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Other Reviews

A systematic review of fast food access studies

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Summary

The frequent consumption of energy-dense fast food is associated with increased body mass index. This systematic review aims to examine the methodology and current evidence on fast food access and its associations with outcomes. Six databases were searched using terms relating to fast food. Only peer-reviewed studies published in English during a 10-year period, with data collection and analysis regarding fast food access were included. Forty articles met the aforementioned criteria. Nearly half of the studies ($n = 16$) used their own set of features to define fast food. Studies predominantly examined the relationship between fast food access and socioeconomic factors ($n = 21$) and 76% indicated fast food restaurants were more prevalent in low-income areas compared with middle- to higher-income areas. Ten of 12 studies found fast food restaurants were more prevalent in areas with higher concentrations of ethnic minority groups in comparison with Caucasians. Six adult studies found higher body mass index was associated with living in areas with increased exposure to fast food; four studies, however, did not find associations. Further work is needed to understand if and how fast food access impacts dietary intake and health outcomes; and if fast food access has disparate socioeconomic, race/ethnicity and age associations.

Keywords: Built environment, fast food, local food access, obesity.

obesity reviews (2010)

Introduction

Frequent consumption of fast food has been associated with increased body mass index (BMI) (1). In the USA, the diets of children and adults increasingly includes fast food (2). Eating fast food has been associated with higher intakes of energy, fat, sodium, added sugars and sugar-sweetened beverages, and lower intakes of fruits, vegetables, fibre and milk in children (3), adolescents (4) and adults (5). Fast food also tends to have higher energy densities and poorer nutritional quality than foods prepared at home and in comparison with dietary recommendations (2). A recent review on US neighbourhood environments reported fast food restaurants are more prevalent in low-income and ethnic minority areas, possibly contributing to economic and ethnic obesity disparities (6). The authors of this review proposed requiring fast food restaurants locate a minimum distance from schools and limiting the total number of per capita fast food restaurants in a community. Policy makers have been making decisions related to fast food availability; for example, Los Angeles enacted a fast food ban (7).

Evidence-based environmental and policy approaches to obesity are important, because interventions primarily targeting individual-level behaviours, such as eating more fruits and vegetables, have had generally modest, mixed or null effects on sustaining weight loss (8,9). Recognizing these shortcomings and the complexity of eating and activity behaviours, obesity research and interventions are increasingly using ecological approaches that link multilevel factors (e.g. individual food choices with environmental and policy influences) (10). To effectively investigate the food environment and shape-effective strategies to improve access to healthy foods, valid and reliable measures are needed (11).

In light of these limitations and given the interest in using ecological approaches, this systematic review aims to

examine the methodology and current evidence on fast food access and its associations with outcomes. The end goal of the review is to identify gaps with data collection and measurement, understand the limitations of previous research and designs and focus future research on areas in most need of attention.

Methods

A systematic review was conducted to identify all published literature relating to fast food access. For our purposes, a fast food restaurant refers to food service outlets quickly serving inexpensive foods with minimal preparation and table service. The literature review was conducted by searching the following databases: PubMed (Medline), Web of Science, ScienceDirect, Cumulated Index to Nursing and Allied Health Literature (CINAHL), Education Resources Information Center (ERIC) and SPORTDiscus, along with the Robert Wood Johnson Foundation's Active Living Research and Healthy Eating Research resources. We also reviewed the references cited in each of the identified studies.

Peer-reviewed studies were considered for review if they included human subjects and were published in English between 1998 and 2008. This 10-year period spanned the majority of environmental fast food assessments, particularly studies using spatial data. Medical Subject Heading (MeSH) terms, along with key words extracted from relevant reviews and articles, guided the search terms. Searches were conducted using the following key words in a study's title or abstract: 'fast food', 'fast-food', 'fast food retailing', 'fast food restaurant', 'fast food outlet', 'food outlet', 'quick service restaurant', 'open campus', 'closed campus', 'full-service restaurant', 'family restaurant', 'limited service restaurant', 'food environment', 'school environment', 'local environment', 'neighborhood environment' and 'food environment health.'

We included only research articles examining fast food access with data collection and analysis. Studies examining fast food restaurants *on* school campuses rather than *near* school campuses were excluded, as the school lunch policy implications for competitive foods differ significantly from the environmental and policy implications of off-school campus venues. When possible, the following information was extracted from each study: year of publication, year of data collection, sample age, sample size used for final analyses, sample location, study design, data sources, fast food definition, psychometric properties, outcomes, covariates and results.

Results

Forty articles met the aforementioned criteria (12–51). The following sections summarize: (i) Methodology and (ii) Association of fast food exposures to the outcomes studied most often.

Methodology

Our methodology findings focus on (i) Study design and samples; (ii) Participant or context information; (iii) Neighbourhood or geographical location of interest and (iv) Fast food definition, characterization, data sources and psychometric properties and inclusions.

Study design and samples (Table 1)

One study was longitudinal (25) while the remaining 39 were cross-sectional. Five cross-sectional studies explicitly stated employing an ecological approach (14,21,22,31,48). The majority of the fast food access studies ($n = 25$, 62%) were conducted in the USA. Twenty-four of the 40 studies (60%) were based in urban settings. Eight of the 11 (73%) urban/rural mixed studies were in the USA, but only Liu *et al.* (36) focused on a specific setting while the other seven used nationally representative samples. Based in Australia, Simmons *et al.* (26) was the only exclusively rural study. If urban/rural comparisons were discussed, studies tended to note urban areas were more exposed to fast food restaurants than rural areas.

Participant or context information (Table 1)

Children were the focus of about one-third of the articles, either as individuals ($n = 5$), or as students in schools ($n = 7$), with only seven studies focused on adults ($n = 7$). All seven school studies reported fast food restaurants are near schools. Five of the seven school studies also examined the proximity of convenience stores to schools, and all five studies reported convenient stores were located near schools (24,35,45–47).

Neighbourhood or geographical location of interest (Table 2)

Sixteen different geographies (e.g. zip code) or contexts (e.g. home) were used to define neighbourhood or the geographical location of interest to determine fast food access. Twenty-four studies (60%) used geographical information systems software (e.g. GIS). Eight studies (20%) examined area commercial activity, noting generally higher commercial areas increased residents' exposure to fast food restaurants. Fourteen studies (35%) adjusted for population or population density for their fast food access analyses.

Fast food definitions, characterizations, data sources and psychometric properties and inclusions (Table 3)

Close to half of the studies ($n = 16$, 40%) used their own set of features to define the fast food restaurants included in their studies. These features generally captured the time taken to serve food (e.g. a few minutes), the type of service provided (e.g. counter service only) and the type of foods served (e.g. ready to eat, with limited preparation). Sixteen

Table 1 The study samples of fast food access studies ($n = 40$) published between 1998 and 2008 by country

Country	Nationally representative	Specific regions	Urban/rural setting	Participant or context information, if applicable
USA ($n = 25$)	(18,19,25,28*,29†,32,43,46,47) ($n = 9$)	Los Angeles, California (22,35,44); Four mid-sized cities in agricultural regions, California (39); Oahu, Hawaii (49); Chicago, Illinois (15); Marion County, Indiana (36); New Orleans, Louisiana (16); Washington County, Maryland (12‡,13‡); Eastern Massachusetts (37); Minnesota (27); suburbs of Minneapolis, Minnesota (12‡,13‡); Jackson City, Mississippi (12‡,13‡); St. Louis, Missouri (30); East Harlem, New York (34); Forsyth County, North Carolina (12‡,13‡); Cincinnati, Ohio (17); and Portland, Oregon (42) ($n = 16$)	Urban ($n = 15$) (12,13,15–17,22,27,30,34,35,37,39,42,44,49) Urban and rural ($n = 8$) (18,19,25,32,36,43,46,47) Did not indicate the settings of the hospitals ($n = 2$) (28,29)	Children ($n = 3$) (17,25,36) Adult ($n = 6$) (12,27,37,39,42,43) School ($n = 5$) (15,35,44,46,47) Hospital ($n = 2$) (28,29)
Australia ($n = 5$)	($n = 0$)	Geelong (51§), Melbourne (14,33,40,51) and Victoria (26) ($n = 5$)	Urban ($n = 4$) (14,33,40,51) Rural ($n = 1$) (26)	Children ($n = 2$) (40,50) Adults ($n = 1$) (26)
Canada ($n = 5$)	(28,45) ($n = 2$)	Edmonton (41,50) and Ontario (20) ($n = 3$)	Urban ($n = 3$) (20,41,50) Urban and rural ($n = 1$) (47) Did not indicate the setting of the hospital ($n = 1$) (28)	Schools ($n = 1$) (45) Hospitals ($n = 1$) (28)
UK ($n = 4$)	(21,31) ($n = 2$)	Glasgow, Scotland (23,48) ($n = 2$)	Urban ($n = 2$) (23,48) Did not indicate the urbanity/rurality of the settings ($n = 2$) (21,31)	
New Zealand ($n = 2$)	(38) ($n = 1$)	Wellington & Wairarapa regions (24) ($n = 1$)	Urban and rural ($n = 2$) (24,38)	Schools ($n = 1$) (24)

*Also examined Canadian hospitals.
†Also included a specific region component to the study.
‡Also investigated three other specific regions.
§Also investigated the Greater Melbourne areas.

Table 2 Summary of neighbourhood or geographical location of interest reported in fast food access studies ($n = 40$) published between 1998 and 2008

Neighbourhood or geographical location of interest	Citation (connecting to column 1)	Surrounding distance, if considered	Used geographical information systems or a similar spatial software	Considered area's commercial activity or level of commercialization	Adjusted for population or population density
US State ($n = 2$)	(18,19)				(19)
US County ($n = 1$)	(43)				(43)
Non-US city or Local Government Area ($n = 2$)	(26,33)		(33)	(33)	(33)
US community ($n = 1$)	(49)	Within 1 mile (49)			(49)
Zip codes ($n = 7$)					
USA ($n = 4$)	(22,25) (home and school), (32,37)		(37)	(32)	(32,37)
Canadian Forward Sortation area (postal code) ($n = 1$)	(20)				
UK postcode level ($n = 1$)	(23)		(23)		
Australian postal districts ($n = 1$)	(14)				(14)
US census tracts ($n = 5$)	(12,13,16,30,39)		(12,13,16,30,39)	(16,30)	(13)
US census block groups ($n = 2$)	(39,42)		(39,42)	(42)	
US census block ($n = 1$)	(34)		(34)		(34)
Canadian standard neighbourhood (similar to US census tracts) ($n = 1$)	(41)		(41)	(41)	
Scottish data zones (representing ~500–1000 people) and English super output areas (representing ~1500 people) ($n = 3$)	(21,31,48)		(48)		(21)
New Zealand census meshblocks (each represent approximately 100 people) ($n = 1$)	(38) (also used schools within the area to assess proximity)		(38)		(38)
Schools ($n = 7$)	(15,24,35,44–47) ((25,38,51) also used school addresses to assess the fast food environment)	300 m (35) 400 m (15,44,46) 500 m (35) 800 m (15,44,46,47) 1 km (24,45) 5 km (45) Zip code (35)	(15,24,35,44,47)	(15,44)	(45,47)
Home ($n = 5$)	(17,27,36,40,51)	Within 800 m (27,51) Within 1 mile (27) Within 2 km (36,40) Within 2 miles (27)	(17,27,40,51)		(36)
Hospital ($n = 2$)	(28,29)				
Work ($n = 1$)	(27)	Within 800 m (27) Within 1 mile (27) Within 2 miles (27)	(27)		

Table 3 Fast food access studies ($n = 40$) published between 1998 and 2008: definitions, characterizations, data sources and food and non-food outlet inclusions (M indicates the study used multiple approaches)

	Categories	Citations
Definitions	Features (included counter service, eaten on premises or takeout, number of chains nationally or within study area, quick service, ready to eat foods, chain, franchise, or in contrast to other outlets like sandwich or coffee shops) ($n = 16$)	(15–17,23,24,26,28–30,33,35,41,44,45,49,50)
	Federal industrial classifications ($n = 16$)	
	North American Industry Classification System (NAICS) Codes (included modifications, generally limited service restaurant, code # 722211) ($n = 10$)	(12,13,22,25,34,36,37,39,43,46)
	Standard Industrial Codes (SIC) (included modifications, codes noted: 5812/40, 58120300-58120303, 58120305-58120315) ($n = 6$)	(19,27,32,42,43,47)
	Most common, largest, top sales or specific fast food chains (ranged from only one fast food franchise to 18 specific chains) ($n = 9$)	(14,18,20,21,28,31,38,40,51)
Characterizations	Density (count per unit of area or other denominator, such as number of fast food restaurants per 1000 individuals; studies using counts per census area [e.g. tracts or blocks] were also classified as a density measure) ($n = 25$)	(12–14,16,18–24[M],26,30–32[M],37,39[M],40[M],41–43,45[M],47[M],48[M],51[M])
	Count (number of fast food restaurants within a specific distance, such as within 800 m from an address) ($n = 14$)	(15*[M],24,27*,34,35*,39[M],40[M],44,45[M],46,47[M],49,50[M],51[M])
	Proximity (distance to closest fast food restaurant from a certain location, such as schools) ($n = 8$)	(15[M],17,33,36,38,40[M],50[M],51[M])
	Ratio (compares number of fast food restaurants in area to other food outlets, such as grocery stores) ($n = 4$)	(25[M],32[M],43,49[M])
	Presence ($n = 2$)	(28,29)
Data sources	Internet sources ($n = 21$)	
	Online telephone directories, such as Yellow Pages and Canada 411($n = 13$)	(14,15[M],16[M],17[M],18[M],20,21,31[M],38[M],40[M],45,48,51[M]
	Fast food website search engine ($n = 6$)	16[M],18[M],30[M],31[M],40[M],51[M]
	Online dining guides, such as Fast Food Source, Centerstage and CitySearch ($n = 2$)	(15[M],51[M])
	Government public domain ($n = 19$)	
	Health or agriculture registry data at the city, county and/or state levels ($n = 11$)	(12,13,16[M],22[M],23,36,38[M],41,45,50,51[M])
	Census data ($n = 5$)	(19,25,30[M],37,43)
	Only indicated data from public source ($n = 2$)	(27,33)
	California State Board of Equalization (collected state sales and use tax) ($n = 1$)	(39[M])
	Private ($n = 7$)	
	InfoUSA ($n = 3$)	(35[M],42,46)
	Dun & Bradstreet ($n = 3$)	(32,44[M],47)
	Technomic Inc. ($n = 1$)	((15)M)
	Direct observation (included walking surveys and field audits) ($n = 7$)	(22[M],24,26[M],30[M],34,35[M],49)
	Phone book ($n = 3$)	(17[M],26[M],39[M])
	Telephone survey data ($n = 2$)	(28,29)
	Printed dining guide ($n = 1$)	(51[M])
Foot outlet inclusions	Multiple food outlets ($n = 13$)	(12,13,24,25,30,33,34,37–39,45,50,51)
	Fast food restaurants ($n = 11$)	(14,15,18–21,29,31,40,41,44)
	Multiple venues such as parks, exercise resources and bus stops ($n = 7$)	(16,17,35,36,42,48,49)
	Restaurants, including full-service and limited-service ($n = 6$)	(22,23,26,27,32,43)
	Fast food restaurants and convenience stores ($n = 2$)	(46,47)
	Fast food restaurants and vending machines ($n = 1$)	(28)

*Also examined Canadian hospitals.

studies also used the North American Industry Classification System (NAICS) or the Standard Industrial Classification (SIC) system or modified versions of these two coding systems to identify limited service restaurants and, if possible, franchised fast food restaurants. Chains commonly noted in the studies focused on specific fast food restaurants were: McDonald's ($n = 13$), Burger King ($n = 9$), Kentucky Fried Chicken (KFC) ($n = 9$), Pizza Hut ($n = 7$), Wendy's ($n = 5$), Subway ($n = 5$) and Taco Bell ($n = 5$). Twenty-nine other chains were specifically named and studied. All studies used mutually exclusive coding by which a food outlet could only fall into one classification category. When uncertain of how to categorize a food outlet, investigators generally relied on name recognition (e.g. Morland *et al.* (13)) or categorizations given by: the telephone directory (e.g. Morland *et al.* (13)), the store owner (e.g. Wang *et al.* (39)), long-term neighbourhood residents (e.g. Block *et al.* (16)), the media (e.g. Block *et al.* (16)) or prior studies (e.g. Liu *et al.* (36) and Mehta and Chang (43)).

Measures used to characterize fast food access included density, count, proximity or ratio. Density refers to the number of fast food restaurants within a certain unit measure, like a census tract or neighbourhood (11,52). Proximity means how close or near a fast food restaurant is to something else, such as a school or low-income neighbourhood. Count means the number of fast food outlets within a specific distance. Ratio refers to the number of fast food restaurants in comparison with something else, such as full-service restaurants. Density was the most common measure ($n = 25$, 62%), but the denominator, such as number of restaurants per a certain number of individuals or population size, varied. Studies using density tended to not discuss if and how population adjustments were made. Fourteen studies (35%) used a count measure, including studies (15,27,35) using density to describe their measure. Proximity was used for only eight studies (20%), of which five focused on children (15,17,36,40,51). Ratio was only used by four studies. Eight studies used two types of measures (15,25,32,39,45,47,48,50), and two other studies used three types of measures (40,51).

About a third of the data sources used to identify fast food restaurants (35%) were from the Internet, and another third of the sources came from the government (32%). Four of the 12 studies published in 2008 used private sources. Only seven studies (18%) directly observed the restaurants' physical locations. Fourteen studies (35%) used multiple data sources.

Overall, studies did not document their fast food environment data for any psychometric properties. This could include assessment for evidence of inter-rater reliability (e.g. comparing between raters when making decisions about whether to identify a restaurant as fast food) or validity (e.g. documenting the agreement between direct observations of fast food restaurants compared with Internet or government sources of fast food restaurants). Studies using multiple databases to create a comprehensive fast food listing or studies using direct observations generally did not include any information comparing or contrasting these sources or approaches. The following three studies provided some detail on how they compared their fast food environment data. First, Pearce *et al.* (38) verified health inspection data of fast food listings by comparing with an online telephone directory. When data were incomplete or missing, the master list was updated, but no comparison statistics were provided. Although a restaurant by restaurant match was not reported, Simon *et al.* (44) compared two data sources and found 30% more restaurants in the food inspection database ($n = 2468$) than in the commercial database ($n = 1848$). The third study, Maddock (18), compared two data sources (Yellow Pages and restaurant chain locator engine) for five states in the USA and reported a perfect match.

Only 11 studies reported data exclusively on fast food restaurants. The remaining 29 studies, while having separate restaurant analyses, examined a variety of associations using other food (e.g. grocery stores or convenience stores) or non-food outlets (e.g. exercise facilities or bus stops).

Fast food access associations

This section summarizes fast food access associations with (i) Socioeconomic status (SES); (ii) Race/ethnicity; (iii) Obesity and (iv) Other health behaviours or health outcomes. We focused on associations derived from final adjusted analyses in each study.

Socioeconomic status (Table 4)

Studies predominantly examined the relationship between fast food access and SES factors ($n = 21$). The majority ($n = 16$, 76%) indicated fast food restaurants were more prevalent in low-income areas compared with middle- to higher-income areas. Only three non-US studies did not find significant associations when exploring the association of fast food access with SES (20,23,48). A variety of approaches were used to measure SES. Non-US studies ($n = 5$) frequently used deprivation scores or a SES index. For 11 of the 18 studies where data collection dates could be determined, the difference between the year of food environment data collection and the year of SES data collection exceeded 3 years, indicating temporal mismatch of data sources.

Race/ethnicity (Table 5)

Ten of 12 studies reported fast food restaurants were more prevalent in areas with higher concentrations of ethnic minority groups in comparison with Caucasians. One study in the USA found the opposite: fast food restaurants were

Table 4 Summary of socioeconomic status (SES) associations reported in fast food access studies (21 of 40) published between 1998 and 2008

Association	No association	Other findings	Measures	Data collection timing	Statistical adjustments
Increased fast food restaurants more likely to be in low-income areas in comparison with higher-income areas ($n = 16$) (13,14,16,21,22,25, 30–33,38,41,44,46,47,50)	($n = 3$) (20,23,48)	(15): Found a small number of fast food restaurants located in the lowest-income tertile areas (24): Although not significant, higher proportions of outlets serving lunch or dinner meals were in high-SES neighbourhoods	Median household income ($n = 9$) • of zip code or postal code: (14,20,22,32) • of census tract: (15,16,44,47) • of census meshblock group: (38) (also included median rent) Deprivation scores or SES index ($n = 5$) (21,23,31,33,48) School classification systems ($n = 2$) (24,46) Various SES parameters (e.g. median income, unemployment, etc.) ($n = 2$) (41,50) Median value of homes in each census tract ($n = 1$) (13) Self-reported income ($n = 1$) (25) Percentage living below the federal poverty level ($n = 1$) (30)	1–2 years between the collection of SES data and food environment data ($n = 7$) (15,23–25,32,47,48) 3–4-year difference ($n = 9$) (14,16,21,30,31,38,44,46,50) Over 5-year difference ($n = 2$) (13,20) Difficult to determine data collection years ($n = 3$) (22,33,41)	Geographical (e.g. population density or size, regional differences, spatial dependence or clustering, urbanization or rurality and commercialization) ($n = 15$) (13,15,21–24,30–32,38,44,46–48,50) Area income ($n = 12$) (14–16,20,24,30,32,38,41, 44,47,50) Race/ethnicity ($n = 5$) (25,30,32,46,47) Individual income ($n = 2$) (20,25) Education ($n = 2$) (25,41) Age or grade level ($n = 2$) (33,47) Environmental variables (e.g. alcohol outlet density) ($n = 1$) (16) Percent eligible for title 1 ($n = 1$) (46) School size ($n = 1$) (47) Unemployment, renters and immigrants ($n = 1$) (41) Birth weight, baseline body mass index, gender ($n = 1$) (25)

Table 5 Summary of race/ethnicity associations reported in fast food access studies (12 of 40) published between 1998 and 2008

Association	No association	Other findings	Measures	Data collection timing	Statistical adjustments
Increased fast food restaurants more likely to be in areas with higher concentrations of ethnic minority groups in comparison with Caucasians ($n = 10$) (16,22,25,30,32,34,41,46,47,50)	($n = 1$) (12)	(13): Twice as common in Caucasian and racially mixed neighbourhoods than African–American neighbourhoods	Census data to describe racial composition ($n = 9$) • by census tract: (13,16,30,47) • by zip code: (22,32) • by census block: (34) • by Canadian neighbourhood: (41,50) Self-reported ($n = 2$) (12,25) National Center for Educational Statistics Common Core Data ($n = 1$) (46)	Race/ethnicity data and food environment data were collected roughly in the same year ($n = 3$) (25,32,47) 2–5 years between the collection of race/ethnicity data and food environment data ($n = 5$) (16,30,34,46,50) 4–6-year difference ($n = 1$) (12) About a 9-year difference ($n = 1$) (13) Difficult to determine data collection years ($n = 2$) (22,41)	Geographical (e.g. population density or size, regional differences, spatial dependence or clustering, urbanization or rurality and commercialization) ($n = 8$) (13,22,30,32,34,46,47,50) Area income ($n = 7$) (12,16,32,34,41,47,50) Education ($n = 3$) (12,25,41) School size and grade level ($n = 1$) (47) Environmental variables (e.g. alcohol outlet density) ($n = 1$) (16) Percent eligible for title 1 ($n = 1$) (46) Unemployment, renters and immigrants ($n = 1$) (41) Birth weight, baseline body mass index, gender and family income ($n = 1$) (25)

twice as common in Caucasian and racially mixed neighbourhoods than African–American neighbourhoods (13). No significant racial differences were reported by Morland *et al.* (12), but the African–American and Caucasian participants in this study came from different geographical areas and Caucasians had three times greater access to private transportation than African–Americans living in similar areas. Only two of the 12 studies (17%) examining race/ethnicity were outside the USA (41,50). Six studies compared predominantly African–American areas to predominantly Caucasian areas, while the other American studies noted Latino findings (12,13,16,22,30,32).

Obesity (Table 6)

Fifteen studies (38%) examined BMI or obesity prevalence associations with the fast food environment. Seven studies (47%) found higher obesity prevalence was associated with living in areas with higher access to fast food restaurants while eight studies (53%) did not find any significant associations. In children, only one of five studies found an association between BMI and the fast food environment. Four of the five studies on children used measured height and weight data to calculate BMI. In contrast, the majority of the adult studies (70%) relied on self-reported data. Among adults, six studies found an association, while four did not find an association. Most adult studies ($n = 7$, 70%) relied on self-reported height and weight.

Other health behaviours and health outcomes

The relationship between fast food access was explored with other health behaviours (e.g. dietary intake and physical activity) or health outcomes (e.g. mortality and admissions for acute coronary syndromes). Specifically, six studies investigated dietary intake associations with the fast food environment (12,26,27,39,42,51).

Using a telephone survey, Jeffery *et al.* (27) found eating at fast food restaurants was positively associated with a high-fat diet, having children and a high BMI, and was negatively associated with vegetable consumption and physical activity. In this study, proximity to fast food restaurants from home or work was not associated with eating at fast food restaurants or BMI. Simmons *et al.* (26) also used self-reported frequency of takeaway consumption and found increased takeaway consumption was associated with increased consumption of higher fat preparations of dairy and meat. BMI, however, was unrelated to takeaway consumption. Over a 9-year period, Wang *et al.* (39) reported increased trends in eating healthy and unhealthy foods as the neighbourhood access to fast food increased. Morland *et al.* (12) found African–American adults living in neighbourhoods with full-service restaurants consumed less saturated fat. Li *et al.* (42) used fruit and vegetable intake to control for dietary intake and did not report any dietary associations with fast food proximity. In children,

Table 6 Obesity associations with fast food access (reported in 15 out of 40 fast food access studies published between 1998 and 2008)

Increased fast food access associated with higher BMI or likelihood of obesity	No association	Statistical adjustments
Children ($n = 1$) Measured height and weight (36)	Children ($n = 4$) Measured height and weight (17,25,40) Self-reported measures (45)	Individual or household income ($n = 4$) (17,25,36,45); area income ($n = 3$) (36,40,45); race/ethnicity ($n = 3$) (17,25,36); gender ($n = 3$) (17,25,45); parental education ($n = 2$) (25,40); individual physical activity ($n = 2$) (40,45); age ($n = 2$) (36,45); baseline BMI and birth weight ($n = 1$) (25); area race/ethnicity, urbanization and employment status ($n = 1$) (45)
Adult ($n = 6$) Measured height and weight (39,42) Self-reported measures (18,19,43,49)	Adult ($n = 4$) Measured height and weight (26) Self-reported measures (27,37,40)	Age ($n = 6$) (26,27,37,39,42,43); race/ethnicity ($n = 5$) (19,37,39,42,43); education ($n = 5$) (19,27,37,39,43); individual or household income ($n = 5$) (19,37,39,42,43); geographical (e.g. population density or size, regional differences, spatial dependence or clustering, urbanization or rurality and commercialization) ($n = 5$) (18,39,42,43,49); gender ($n = 5$) (26,27,37,42,43); area income ($n = 5$) (18,40,42,43,49); martial status ($n = 2$) (19,39); area race/ethnicity ($n = 2$) (18,42); smoking ($n = 2$) (37,43); individual physical activity levels ($n = 2$) (40,43); male per female, age of state residents, percentage of people regularly active, and percentage of people eating five or more fruits and vegetables a day ($n = 1$) (18); employment status, home ownership, health status, individual fruit and vegetable intake and individual fried food consumption ($n = 1$) (42); area education ($n = 1$) (43); self-reported height and weight adjustments ($n = 1$) (19)

BMI, body mass index.

Timperio *et al.* (51) reported living near more fast food restaurants decreases the likelihood of eating recommended fruit and vegetable intakes. Three studies examined the foods offered at fast food restaurants and reported high exposures to unhealthy items and limited selection of healthier items (22,24,30). One study (19) evaluated the price of fast food meals between 1984 and 1999 and noted a reduction in fast food prices over time.

Thirteen studies included measures relating to physical activity to investigate other environmental associations with physical activity (e.g. playground or gym facilities access) or to control for physical activity levels in the fast food obesity assessments (17,18,25–27,35–37,39,40,42,44,48). Only Jeffery *et al.* (27) investigated and reported a negative association between physical activity levels and access to fast food restaurants. In regards to health outcomes, one Canadian study reported mortality and admissions for acute coronary syndromes were higher in regions with greater numbers of fast food restaurants (20).

Discussion

The aim of this review is to examine the methodology and current evidence of associations with fast food access. The following sections summarize our findings in these two areas.

Methodology

Only one of the 40 studies reviewed did not use a cross-sectional design. Cross-sectional studies cannot address causality nor track ongoing dynamic processes. The evaluation of a natural experiment, such as examining the introduction of a new fast food restaurant into a community, may help prospectively monitor the effects of fast food access (53). The use of longitudinal studies could examine how the construction of new restaurants or the closure of grocery stores affects individual weight changes over time.

No studies compared US with non-US settings, except McDonald *et al.* (28) Further work could explore the differences between geographical settings. Only one Australian study (26) focused exclusively on a rural setting. Studies focused on rural food environments require giving special attention to fast food located within convenience stores, as 53% of the fast food opportunities identified in a rural Texas study were within convenience stores (54). None of the school studies examined open/closed lunch policies, even though students at schools with open campus policies were significantly more likely to eat lunch at a fast food restaurant than students at schools with closed campus policies (55). Future school-based studies could also collect more student-level data to gather information on whether or not the students attending the studied schools actually eat at the restaurants near their schools.

A variety of approaches were used to define neighbourhood boundaries. Formative research may help determine neighbourhood boundaries, as community members tend to define their neighbourhoods more broadly than a census block group (56). GIS has emerged as a useful method to model fast food access within an area; yet, the tool has its limitations. Future initiatives could work on developing best practices regarding the software, statistics, sample size and the size and range of the buffers. Researchers might

also incorporate measures to limit errors in the processing and matching of addresses to spatial areas, including reporting matching accuracy rates (6,57).

Most of the studies (40%) used their own set of features to define fast food. Building consensus on what constitutes fast food could potentially reduce inconsistent fast food access findings (6). Similarly, future efforts might work on building consensus on what data sources should be used to determine the location of fast food restaurants. Studies exploring the psychometric properties of fast food data sources and measurements can help determine the most accurate sources, and how the use of multiple sources affects the quality of the data (6). Field-based validation should strengthen the accuracy of the fast food environment data (58).

Studies characterized fast food access using a variety of measures, each having advantages and disadvantages. For example, the associations reported in studies using density to describe fast food access with census tracts could be confounded by the varying size of the census tract. In other words, a high density of fast food restaurants may be the result of a smaller census tract or a large number of stores or both. Calculating the number of fast food restaurants per capita or per a certain population size is subject to similar errors. Future studies can appreciate the distinctions between density, proximity, count and ratio and aim to use language consistent with their measurement approach. Studies measuring proximity can specify whether Euclidean or network distances were used. Future research could help establish the relevant distances to study the fast food environment and the value of using multiple approaches to characterize fast food access.

Less than a third of the studies reviewed focused exclusively on fast food restaurants. Focusing only on fast food could enable researchers to invest more time into systematically examining the association between fast food access and diet and health outcomes. On the other hand, exploring the broader food environment, including pertinent transportation systems, seems logical and could provide a more robust understanding of a community's overall food access. Future work could determine the appropriate balance between more specific and broader food environment assessments.

Fast food access associations

Our findings related to SES support a recent review on healthy food access disparities in the USA, which reported fast food restaurants are more prevalent in low-income areas (6). In our review, 16 out of 21 studies indicated fast food restaurants were more prevalent in low-income areas compared with middle- to higher-income areas. We identified some gaps with data collection and measurement; for instance, varying approaches were used to describe SES and account for potential confounding. Future studies focused on SES disparities could explore how individual-level economic changes (e.g. recently laid off) relate to individual changes in fast food access (e.g. move to low-rent area), fast food consumption and health outcomes. Studies could also focus on how downturns in the economy impact fast food restaurants (e.g. go out of business, reduce their number of outlets in certain areas, reopen, increase their menu offerings of cheaper, lower nutritional quality items or increase their promotion of cheaper, energy-dense items).

Similarly, our race/ethnicity findings support a recent review on healthy food access disparities in the USA (6). Ethnic minority groups in comparison with Caucasians were more likely to live in areas with higher access to fast food restaurants. Similar to SES studies, we identified methodology gaps, including inconsistent methods to characterize the racial composition of neighbourhoods, lack of community input on ethnic/race and neighbourhood definitions and limited information on under-studied ethnic groups, such as American Indians and Asian Americans. A recent commentary discussed possible factors, such as economic characteristics, physical infrastructure and social processes, rationalizing why fast food restaurants locate more frequently in African–American communities (59). This commentary noted cheaper land prices or reduced political strength in some African–American communities could potentially induce fast food corporations to invest in these areas. Future studies could seek a broader understanding of the historical, political and cultural underpinnings to SES and racial segregation within a region. Economists could explore how a region's SES and race/ethnicity interact with the region's fast food restaurant supply and demand.

Unlike SES and race/ethnicity, our BMI findings were too uncertain to draw solid conclusions on the relationship between fast food access and BMI. The lack of individual BMI data based on measured values in this literature is a significant limitation. Future research in this area could include more qualitative and quantitative assessments of fast food consumption, among other individual-level characteristics (e.g. gender) and lifestyle behaviours.

Conclusion

The findings from 40 studies demonstrate fast food restaurants are prevalent in low-income and ethnic minority areas and around school campuses. With over half of these studies published in 2007 and 2008, fast food environment researchers are continuing to build their capacity to incorporate stronger methodological approaches, focus on specific research gaps and strengthen the utility of their research to inform future environmental and policy strategies. Establishing evidence-based policy regarding fast food access is limited by the cross-sectional nature of the current

studies and the lack of consensus on the definition of fast food, the best databases to use to determine and verify the location of fast food restaurants, the characterizations of fast food access and whether or not to focus only on fast food restaurants or include more robust food and non-food outlet analyses. Further work is needed to understand (i) If and how fast food access impacts dietary intakes and health outcomes and (ii) If fast food access has disparate socioeconomic, race/ethnicity and age associations. A conceptual or theoretical framework for examining fast food access and synthesizing the individual, social, environmental and policy influences could strengthen the fast food environment evidence base and improve the linkages between research and effective interventions and policy initiatives.

Conflict of Interest Statements

No conflict of interest was declared.

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