current evidence synthesis related to local food availability and food choice*

Evidence synthesis to date has included systematic reviews that focused on the relationship between a broadly defined food environment, diet (or diet related behaviour) and obesity<sup>14,17,18</sup>. Such studies report on evidence focussed on identifying consumer level (i.e. small outlet interventions, prepared food outlet interventions)<sup>19,20</sup> or community level (i.e. change in food outlet offerings)<sup>21,22</sup> food environment interventions and their effectiveness to improve diet or modify food choice. Also systematic reviews have focused on methods used in food environment exposure (e.g. perceived or objective measures) and outcome assessment (e.g. food purchasing or diet quality).<sup>14</sup> However, reviews to date have yet to conduct a synthesis that can help to understand *how and why* local food availability might influence food choice or diet quality.

### *Theories of change and the realist approach to causation*

Current frameworks that describe the food environment, and by extension aspects of local food availability, are helpful for defining the scope of a rapidly growing field and identifying concepts and settings relevant for research and intervention.<sup>14,23</sup> Understanding how and why specific dimensions of the food environment influence diet behaviour raises several conceptual<sup>24,25</sup> and methodological<sup>26,27</sup> challenges for existing frameworks. Principal among these is the need to transform descriptive frameworks into coherent theories of change (ToC).<sup>28,29</sup> In particular, ToC could be useful to visualise and conceptually integrate a range of factors that have been described at the intrapersonal, interpersonal, institutional, community, and public policy levels and reflect the realities of how and why people procure food across space and time.<sup>30</sup>

The development of an appropriate ToC for any given intervention strategy is considered best practice in terms of effective intervention and evaluation research<sup>31</sup>. Theories of change are defined simply as an articulation of how and why an initiative works, and therefore should make explicit the hypothesised causal chains and potential pathways of influence.<sup>32</sup> Given the wide application of evaluation methods, there is no single accepted approach to developing an appropriate ToC. With respect to local food availability interventions, ToCs are not routinely reported, at least in the peer-reviewed literature. In part this may be due to the design and implementation of food availability interventions at times lead by communities, organisations or policy makers rather than researchers.

Realist review and synthesis is a method for synthesising research that holds its foundations in realist philosophy of science. It seeks an explanatory, theory-driven approach<sup>33</sup> focused on unpacking the mechanisms and contexts surrounding why a given intervention results in a specific outcome pattern<sup>34</sup>. The approach focuses on understanding causation at the societal level through examining how mechanisms are shaped and/or constrained by a broader multi-levelled context. The theories are also examined at mid-level of abstraction to allow for a greater specificity than descriptive frameworks but greater abstraction than statistical models. Although several systematic reviews have been conducted on the broad topic of food environment and diet behaviour<sup>14,19–22</sup>, their conclusions regarding the effectiveness of various intervention strategies are not definitive. Employing a research synthesis focused on theory development and capable of dealing with greater complexity could provide an opportunity for new insights.

Therefore, the objective of this study was to develop a ToC for local food availability interventions to address the following questions: 1) how could a change in food availability influence diet? 2) for whom could a change in food availability influence diet? and 3) under what circumstances could a change in food availability influence diet? The realist review and synthesis of published local food availability evaluation literature was also mapped onto the theory. This provided the opportunity to reflect on the theory and consider possible explanations for how local food availability interventions work or why they might fail.

## **Methods**

The realist review and synthesis was informed by the Realist And Meta-narrative Evidence Syntheses (RAMESES) publication standards<sup>33</sup>, the protocol was registered (PROSPERO #CRD42014009808) and published in full.<sup>35</sup> There were three stages to this review and synthesis including the development of the initial theory of change, identifying evaluation literature and conducting the synthesis. These stages are summarised below in turn.

### *Developing an initial theory of change*

A facilitated workshop was conducted involving seven academic content experts from a range of disciplines including epidemiology, public health, nutrition, geography, psychology, medicine and political science, with research interests in inequalities in diet, neighbourhood food access, and dietary public health intervention and evaluation.

The workshop included an introduction to realist review and synthesis concepts and methodology, followed by the use of concept mapping procedures<sup>36</sup> and consensus-building using the nominal group method with one-to-one follow-up interviews<sup>37</sup>. For example participants were asked to generate a list of as many concepts and relationships as possible when asked: ‘What factors are involved in changing food availability to improve diet?’, ‘Why would a change in local food availability results in a change in diet?’, ‘What might change the effect of local food availability on diet?’, and ‘Who is likely to be affected by a change of local food availability?’

Participants were asked to organise these concepts into themes and to reflect on the role of each as a contextual or mechanistic factor. Field notes from the workshop were used to inform an initial theory by assembling the factors, pathways, mechanisms and contexts discussed, and combined into a single diagram. This initial theory was used as the basis for the face-to-face meetings between TLP and each member of the team, tracking the evolving

configuration of the initial theory of change with each meeting. Each group member had the opportunity to provide new factors or question pathways with revisions integrated by TLP throughout discussions.

#### *Systematic search for local food availability evaluation literature*

A systematic search was conducted to identify relevant evaluation studies published up to and including July 2014 with no limit on earliest year of publication within MEDLINE (Ovid SP), EMBASE (Ovid SP), PsychINFO (Ovid SP), EconLit (EBSCO), Applied Social Sciences Index and Abstracts (CSA Illumina) and Cochrane Database of Systematic Reviews (Wiley Online Library). A particular tenet of the realist synthesis approach is the inclusion of a range of evidence sources and an emphasis on an iterative search processes. Therefore, in addition to the screening for peer-reviewed outcome evaluations for interventions, hand searching was conducted for each intervention selected to identify a selection of 1) peer reviewed publications that were secondary to the outcome evaluation including process evaluations, 2) secondary data analysis of intervention samples, and 3) final project reports or short articles discussing the context of the intervention being conducted. Additionally, continued monitoring of new relevant literature was done up to December 2016. Given the aim of this review, depth of the analysis and need to stay up to date, this review may be considered more systematized than systematic in terms of its claims of exhaustiveness.<sup>38</sup>

All titles and abstracts were screened for eligibility based on 1) the aim to improve diet through a change in the availability of outlets (i.e. the opening or removal of an outlet) or the availability of foods in outlets (i.e. new food items in an outlet); 2) included food outlets that did not have restriction of use including convenience outlets, small food outlets, grocery outlets, take away outlets or full service sit-down restaurants; 3) included adults aged  $\geq 19$  years at baseline; 4) reported on results from a measure of diet or food choice (i.e. diet quality or food purchasing) and 5) had been published in a peer-reviewed journal and in English. Quality assessment was conducted by the lead author (TLP) using the Effective Public Health Practice Project (EPHPP) Quality Assessment Tool for Quantitative Studies<sup>39</sup>; this was duplicated by additional authors (ERM and EW) and consensus reached.

#### *Mapping intervention-related literature and realist synthesis process*

The purpose of mapping and critically assessing intervention related literature was to provide an opportunity to reflect on the initial ToC, to look for missing concepts from the concept

mapping process, identify implicit theories of change of the included interventions (i.e. those that were tested during evaluation) and examine the scope of hypothesized contexts or mechanisms that were not included in evaluation studies (i.e. factors or pathways that have been discussed or hypothesised but not tested).<sup>40</sup>

The process involved two stages, firstly reviewing and coding each paper for aspects of the theory that were tested or discussed, or to identify other factors that were not uncovered during the workshop. Secondly, the process involved mapping the resulting codes onto the theory of change to visually reflect the degree to which the theory was tested or hypothesised in published intervention related literature.

### Coding intervention and companion papers

In addition to the inclusion criteria used for the systematic search, the included studies were selected based upon the principles of 'relevance' (i.e. whether the data can contribute to theory building) and 'rigour' (i.e. whether the method used to generate the data is credible and trustworthy).<sup>33</sup> The purpose was to ensure as much contextual information as possible for the coding of intervention related papers, as this review was focused on the circumstances of the interventions and how they might work, rather than their effectiveness. To this end, each paper was considered a source of qualitative data that was analysed for reporting 'how local food availability might influence food choice', 'for whom' and 'under what circumstances'.

As a consequence, while the entire publication was read and coded, most codes were applied in the introduction and discussion sections of the papers where authors provided most of the context. These descriptions often included an implicit reference to a process that could be considered the underlying theory of change for that intervention. The reason for this coding approach, rather than simply summarising the content of the papers in a narrative style review, was to allow for tracking the different aspects of the theory that were discussed in the article, and informing the synthesis (i.e. combining in a meaningful way) and mapping (i.e. adding what was found onto the theory diagram) of literature that followed.

The qualitative data were coded from primary (i.e. outcome evaluation study) and secondary (i.e. process evaluation or other published work) intervention study publications using ATLAS.ti qualitative analysis software (first by one author (TLP); and then discussed with co-authors (HEB and EW/ERM)). Coding was guided by the initial ToC and the review questions of how food environment interventions work, for whom and under what conditions,

with the purpose of exploring data on context, mechanisms and outcome configurations, and patterns. Distinctions in coding were made between realist informed contextual or mechanistic aspects of the theory that were measured and tested (typically, reported in the results section of outcome evaluations) during the evaluation versus those that were hypothesised (typically reported in the discussion section or in secondary papers).

### Synthesis, mapping and interpretation

Data synthesis involved examining the codebook and comparing with the initial theory of change from the workshop. Codes were assigned to represent an implicit theory of change or different contextual or mechanistic factors described by authors of included studies. These codes were then reinterpreted to describe a context, mechanism and outcome pattern. For example – throughout an article the authors may mention that with a proliferation of less healthy food sources outlets (identified as ‘density of outlets’ in the theory – a context), the presence of a single new supermarket in a low-income community (identified as ‘outlet exposure’ in the theory – a mechanism) did not result in a change in the diet of residents (identified as ‘food choice’ – an outcome).

This was done iteratively and checked between authors (TLP, HEB and ERM) reviewing and coding the literature, reflecting on the different codes and what they described, comparing the theory of change and reviewing additional codes. Context, mechanism, outcome codes, and combinations that created a configuration were then classified into tested (represented using a solid line in the theory diagram) and hypothesized codes (represented using a dotted line in the theory diagram) and cross-referenced against the initial theory of change developed by the study team. A code that represented either one factor or pathway (several factors in a chain) was highlighted on the diagram. No additional factors were found in the intervention literature beyond those identified during the workshop.

## **Results**

The findings are divided into two sections, the outcome of the initial theory development from the workshop, followed by the outcome of the systematic search for local food availability evaluations and synthesis of relevant details mapped onto the initial theory of change.

*Theory of change for how a change in local food availability influences food choice*

The initial theory of change covers a broad range of contextual factors and mechanisms. These aspects of the theory clustered into three possible interrelated ‘pathways’ of causal influence and suggested a cyclical system of reinforcement between exposure to, adoption of and preference for particular foods and food outlets by adults in the population (**Figure 1**).

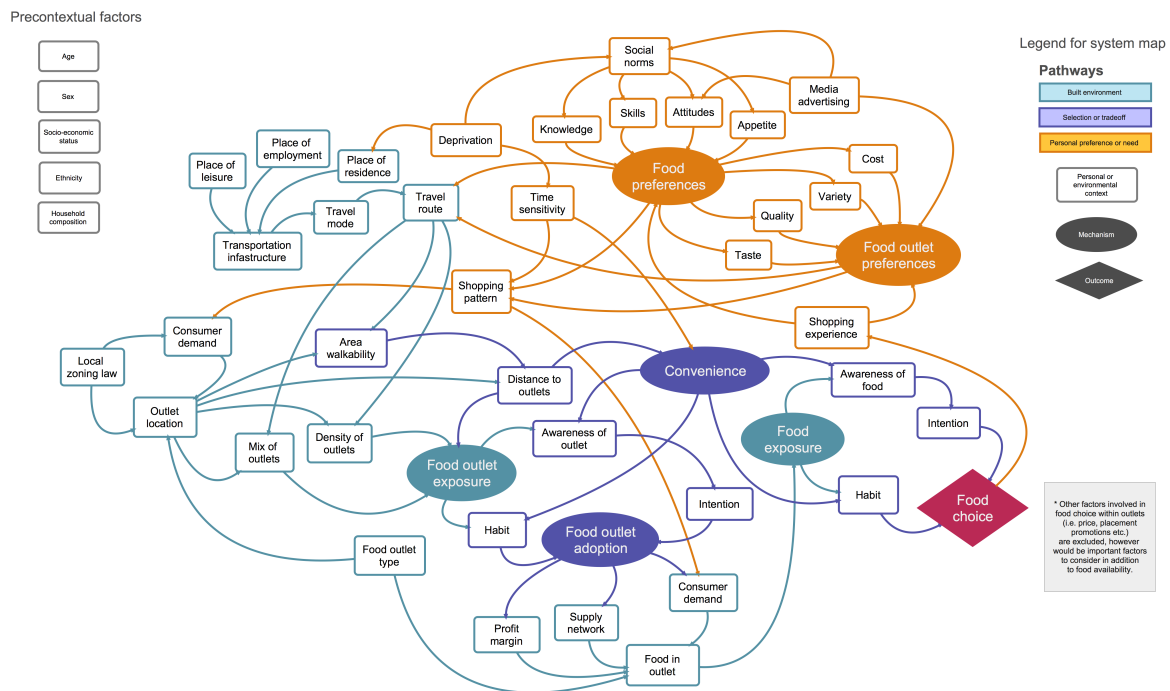


Figure 1: Initial theory of change from workshop

The systemic theory of change that emerged from the workshop better approximated the interventions of interest as events within a wider system of relevant factors, rather than a linear set of inputs, actions and outputs. This local food availability theory of change ‘system’ included three distinct but interrelated pathways of influence with several long causal chains and potential feedback loops. Across these pathways, six possible mechanisms were identified, for which multiple levels of context represent precursors to the triggering of these mechanisms and therefore, a theorised change in food choice.

**Built or physical environment pathway:** this pathway was theorised to include all the contextual factors involved in the activity patterns of people that provide an opportunity to select either a particular food outlet, or food within an outlet. These factors begin distally with the location of residence, work and leisure; the travel mode and infrastructure; followed

by the existing mix of different outlet types and density of those outlets that provides a set of opportunities, or a food outlet exposure that people can select from. In addition, there is a set of contextual factors that may influence the location of food outlets (e.g. local zoning laws, consumer demand for particular foods, and shopping patterns) determining the mix and density of certain types of food outlets in which people are exposed. Food outlet exposure, is then followed by a repeating set of contextual factors, including the food within the outlet that may be influenced by the profit margin of the food outlet, the food supply network available to that outlet and the customer demand, combining to trigger the type and amount of food exposure within an outlet that could (when coupled with in store sufficient conditions such as price, placement etc.) lead to food choice. These choices are then either reinforced or disrupted based on food preferences (explained below), and when repeated over space and time contribute to overall diet quality and health outcomes.

**Selection or trade-off pathway:** this pathway was theorised to interrelate with, but operate separately from, exposure. Context for this pathway begins with the walkability of the area where outlets exist and distance to the outlet, which could trigger a need for convenience. If the individual is aware of a convenient outlet and intends to purchase food at that location, they adopt the outlet. Once selected, that outlet, again depending on the drivers of food exposure and a need for convenience, is faced with foods in the outlet resulting in food choice.

**Personal preferences or needs pathway:** this pathway includes a set of contextual factors that again include a causal pathway with a starting point distal from food choice. While the colloquial term ‘preference’ gives a suggestion of pure agency, this pathway also includes needs that may be outside of the direct control of the individual but shape their preferences (e.g. deprivation or time sensitivity). Starting with level of deprivation and exposure to media and advertising that potentially shape social norms; knowledge, skills, attitudes and appetite could contribute to food preferences. In turn, food preferences can then influence exposure by driving the individual toward a travel route and/or shape a shopping pattern that leads to a particular food outlet.

However, food preferences can also influence outlet preferences depending on needs or preferences for food cost, variety, quality or tastes. This can help shape food outlet preferences that again drive people toward a route and give rise to a shopping pattern and therefore feed into the exposure pathway. Tangential to the interrelationship between

preferences, needs and exposure is the influence of level of deprivation on time sensitivity, which can then influence a need for convenience. Additionally, once preferences (either outlet or food) drive people toward a food outlet, or particular food choices, the experience of that selection then proves either a reinforcing or disruptive loop with preferences and needs, exposure and adoption that again influence food choice patterns.

**Food choice:** Although conceptualised as an outcome for this work, food choice was challenging to identify as a static outcome. That is, when applying a time dimension, arriving at food choice as the outcome would then change from an outcome to the context for the next shopping experience. If it was a positive shopping experience, this may indicate the beginning or reinforcement of a particular food preference that influences a pattern of travel with exposure to outlets and foods, with similar needs for convenience, resulting in the same food choice in the future. Similarly, if it was a negative experience, this could mean the disruption of any habitual food choices and preceding contexts and mechanistic triggers – leading back to food choice.

**Personal factors:** It is also recognised that individuals arrive at any given intervention with a certain set of characteristics, or demographic factors that are not modifiable by the intervention itself. These are labelled as personal factors, meaning they are determined prior to the circumstances surrounding the intervention. These are likely intervention modifiers and include age, sex, socio-economic position, ethnicity and household composition.

It is also noted in this initial ToC, that a range of other factors including those that make up the environment within a food outlet have not been included in the theory. These could include specific food prices, food promotions and the placement of foods. However, with the focus on effects of the necessary conditions (i.e. effect of local food availability on food choice), these are not included in the theory of change, which represents only aspects directly related to food availability of outlets and specific foods within an outlet, but not other sufficient conditions required for food choice.

#### *Summary of local food availability related evaluation literature*

Thirteen evaluations met inclusion criteria with an additional 32 articles identified as providing additional context to the primary evaluations. Four included evaluations were of new supermarkets opening in a neighbourhood with high levels of deprivation and limited access to supermarkets, namely Pennsylvania Fresh Food Financing Initiative (PFFF)<sup>41</sup>,

Leeds Retail Intervention (LRI)<sup>42</sup>, Glasgow Supermarket (GSM)<sup>43</sup>, NYC Supermarket (NYCM)<sup>44</sup>. One included evaluation was of a mobile food vending van with affordable fruits and vegetables in a communities with the greatest need, namely Mobile Food Store (MFS)<sup>45</sup>, six included within-store interventions where improving food provision was one strategy among a range of other in-store strategies (e.g. signage or food placement), namely Baltimore Healthy Stores (BHS)<sup>46</sup>; Baltimore Healthy Carry-outs (BHC)<sup>47</sup>; Navajo Healthy Stores (NHS)<sup>48</sup>; Proyecto MercadoFRESCO (PMF)<sup>49</sup>; Waupaca Eating Smart (WES)<sup>50</sup>; and Pittsburgh Hill/Homewood Research on Eating, Shopping, and Health (PHRESH)<sup>51</sup>, and finally two included fast food outlets, one examining a fast food ban Zoning LA (ZLA)<sup>52</sup>; the other examining effect of a new McDonalds restaurant opening McDonalds in Australia (MDA)<sup>53</sup> **Figure 2** provides the results of the systematic search for intervention literature and hand searching for related articles and monitoring for evaluation literature.

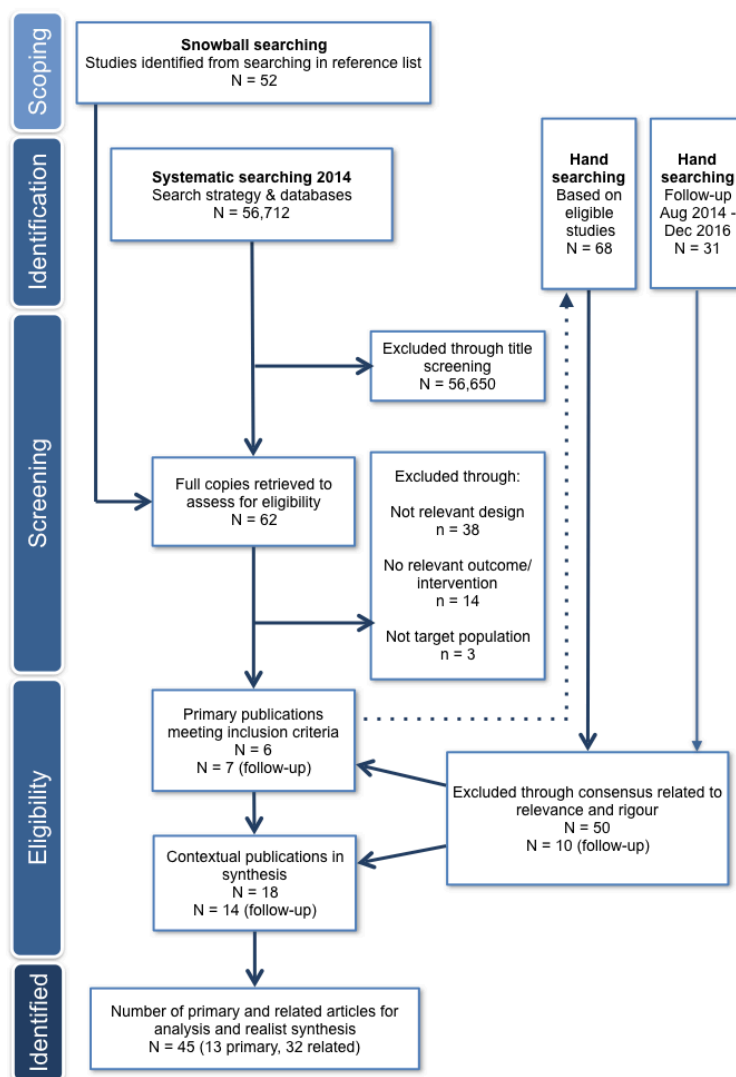


Figure 2: PRISMA diagram

**Table 1** provides an overview of included studies and intervention effects. Local food availability was changed using three community-level intervention strategies (i.e. supermarket opening in neighbourhood, a mobile food store and restricting or introducing fast food outlet(s)) across seven of the included interventions (PFFF, LRI, MFS, GSM, NYSM, MDA and ZLA), and six consumer-level intervention strategies (e.g. incentives for store owners to stock healthy foods in a convenience store and providing healthy sides at carry-outs) across the remaining interventions (BHS, BHC, NHS, PMF, WES and PHRESH).



Table 1: Summary table for extracted data from included primary outcome evaluation studies

Food outlet type and level	Intervention Name (primary citation)	No. Context papers (citations)	Country, Year	Design (evaluation design)	Sample (total)	Diet or food related behavioural measure	Intervention strategy	Outcome	EPHPP Score (Global) <sup>a</sup>
<b>Supermarket</b>									
<i>Community</i>	Pennsylvania Fresh Food Financing Initiative (PFFF) <sup>41</sup>	2 <sup>54,55</sup>	United States, 2014	Controlled 2 group pre-post	N=656 adults (at follow-up)	Total daily fruit and vegetable intake	Supermarket opening in neighbourhood	No significant impact on daily fruit and vegetable intake	2
	Leeds retail intervention (LRI) <sup>42</sup>	4 <sup>56-59</sup>	United Kingdom, 2003	Pre-post	N=615 adults (at follow-up)	7 day food diary	Supermarket opening in neighbourhood	No significant impact on servings of fruits and vegetables	3
	Mobile Food Store (MFS) <sup>45</sup>	0	United Kingdom, 2012	Pre-post	N=255 adults (at follow-up)	Frequency of fruit and vegetables	Mobile food store arrive in community, selling affordable fruit and vegetable	Significant increase of 1.2 portions of fruit and vegetable per day	3
	Glasgow Supermarket (GSM) <sup>43</sup>	3 <sup>60-62</sup>	United Kingdom, 2005	Controlled 2 group pre-post	N=412 adults (at follow-up)	Daily fruit and vegetable consumption	Supermarket opening in neighbourhood	No significant impact on portions of fruit and vegetable per day	1
	NYC Supermarket (NYSM) <sup>44</sup>	0	United States, 2015	Controlled repeat cross-sectional pre-post	N=363 parents of child aged 3-10 (at follow-up)	24 h dietary recall (parent completion)	Supermarket opening in neighbourhood	No significant impact on children's dietary intake	3
<b>Convenience</b>									
<i>Consumer</i>	Baltimore Health Stores (BHS) <sup>46</sup>	5 <sup>63-67</sup>	United States, 2010	Controlled 2 group pre-post	N=84 adults (at follow-up)	Healthy food getting scale	Multicomponent intervention including incentives for store owners to stock healthy foods	No significant impact on healthy food getting score	3
	Baltimore Healthy Carry-outs (BHC) <sup>47</sup>	4 <sup>68-71</sup>	United States, 2013	Controlled 2 group pre-post	Not clear	Sales receipts for types of healthy items purchased	Multicomponent intervention including healthy sides and beverages	4.5 types of healthy items purchase in intervention stores, less than 1 healthy item purchased in comparison stores – significance unclear	2

Food outlet type and level	Intervention Name (primary citation)	No. Context papers (citations)	Country, Year	Design (evaluation design)	Sample (total)	Diet or food related behavioural measure	Intervention strategy	Outcome	EPHPP Score (Global) <sup>a</sup>
	Navajo Healthy Stores (NHS) <sup>48</sup>	2 <sup>72,73</sup>	United States, 2013	Clustered, randomised, controlled pre-post	N=145 adults (at follow-up)	Healthy food getting scale	Multicomponent intervention including work with stores to stock key promoted healthier foods	No significant impact on healthy food getting score	3
	Proyecto MercadoFRESCO (PMF) <sup>49</sup>	6 <sup>74-79</sup>	United States, 2016	Controlled repeated cross-sectional pre-post	N=891 households (at follow-up)	Purchasing: proportion of total food spending spent on fruit and vegetables  Diet: estimated fruit and vegetable intake per day	Multicomponent intervention focused on increasing the availability of fruits and vegetables in corner shops, including provision of refrigeration equipment to display fresh fruits and vegetables	No significant impact on purchasing or consumption of fruits and vegetables	2
	Waupaca Eating Smart (WES) <sup>50</sup>	1 <sup>80</sup>	United States, 2015	Randomised controlled repeat cross-sectional pre-post	N=338 adults (restaurant at follow-up), 406 adults (store at follow-up)	Self-report perception of fruit and vegetable choices, purchase of promoted food	Multi-component intervention included increase in availability of healthy food products	No significant impact on satisfaction with fruit and vegetable choices or purchases of promoted foods	3
	Pittsburgh Hill/Homewood Research on Eating, Shopping, and Health (PHRESH) <sup>51</sup>	3 <sup>81-83</sup>	United States, 2015	Controlled follow-up pre-post	N=831 adults (at follow-up)	24-hour dietary recall. Survey items on food purchasing practices	Opening of a Healthy Food Financing Initiative-funded full-service supermarket	In the intervention neighbourhood there were positive changes in overall dietary quality; average daily intakes of kilocalories and added sugars; and percentage of kilocalories from solid fats, added sugars, and alcohol. However these changes were not associated with use of the	3

Food outlet type and level	Intervention Name (primary citation)	No. Context papers (citations)	Country, Year	Design (evaluation design)	Sample (total)	Diet or food related behavioural measure	Intervention strategy	Outcome	EPHPP Score (Global) <sup>a</sup>
								new supermarket.	
<b>Fast food</b>									
<i>Community</i>	McDonalds in Australia (MDA) <sup>53</sup>	1 <sup>84</sup>	Australia, 2016	Controlled, repeated cross-sectional survey	N=346 adults (at follow-up)	Reported frequency of McDonald's food consumption	McDonald's restaurant opening in new neighbourhood	No change in reported frequency of McDonald's product consumption.	3
	Zoning LA (ZLA) <sup>52</sup>	1 <sup>85</sup>	United States, 2015	Controlled, repeated cross-sectional survey	N=11,821 adults (at follow-up)	Dietary intake frequency, including fast food	Restricted opening of fast food outlets	No significant impact on dietary intake.	3

<sup>a</sup> EPHPP Global Score for Quality Assessment: 3 = Weak, 2 = Moderate and 1 = Strong

Of the thirteen interventions, the MFS found a significant increase in 1.2 portions of fruit and vegetable intake per day post intervention<sup>45</sup> and PHRESH found a positive change in diet quality in the intervention neighbourhood however unclear whether they were due to use of the new supermarket. PMF<sup>49</sup> and WES<sup>50</sup> found an increase in perceived accessibility of healthy foods, but no change in purchasing or consumption. PFFF<sup>41</sup>, LIR<sup>42</sup>, GSM<sup>43</sup>, NYSM<sup>44</sup> BHS<sup>46</sup>, NHS<sup>48</sup>, MDA<sup>53</sup> and ZLA<sup>52</sup> found no significant effects. BHC<sup>47</sup> did not discern robust effects although more healthy items were purchased in intervention stores than in comparison stores (no significance testing).

Two interventions had no additional articles (MFS and NYSM), with 1-5 relevant contextual papers for each of the remaining interventions. These papers provided a range of insights into intervention context. For example, the BHS process evaluation for a change in healthy offerings in a convenience store suggested that storeowners were very hesitant to change offerings if they conflicted with perceived consumer preferences, regardless of reimbursement during the intervention phase.<sup>63</sup>

Study quality assessment showed that over half (n=9) studies were deemed ‘weak’, three ‘moderate’ and one ‘strong’. The greatest challenges to quality including selection bias, confounding and participant drop-out (see appendix for quality score breakdown).

#### *Mapping evaluation-related literature onto theory of change*

These interventions displayed a moderate amount of consistency with regard to the tested context, mechanism and outcome configuration when mapped against the initial theory of change at the community level (introducing a supermarket in an area with limited access to healthy foods). Although the intervention strategies used at the consumer (i.e. store) level varied greatly, again the context, mechanism and outcome configuration mapped similarly onto the theory shown in solid lines (**Figure 3**).

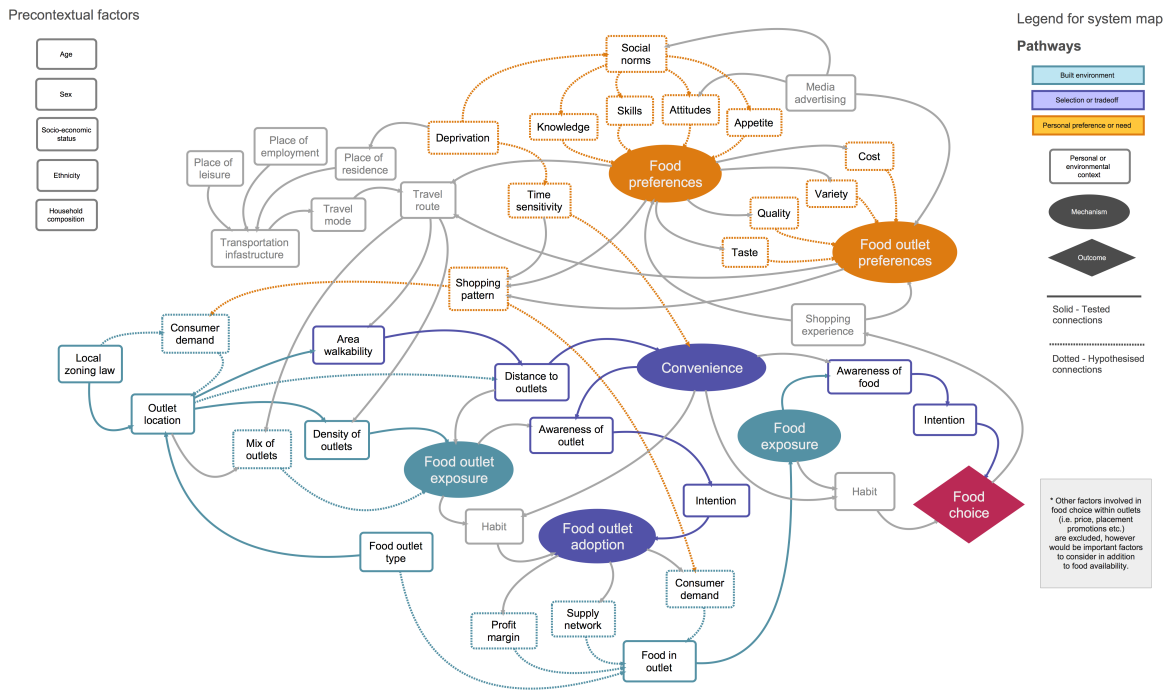


Figure 3: Theory of change with evaluation related literature mapped representing tested and hypothesised pathways

As many interventions were not found to result in a change in diet, authors provided hypothesized reasons for their inability to detect an effect. Reasons relevant to theory development that were mapped included proliferation of other, often less-healthy (e.g. fast food or convenience stores) choices in the area (i.e. exposure pathway) and the needs or preferences of the individuals and their existing shopping patterns (i.e. preferences and needs pathway). These are shown as dashed lines in Fig 3. For the two types of interventions (i.e. community and consumer), a set of context, mechanism, outcome patterns emerged that demonstrate the complex nature of potential programme theories for interventions of this type (Figure 4).

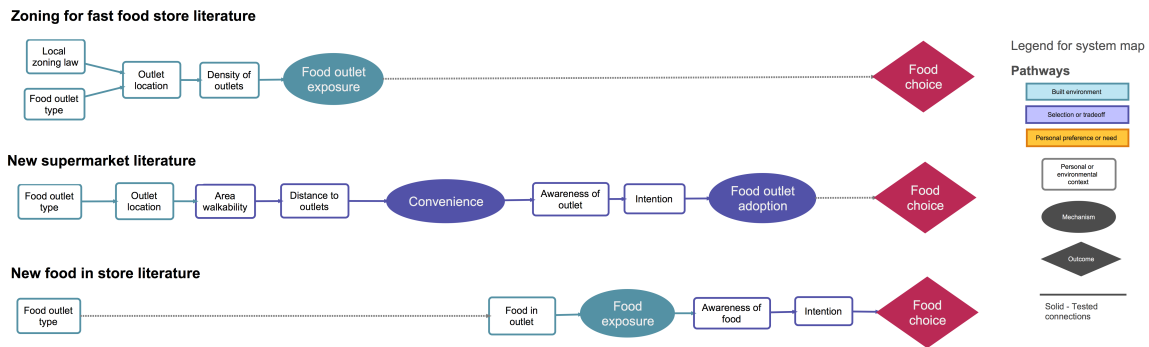


Figure 4: Tested context (rectangle), mechanism (oval), outcome (diamond) configuration chains from exposure (blue), convenience (blue) and convenience (purple) pathways for fast food, supermarket and convenience store interventions

## Discussion and synthesis

The purpose of this systematic review and realist synthesis was to generate a theoretical basis for grounding future evaluation or evidence synthesis by conceptualising how, for whom and under what circumstances interventions to change food availability influence food choices. It also sought to map local food availability interventions against the developed theory to deepen understanding and to reflect on the current state of discordance within observational and intervention evidence regarding food availability and diet behaviour.

### *How food availability influences food choice: causal pathways, context and mechanisms*

The theory developed in this work has conceptualised the influence of local food availability on food choice as approximating changes that occur within a wider system that includes three, interrelated and mutually supporting pathways of influence along with six identified mechanisms that may trigger dietary outcome patterns. The theory suggests a cyclical system of reinforcement between built environment exposure to, selection of and preference for particular foods and food outlets by the population. Across these pathways, mechanisms were described, for which multiple levels of context represent precursors to the triggering of these mechanisms, resulting in further contextual changes and a theorised change in food choice. Specifically, this theory includes some important characteristics not yet presented in other food environment frameworks, theories of food choice or intervention specific programme theory.

Firstly, it is focused on one aspect of the food environment, local food availability, which was chosen to represent an aspect of food environment research and class of intervention expected to be important for dietary public health (i.e. low-agency, environmental and structural changes that promote sustained, equitable healthy behaviours in the population).<sup>86</sup> Focusing on this aspect of the food environment allowed for a more coherent synthesis of interventions, which was demonstrated by the consistent context, mechanism and outcome configurations found during the mapping of tested aspects of the included interventions. This is in direct contrast to the reporting of significant heterogeneity in other systematic reviews<sup>87,88</sup>, which tend to include more varied interventions and report less-consistent findings.<sup>14,19–22</sup>

Secondly, the theory was developed using questions that seek to understand *change* within the context of a larger social, economic and environmental system, supporting the perspective that complex public health interventions might be best considered an event within a wider complex system.<sup>89</sup> Because the method used was not bound to previous conceptualisations of the food environment, the theory generated is not simplistic, with separate but interrelated pathways and reinforcement of these pathways depending on the outcomes. The realist approach used here allowed the theory to distinguish between important contextual factors, and demonstrate their multi-levelled nature while still allowing for conceptual specificity.<sup>34</sup>

As such, this theory of change might challenge current traditional or positivist approaches to defining and supporting causal inference, related to food availability interventions in particular.<sup>90,91</sup> For example, an alternative view of causality within other fields dealing with complexity and causality (e.g. computer science and neuroscience) is called ‘top-down’ causation. Rather than seeking evidence that one factor directly and independently predicts another at the same level of operation, top-down causation describes causality within a complex, multi-levelled system by accounting for the restriction of outcomes available to an agent moving through concentric levels of that system. While no one level exerts a causal influence, the ‘effect’ of passing through each level represents a progressive restriction of possible outcomes. When the agent reaches the end of the ‘system’, possible outcomes are few, and this restriction of possible outcomes approximates a causal effect.

This approach toward causality applied to the theory here suggests that, while food choice has the appearance of a broad set of choices and outcomes, in reality, the effect of moving through multiple levels of context toward food availability will increasingly restrict or

expand depending on your personal circumstances. For example, given a person's socioeconomic characteristics, place of residence, daily travel routes, needs and preferences for convenience – by the time they arrive at a food outlet, with a selection of foods to choose from, there may be little true choice remaining.<sup>92</sup>

Lastly, the mapping of intervention evidence reinforced the importance of other mechanisms of change that have not been incorporated into subsequent interventions or policies to change local food availability. Specifically, this applied to the role of exposure to a mix and density of other food outlets, especially if individuals preferences or need for convenience, were hypothesized but not tested. This is an important consideration as when a new supermarket arrives in an existing neighbourhood, the current residents have already established preferences or needs for particular foods or outlets; and therefore have shopping patterns that do not include the new supermarket.<sup>93</sup>

One could hypothesize that the addition of the supermarket did not change the distribution of food outlets surrounding the supermarket in any significant way (i.e. did not change exposure mechanism) and depending on the existing preferences or needs of the communities, will not change individual shopping habits making a switch to the new supermarket unlikely. There is compelling evidence that deprived neighbourhoods tend to have a less favourable distribution of healthy outlets, often called 'food swamps' to describe a proliferation of unhealthy food outlets.<sup>94</sup> Although the new supermarket may be closer to the previous food outlet option, we don't know if it is truly convenient based on what other food outlet options (i.e. exposure) are available and the skills, knowledge and attitudes toward foods (i.e. preferences or needs) that exist within the population.<sup>95</sup>

In contrast to additional supermarkets, the mobile food vendor was the only intervention to demonstrate a significant improvement in fruit and vegetable consumption. It included a specific selection of healthy foods (fruits and vegetables) for a reduced price, delivered direct to the selected deprived areas.<sup>45</sup> For those with a preference for fruit and vegetables, convenience was increased and exposure to other options was decreased, resulting in a favourable change in food choice.

*For whom and under what circumstances does local food availability influence food choice*

An important aspect of this work was to explore the context of these interventions - specifically, for whom and under what circumstances might food availability influence food

choice. While the theory does not break down specific pathways by different groups within the population, the review of intervention related evidence provided some specific insights. The interventions examined within the evaluation literature included in this review emerged out of a very specific set of concerns for the health of the public. In particular they were developed within the UK and US to provide a response to ‘food deserts’, which represented large geographic areas with a high proportion of low income, ethnic minority, residents whom did not have sufficient access to healthy affordable foods.<sup>96,97</sup> Related to these investments, other programmes were developed, particularly in the US that sought to also improve the healthy offerings within convenience stores, particularly in economically deprived communities that also suffered from poor access to healthy foods.<sup>19</sup> More recently these concerns transformed into concerns for ‘food swamps’, which represent a proliferation of unhealthy food options within more deprived areas.<sup>52</sup>

*Why some interventions fail – reflection on the logic of food availability interventions and the exclusion of the wider system*

An important motivation for theory development is to test the logic of an intervention or policy to ensure that, at least in theory, an intervention is capable of logically producing the desired results.<sup>40</sup> When reviewing the systemic theory in full, the failures observed in several of the included evaluations are not surprising. Most interventions address only a small part of the overall ‘local food availability system’, and often focus on structural factors to the exclusion of personal factors, therefore addressing only one mechanism in what is likely a long causal chain encompassed of multiple mechanisms and contextual factors needed to generate the desired outcomes.

Additionally, the ‘system’ was not considered during the development of the evidence that informed these policy actions, and therefore it could be argued were not designed to have systemic impact (i.e. shift the system of factors that produce outcomes).<sup>98</sup> The discordance between the observational and intervention literature and paucity of explicit theories of change in the field could provide an important opportunity to reflect on the foundational assumption upon which this type of preventative research is based. In fact, questioning the suitability of the biomedical, positivist approach to scientific inquiry for use as the basis for disease prevention and production of public health evidence is becoming more common.<sup>99–101</sup>

The lack of breadth of these interventions is likely a reflection of their status as ‘natural’ experiments, in the sense that these were changes to the local environment born out of policy

change that were then evaluated by researchers who did not have direct control of the intervention.<sup>102,103</sup> Even process evaluations of convenience store-based interventions that were researcher-driven often reported a lack of control over the dose and fidelity of environmental strategies to be implemented within the stores. The authors cited both hesitation and concern by the store owner about profit risk, which persisted even when the researchers were willing to reimburse store owners for losses.<sup>63</sup>

Although this challenge could be viewed negatively, namely as store owners not being committed to health, the theory presented here suggests that this could be a legitimate concern of store owners. The theory puts forward possible factors that influence what types of foods are available in any given food outlet including the profit margin, supplier network and again customer demand of people using a food outlet; factors the store owner must consider to remain economically viable. Without an improved understanding of these factors, and the contributions of both in terms of supply and demand for particular foods at particular prices, we may be asking storeowners to make changes that are not likely to succeed in the long term, even if they are willing to make short term changes.

The fundamental result of this review and synthesis suggests that to improve our understanding of *how and why* food availability might influence, diet and obesity, it may be important to consider the *role of a broad system of factors*, and explore possible methodologies to support the development of systemic theories of change for structural interventions, and their evaluation. Indeed, the MRC complex interventions framework begins with Theory Development as its initial stage.<sup>104</sup> However, given that many population health interventions are implemented outside of the academic sphere, and not researcher-driven (i.e. represent natural experiments)<sup>105</sup>, this guideline may go unaddressed. The first step therefore may often fall on the evaluator to investigate the implicit theories that drive the impetus for the intervention or policy, and to develop explicit theories of change suitable of guiding not only simplistic evaluation, but evaluation of events that may have a range of potential impacts and sectoral actors.

It is also important to reiterate that theory development is but the first step in intervention development. As recommended in the MRC framework, the next step requires testing and modelling the assumptions and hypotheses put forth in the theory<sup>104</sup>, which also has its own challenges regarding availability of methods of analysis for a systemic theory that has several long causal chains, and interrelated pathways of influences, like the theory presented here.

Although much of the discourse about public health evidence is moving in the direction of systems thinking and related approaches<sup>91,106,107</sup>, there is some discussion regarding the utility of this approach as an organising principle. For example, what are the defining characteristics of complexity and systems that are best applied to public health intervention?<sup>108</sup> Does applying the principles of systems and complexity science to understanding public health problems necessitate abandoning of current empirical methods that are based on examining linear, and possibly non-linear relationships?<sup>109</sup> Should we favour methods such as systems dynamic modelling, network analysis or agent based modelling, which emerged outside of established epidemiological and public health methods?<sup>110-112</sup> Do these methods answer fundamentally different questions? In order to widen our view of public health intervention and evidence, these and many other questions will need to be answered.

#### *Methodological strengths and limitations*

The primary strength of this work was that it sought to improve our causal understanding of how and why food availability interventions may influence food choice and therefore provide insights into why they may fail. To do this, a realist inspired theory of change was developed based on tacit knowledge and a critical examination of the local food availability literature. This work has some potential limitations. First among these is that theory development is only a starting point, and will require future testing. Additionally, the purpose of this realist synthesis is to focus on contextual factors and develop a theory of food availability and diet; however it has done so without directly assessing intervention effectiveness. Further, in order to provide the most comprehensive understanding of how the included food environment interventions work, this review was more inclusive of studies than traditional systematic reviews, giving rise to questions of the quality of included studies. Although studies of low quality according to our tool were not excluded, the quality score helped us during analysis and synthesis. Secondly this study relied on sources of tacit (i.e. the expert panel) and published (i.e. intervention related literature) knowledge to develop and reflect on the theory of change, future work could be done that moves beyond these sources.

The included intervention studies were used to bound the selection of additional literature relevant to the theory; however, this could be expanded to include other observational studies as a source of qualitative data. Other rich sources of data, such as qualitative interviews, could be used to collect personal stories about how food availability influences food choices among different social groups. These data sources could similarly be analysed for context,

mechanism and outcome patterns that might emerge from the experience of people as they navigate their environments and make food choices.

## Conclusions

The resulting theory of change suggests that reductionist approaches to policy development and evaluation of local food availability interventions may result in limited generalisable insights between varying contexts, possible unintended consequences or incomplete conclusions. With the paucity of explicit, empirically supported, systemic theories of change used in the literature, this synthesis may be used to contextualise observational research and future efforts for policies to improve efforts to improve local food availability.

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