Title

Health on Main Street USA: Investigating Business Mix and Health Outcomes in Retail Areas of the United States using Geographic Information Systems (GIS)

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A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy
in Environmental Health Sciences

by

Christina Marnita Batteate

2024

ABSTRACT OF THE DISSERTATION

Health on Main Street USA:

Investigating Business Mix and Health Outcomes in Retail Areas

of the United States using Geographic Information Systems (GIS)

by

Christina Marnita Batteate

Doctor of Philosophy in Environmental Health Sciences

University of California, Los Angeles, 2024

Professor Michael Leo B. Jerrett, Chair

The built environment influences health and well-being at the individual to community scale. I sought to understand if retail environments are associated with local health by testing hypothesized relationships using a novel geographic-information system (GIS) approach.

First, I conducted a scoping review to identify and synthesize linkages between U.S. retail environments and health. I reviewed outlet-specific literature on food, alcohol, tobacco, and marijuana outlets. At the neighborhood-level, retail environments are linked to health through facilitating physical activity, social cohesion for vulnerable populations, community crime and violence, and noise. Understanding the specific influences of retail environments on health remains challenging. Many studies have methodologic inconsistencies limiting

comparison. Through focusing on only one outlet type or health outcome, most literature on retail environments and health does not provide a cohesive framework for tying together findings from diverse disciplines. To understand the composite retail environments' influence on health, future research should evaluate multiple retail outlet types concurrently.

To systematically study cities across the United States, I developed a static kernel density-based GIS method to identify the presence and outlet mix of retail areas, or business districts, in each city. In a random sample of fifty cities, I identified 1,416 business districts of varying sizes and assigned each a health score based on presence of thirteen types of outlets known to influence health. I found that health outcomes were consistently and significantly associated with business district scores to a moderate degree when controlling for census region and city size. Relationships between health outcomes and district scores were stronger in communities with the least social vulnerability, indicating additional variables may be needed for assessing retail areas in socially vulnerable communities and addressing health disparities.

Our findings align with built environment literature that found relationships between health and place. While retail environment literature remains mixed in its focus, methods, and overarching conclusions, this work is a methodological advancement in understanding the role of the retail environment in U.S community health. Future research should adapt methods described in this work to study a broader range of retail environments in varied social contexts over time.

The dissertation of Christina Marnita Batteate is approved.

Brian L. Cole

Richard J. Jackson

May-Choo Wang

Michael Leo B. Jerrett, Committee Chair

University of California, Los Angeles

2024

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ACKNOWLEDGEMENTS

This work was sponsored by Royal Society for Public Health (RSPH) through a grant from the Robert Wood Johnson Foundation (RWJF) titled “Health on the High Street”, and by UCLA Ziman Center for Real Estate. Financial support to Christina M. Batteate for doctoral research was also provided by the UCLA Environmental Health Sciences Department in the form of the Richard J. Jackson Designing Healthy Communities award and other graduate student awards. Overall, “Health on the High Street” was supervised by Principal Investigator Michael L. Jerrett, doctoral committee chair. Work on the overall project was also conducted by Co-Investigator Brian L. Cole, doctoral committee member. Specific roles of individuals related to dissertation chapters are described below.

Special thanks to Duncan Stephenson, Toby Green, and Shirley Cramer from RSPH and Susan Mende at RWJF for their vision and support. The “Health on High Street” project had a Technical Advisory Committee (TAC) made up of experts around the United States, who deserve many thanks for their thoughtful reviews and guidance. Gratitude goes out to all TAC members: Tina Yuen, Andrew Rundle, Richard Jackson, Casey Durand, Anne Vernez-Moudon, Sara McLafferty, Ann Forsyth, Dave Pogue, and Melissa Sullivan.

Chapter 1 of the dissertation is in preparation for submission to Health and Place. It was previously submitted to International Journal of Environmental Research and Public Health (IJERPH) and underwent review, but we ultimately withdraw it when we did not get ample direction from the journal’s editor to guide final revisions. The literature review was overseen by Michael L. Jerrett and Brian L. Cole, and assistance was provided by Anissa Raja who performed literature searches and summarized data, and by Nicholas Green who conducted a separate policy literature review.

Chapter 2 is in preparation for submission to International Journal of Health Geographics. Conceptualization of the geographic information system (GIS) method was led by

Michael L. Jerrett, with assistance from Madeline Brozen and Jonah Lipsitt. Christina Batteate wrote the guide for performing the kernel density analyses while processing data for a number of cities before codifying the process for Anissa Raja who completed kernel density analyses and the data cleaning of business districts described in Chapter 2.2 under the supervision of Christina M. Batteate, Michael L. Jerrett, and Brian L. Cole. Brian L. Cole led the national opinion poll and summarized response data into a scoring scheme by outlet category and wrote SPSS script to assign a score to each outlet type to calculate a health score for every business district studied, as described in Chapter 2.3.

Chapter 3 is in preparation for submission to Journal of Urban Health. Michael Jerrett and Brian Cole oversaw the analysis and reviewed the summary of findings, but all analyses were performed solely by Christina M. Batteate.

VITA

A. EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE	Completion Date	FIELD OF STUDY
California Polytechnic State University, San Luis Obispo	BSCRP	06/2008	City and Regional Planning; Sustainable Environments
University of California, Los Angeles	MPH; MA	06/2012	Community Health; Latin American Studies

B. POSITIONS, SCIENTIFIC APPOINTMENTS, AND HONORS

2012 – Present	Research Program Manager, Center for Occupational and Environmental Health, Department of Environmental Health Sciences, University of California, Los Angeles
2011 – 2011	Consultant, Human Impact Partners, San Diego, CA
2010 – 2012	Administrative Analyst, Department of Environmental Health Sciences, University of California, Los Angeles
2007 – 2008	Consultant, Planning Division of Community Redevelopment, City of Ventura, CA

Honors

2016	Highest scoring research abstract, International Conference on Transport and Health
2012	Health Impact Assessment (HIA) Practitioners summer training scholar
2011 – 2012	UCLA Foreign Language and Area Studies (FLAS) Fellow
2011	Monica Salinas and Drabkin-Bixby Scholar
2007	California Planning Foundation Award, Outstanding student

C. CONTRIBUTIONS TO SCIENCE

Publications

1. Cohen, D., Han, B., Derose, K. P., Williamson, S., Paley, A., & **Batteate, C.** (2016). CicLAvia: Evaluation of participation, physical activity and cost of an open streets event

in Los Angeles. *Preventive Medicine*, *90*, 26–33. http://doi.org/10.1016/j.ypmed.2016.06.009

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Conference proceedings and abstracts

1. **Batteate, C.** (2006) "Cal Poly's Symposium on Urban Disaster Risk Reduction and Regeneration Planning: An Overview." *Focus: Journal of the City and Regional Planning Department*. Vol 3 (1).
2. Brozen, M., **Batteate, C.**, Cole, B., & Cohen, D. (2016). A69 – Open Streets and Business Volumes in Los Angeles: Friend or Foe? *Journal of Transport & Health*, *3*(2). http://doi.org/10.1016/j.jth.2016.05.100
3. **Batteate, C.**, Shu, S., Cohen, D., Brozen, M., Zhu, Y., & Cole, B. (2016). A01 – Ciclavia: A Magnet for Health in Los Angeles. *Journal of Transport & Health*, *3*(2), S4–S5. http://doi.org/10.1016/j.jth.2016.05.032

Presentations

1. “Bringing a Community Health Lens to Highway to Main Street Conversions Through the Integration of Top-down Expert Guidance and Bottom-up Community Engagement”, November 2017 at *American Public Health Association Conference.*
2. “Why Evaluate Open Streets? Summary of CicLAvia Research Group findings”, September 2015 at *National Open Streets Summit* in Atlanta, GA.
3. "Applications of the Pedestrian Environmental Quality Index (PEQI) in Southern California”, July 2012 at SFDPH at *Health Impact Assessment Practitioners Summer Training Course.*

BACKGROUND

The work described in this dissertation are components of a larger body of work commissioned by Royal Society for Public Health (RSPH) through a grant from Robert Wood Johnson Foundation. Our work built upon and extended a national proof-of-concept project conducted by RSPH in the United Kingdom (UK) in 2015, known "Health on the High Street."[1] In the UK, the 'High Street' refers to what Americans often call main street in a town or city (e.g. Main Street USA). The UK project successfully raised awareness of the relationship between the density and clustering of certain types of retail outlets and local population health. Their report also highlighted how the retail environment can contribute to health inequalities, by examining life expectancy and social depravation. Their project also sought to identify positive steps which different stakeholders can take to mitigate the negative effects and make High Streets more health promoting, including:

A. Action from policy makers around planning and licensing to tackle issues such as clustering and increasing availability of healthier options;

B. How businesses can make their retail offer on High Streets or Main Streets more health promoting; and

C. Raising awareness among residents and stakeholders about how to improve the health on their High Streets or Main Streets.

In 2018, RSPH undertook an updated analysis of UK High Streets adding additional vacancies and outlet types associated with health and conducting the analysis with up-to-date data. Their resulting work 'Health on the High Street. Running on Empty' found the same relationships between retail environments and local health and social deprivation across the UK.[2] Interestingly, in some areas where the retail environment scored healthier in 2018 than in 2015,

population health in those areas also improved, though many areas had no change to health score or health outcomes.[2]

In our U.S. work, we adapted and expanded the methods used for Health on High Streets to the U.S. context. In addition to identifying how retail outlets can impact upon health, we also produced a policy and practice review of what positive steps businesses, policy makers, communities and residents could take to build a culture of health on Main Streets in America. The main objectives and activities of the grant-funded work were to:

1. To review existing scholarly literature on links between commercial and institutional outlets and health or health behaviors;
2. To develop a method for identifying clustered retail districts across the U.S. based on data from the ERSI Business Analyst and other sources;
3. To systematically solicit expert advice from a panel of nationally recognized experts on how which types of outlets had the potential to affect health negatively or positively;
4. To develop and administer a nationally-representative poll to solicit opinions from the public on what kinds of business and institutional outlets could affect health;
5. To integrate data and opinions to develop a health ranking system for each business potential business and to rank the business clusters identified along main streets in 50 U.S. cities;
6. To explore correlations between the health scores and a variety of health indicators such as obesity and life expectancy; and
7. To consult with local communities to develop toolkits for advocating for more healthy business retail environments that fit local needs for addressing health disparities.

The aims of the work contained in this dissertation were to:

1. Conduct a scoping review of literature reviewing retail environment linkages with health;

2. Develop and test a geographic information system (GIS) method for identifying and characterizing retail areas across the United States; and
3. Explore associations between local health and neighborhood retail composition.

Respective roles for conducting this work are described in Acknowledgements section above.

CHAPTER ONE: Scoping review of literature reviewing retail environment linkages with health.

1.1 Introduction

How does the retail environment influence the health of people who live or frequent these areas? Other features of the built environment have well-documented effects on health, such as housing,[3] opportunities for physical activity,[4] air quality,[5,6] noise,[5,7] heat,[5,8] and access to greenspace.[5,9] Healthy places as defined by the U.S. Centers for Disease Control and Prevention are "communities that are developed, designed, and built to promote health" and healthy communities are those that are "continuously creating and improving physical and social environments and expanding community resources that enable people to mutually support each other in performing all the functions of life and in developing to their maximum potential".[10] What, then, constitutes a healthy retail environment?

Late twentieth-century scholars pioneered exploration into specific retail outlet types' health impacts, focused on alcohol and tobacco sales. Alcohol abuse and externalities from alcohol sales outlets [11,12] have long been a considered a significant public health problem.[13] Excessive drinking is a leading cause of death in the U.S. and a leading contributor to global morbidity, mortality, and loss of livelihood.[11,14] Alcohol consumption is associated with firearm violence [15,16] and high risk sexual behavior leading to sexually transmitted infections, including HIV/AIDS.[17] Use of tobacco products (cigarettes, smokeless-tobacco, e-cigarettes [18,19], and hookahs [20]) leads to addiction and has damaging effects leading to many adverse outcomes, including cardiovascular and pulmonary diseases and cancer.[21–23] In recent decades, concerns about rising rates of obesity,[24–27] diabetes,[28] and cardiovascular disease [29,30] have driven research on the health effects of retail food establishments. Associations between weight status and access to healthy or unhealthy food outlets has been studied extensively.[24,31,31–41] Access to healthy food or the lack thereof has expanded into an area of environmental justice study.[42,43]

The obesity epidemic has been a major driver of research on the health effects of retail food establishments. Associations between weight status and access to healthy or unhealthy food outlets [24,31–38] has been studied extensively, as obesity rates in the U.S. maintain high levels of 38% of adults and 17% of youth [24,31,39,40,44–47]. Alcohol abuse and externalities from alcohol sales outlets [11,12] have long been a considered a significant public health problem.[13] Excessive drinking is a leading cause of death in the U.S. and a leading contributor to global morbidity, mortality, and loss of livelihood.[11,14] Adolescent drinkers are more likely to experience harm than adults.[14,48] Alcohol consumption is associated with firearm violence [15,16] and high risk sexual behavior leading to sexually transmitted infections, including HIV/AIDS.[17] Use of tobacco products (cigarettes, smokeless-tobacco, e-cigarettes,[18,19] and hookahs [20]) leads to addiction and has damaging effects leading to many adverse outcomes, including cardiovascular and pulmonary diseases and cancer.[21–23] In recent years, electronic nicotine delivery systems (ENDS) — also known as e-cigarettes, e-hookahs or vapes — have expanded rapidly in U.S. markets. With recent legalization of medical and recreational marijuana in 29 states, marijuana retailers have emerged as a new feature in the retail environment. Research from diverse disciplines has provided insights into the various ways that certain retail establishments affect health,[3,49–51] but these studies suffer from a relative lack of cohesion compared to research into other aspects of the built environment.

Despite the proliferation of study on certain types of retail establishments, we identified no research literature that comprehensively synthesizes how diverse types of retail establishments individually, and collectively, influence health. Potential influences on health from the retail environment, which may be positive or negative, may occur through numerous pathways, including patterns of consumption, physical activity behavior, concomitant environmental exposures, or social interactions (Figure 1).

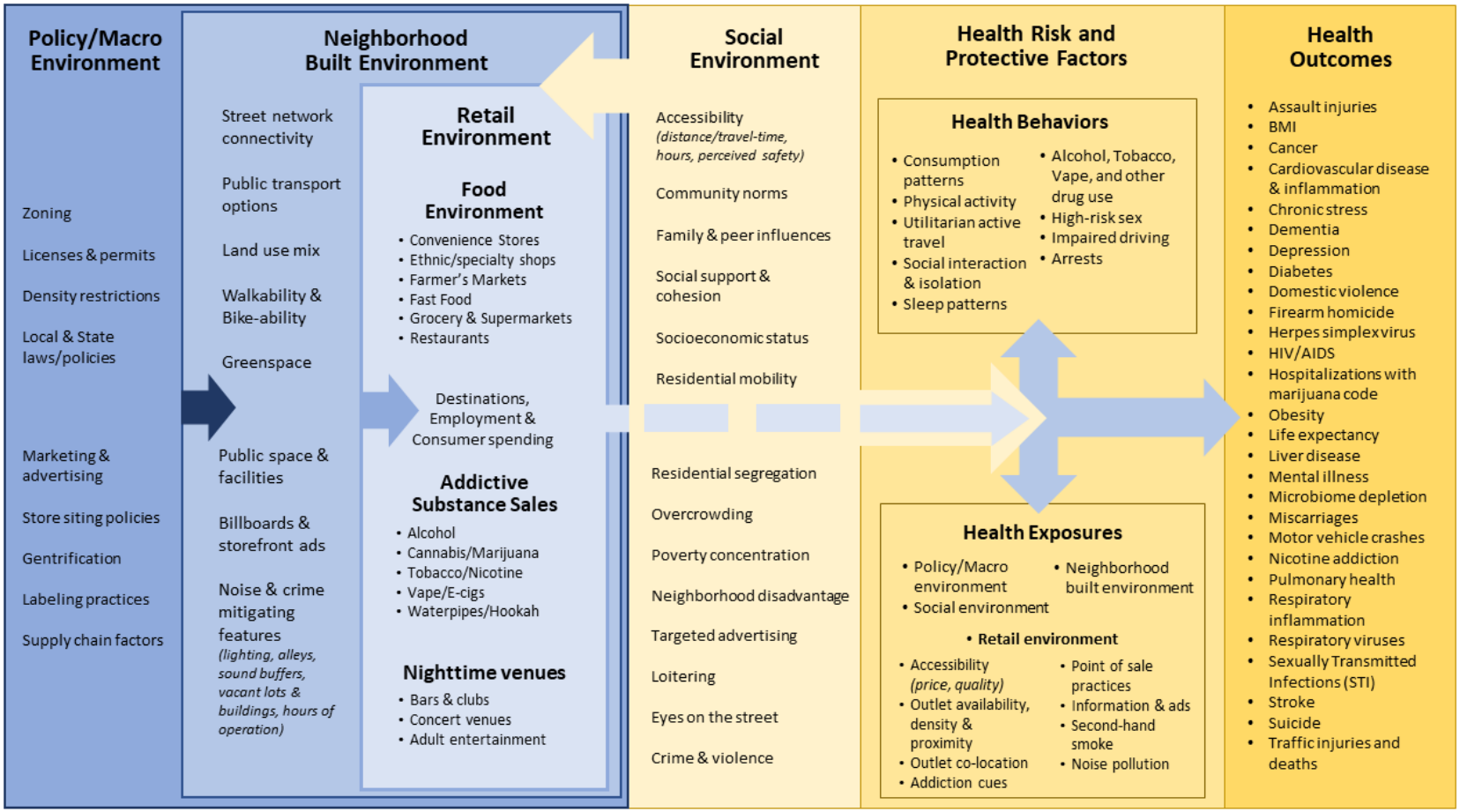


Figure 1: Conceptual diagram of linkages between retail and health, developed by authors

Objectives

This review was inspired by the "Health on High Street" studies conducted in the United Kingdom,[1,2] as we adapted and expanded their rating system for retail environments to apply it to the United States as part of a larger research project. In seeking an overarching framework through which to evaluate the composite retail environment for our own purposes, and finding none in peer-reviewed literature, we undertook this scoping review to identify the strongest evidence bases underpinning the field.

The primary aim of this scoping review of reviews was to describe the extent, range, and nature of reviewed evidence for pathways linking the retail environment and retail outlets to health. Our secondary aim was to develop an initial framework for evaluating the overall retail environments in the U.S., beyond effects of single outlet types. Our objectives were as follows: identify linkages between retail environments and health; characterize health influencing variables; identify gaps in knowledge; and distill recommendations for future research.

1.2 Methods

We conducted a literature search for reviews published in peer-reviewed journals and followed the PRISMA guidelines for scoping reviews.[52] We sought out review papers only, as they compile multiple sources of evidence and often provide a quality assessment of existing literature. Given the diversity of single-studies and interventions published, drawing from review articles allowed us to hone our scoping review on areas where substantial, established evidence existed. Scoping reviews are more inclusive than systematic or meta-analysis reviews, offering greater flexibility, since they allow for collection of heterogeneous literature types.[52]

The retail environment can be defined in many ways, but for the purpose of this review we characterized it as the commercial area of a neighborhood, including shops and service-providers, likely to be accessed by nearby residents and the broader public on a regular basis.

This review focused on the retail environment (as a geographic component within the neighborhood built environment) and pathways to health behaviors and outcomes.

We sought to outline linkages between the retail environment and health by listing commonly-studied indicators and outcomes associated with certain retail establishment types. We then synthesized hypothesized health pathways for specific retail outlet types and for the neighborhood retail environment as a whole. We did not extensively explore distal upstream policy/macro environment factors (refer to Figure 1).

Eligibility criteria

We searched for review articles, using each database's review search feature, from any discipline published between January 2008 – January 2019, with an English title and abstract. Multiple review types across disciplines were eligible, including scoping reviews, systematic reviews, meta-analyses, and reviews of interventions or policies targeting retail, so long as the content reviewed was predominantly from the U.S. This allowed capture of heterogenous literature types. Article eligibility was also based on how much of the paper directly discussed the retail environment. Where multiple reviews covered the same topics, inclusion preference was given to the most recent of the reviews.

Information sources

In October 2018, we consulted research librarians at the UCLA Biomedical library, the UCLA Young Research Library, and the UCLA Anderson School of Business Management library to inform our search strategy. Because retail environments are an intersectional topic, of interest to a wide-range of sectors, we searched databases advised to be distinct and topically relevant: EBSCO; EMBASE; PubMed; PsycINFO; SAGE; and Web of Science.

Search

We conducted the literature search from November 2018 – January 2019. We restricted the search to review articles published between January 2008 – January 2019. Search terms were collaboratively developed among co-authors, using existing knowledge, keywords found in test searches, and reviewing Medical Subject Headings (MeSH) terms. Depending on the database's syntax we used truncation, shown below with an asterisk (*), for terms with multiple derivatives. Every search contained "public health" OR "community health" AND one of the following terms: "retail environment"; "retail enviro*"; "food environment"; "food enviro*"; "local shop*"; "goods and services"; "good* and service*"; "private service*; "consumer"; "consum*"; "consumer health"; "commercial zone"; "commerc* zone*"; "local economic vitality"; "local econom* vitality"; "main street*"; "downtown*"; or "neighborhood enviro*".

Selection of sources of evidence

Search hits from all databases were uploaded by one person to the reference management tool, Zotero, where duplicates were removed. The remaining titles were screened for eligibility by two people. The first round of screening, conducted by two individuals, was based on the title alone. The second round of screening, abstract review, was conducted by one person. Records were excluded for not being a review or for containing studies predominantly outside of the U.S. The third round of screening was done by one person reading section headings of the full-text article and searching the text for explicit mention of the word "retail", "shop", "commerc", "consum","goods" or "services". The presence and extent of discussion surrounding above specific terms was characterized as either "no mention" meaning none of the terms were present in the article, "brief mention" meaning they were mentioned only as a land-use designation or a trip destination, or "extensive mention" meaning there was more than one sentence discussing a term in relation to health. This third round of screening was necessary to

maintain a focused scope on the physical retail environment, excluding papers that focused on upstream factors such as macro-economics, consumer knowledge, labeling practices, and online shopping. The fourth and final round of eligibility assessment sought to select at least one indicative article per outlet type and health pathway to characterize existing knowledge in our qualitative synthesis. Priority for inclusion was given to more-recent publication date, a focus on the general population, and extent of discussion surrounding retail in the review; this was conducted by three individuals and repeated for quality assurance. This final round of selection involved cross-referencing indicators, variables, and health outcomes covered in each review against evidence presented by a more current review within the topic domain. In many cases, more than one article was needed to characterize the domain.

Data charting and data items

We quantified the number of records identified, screened, excluded and included (Figure 2). The article abstracts screened were sorted by their primary topic domain (Figure 3). Of the full-text articles assessed, we characterized them by the discipline of the journal where they appeared (Figure 4). For all eligible articles, one person used a spreadsheet to catalog the year published, discipline of the publishing journal, topic domain, and extent of terms "retail/shop/commerc/consum/goods/service" mentioned. For each of the full-text articles, we extracted the following: health determinants, behaviors, outcomes or measures described; retail and built environment characteristics, measures, or interventions described; key findings; limitations; and future research recommendations discussed. We then evaluated the representativeness of eligible reviews, by cataloging study population, health outcome, and review type by topic domain (Table 1) and cross-checking indicators, variables, and health outcomes described in the review against other articles in that domain. Because reviewed research into some outlet types or health pathways is more developed than others (tobacco

versus marijuana, for example), some results sections contain more evidence that others. Conversely, some reviews were excluded when content within was covered by a more recent or more extensive review.

We organized results in two frames—by outlet type and by linkage to health or health behaviors. In accord with the two frames organizing our findings, we first summarize evidence directly and indirectly linking specific retail types to health. Second, we discuss evidence on how the general retail environment, as a geographic place embedded within the socioecological neighborhood context, is thought to influence health behaviors and outcomes. Evidence presented in selected reviews is heterogenous, including research studies, reviews of interventions, critiques of data sources or methods, and law or policy reviews. In keeping with our aims, we limit our focus to evidence of health linkages directly from physical retail outlets.

1.3 Results

Selection of sources of evidence

From our initial pool of 36,325 search results, we identified 494 article abstracts from multiple disciplines for more in-depth review and screening, which eventually yielded forty-five eligible review articles for full-text synthesis. Figure 2 below shows database search results, quantifying number of articles eligible, screened, assessed, excluded, and included in synthesis.

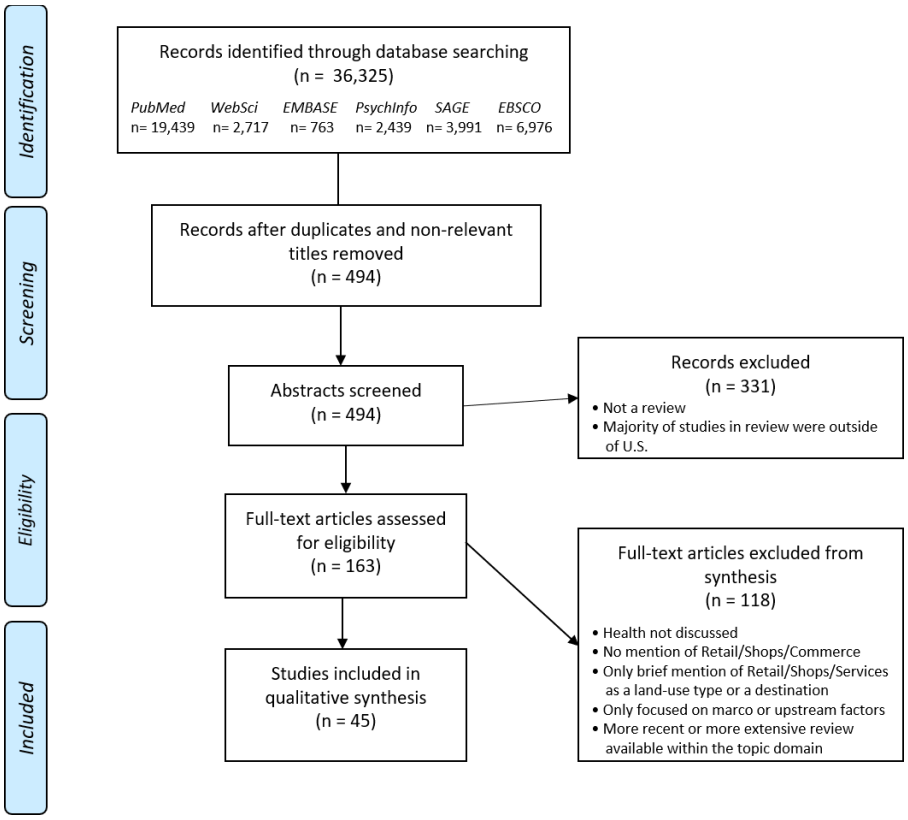


Figure 2: Selection of sources of evidence

Characteristics of sources of evidence

Figure 3 below characterizes the 494 article abstracts screened, full-text reviewed, and synthesized sorted by their primary topic domain. Reviews on the overall neighborhood environment and food environment dominated the literature. Reviews of retail focused on physical activity and vulnerable populations outnumbered alcohol and tobacco in recent years. Noise and marijuana comprised the least number of eligible reviews.

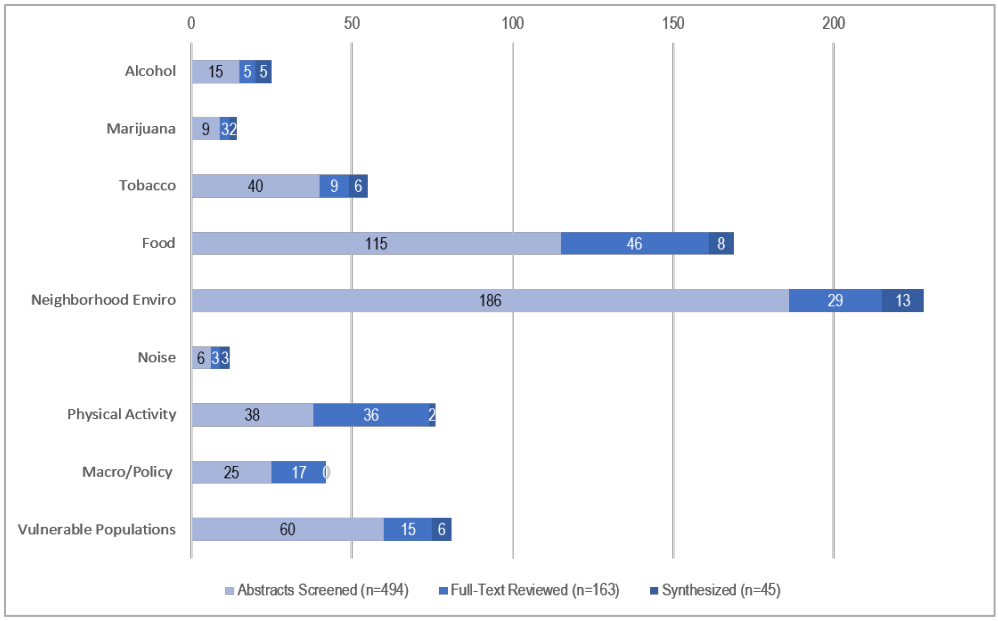


Figure 3: Articles screened, reviewed, and synthesized by topic domain.

Figure 4 characterizes the 163 full-text articles assessed by the discipline of the journal where they appeared. Public health vastly outnumbered all other fields with medicine and urban planning literature far behind, but outnumbering health geography, marketing, social sciences, nursing, and others.

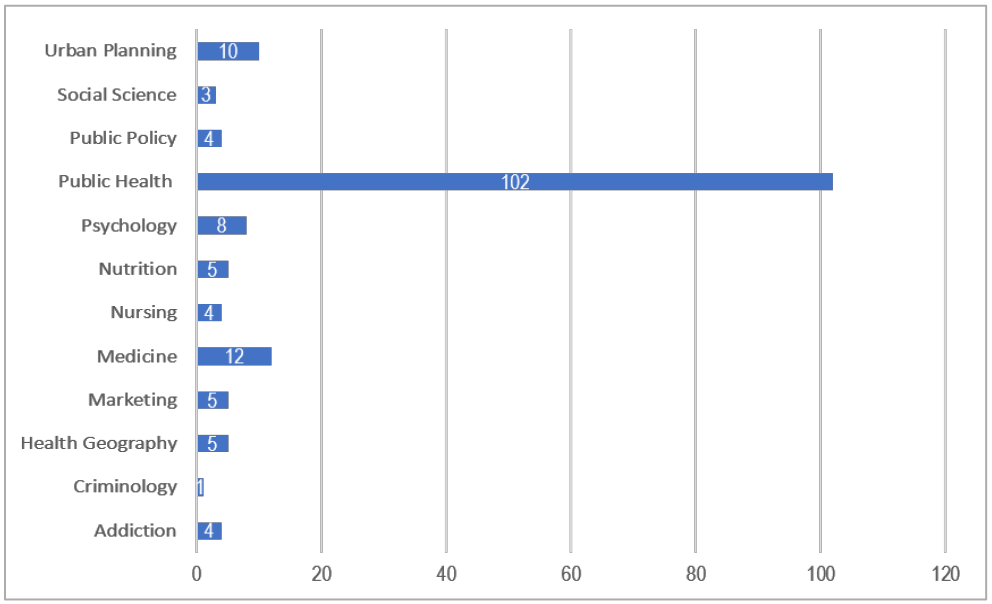


Figure 4: Full-text articles reviewed by publisher discipline (N=163).

Table 1: Summary of variables, indicators, behaviors, and outcomes linking specific retail outlet types to health.

Food outlets [24,31,39–41,53,54]	**Environmental Measures**			**Health Measure**	
	Upstream/Indirect	*Direct*	*Socioeconomic Factors*	*Behavior*	*Outcome*
Retail Food Environment **Convenience stores** **Fast-food restaurants** **Farmers markets** **Grocery & Supermarkets** **Restaurants** **Vending machines**	Availability, access, and affordability of healthy and unhealthy foods [24,39] Healthy food outlets: chain supermarkets [24,31], grocery [24,31], ethnic/specialty-food stores [31,40], supercenter [24,31], full-service restaurants [24,31], farmers markets or farm/produce stands [41], natural and health food stores [31] Unhealthy food outlets: convenience stores [24,31], corner stores [24,31], fast-food [24,31], pizza [31], bakeries [31], meat markets [31], candy and nut stores [31], bodegas [31] Perceived neighborhood safety [39]	Community Nutrition Environment [40,53] • Frequency, Proximity or Presence of outlets in geographic area or within network, Euclidian or sausage buffers [24,31,53] • Proximity/Distance to outlets [24] • Types of outlets available [24] Consumer Nutrition Environment [40] • Number/types/quality of fruits & vegetables in-store [24] • Shelf space dedicated to fruits & veg [49] • Point-of-sale: interventions [24], product placement [39], menu nutrition information [55], promotions [39] Fast food ratio [31] Food desert [49] Food swamp [49] Net density food environment score [31] • 2*Supermarkets + produce vendors - (fast food + convenience) Organizational Nutrition Environment (school and work) [40] Nutrition Environment quality: indices, ratios, GIS measures,	Access influenced by combination of economic, service, spatial-temporal, social, and personal factors [24,41] Affordability of healthy foods [39] Enrollment in food assistance programs [24] Food (in)security [24] Neighborhood median income [24] Racial/ethnic and socioeconomic disparities in access to healthy food outlets [24] Perceptions of access to healthy/unhealthy food [24] Population density (urban vs rural) [24] Transportation access [39]	Dietary: behaviors, intake, quality [24] Fast food consumption [24] Fruit & vegetable consumption [24] Individual activity space [24] Shopping frequency [39] Store choice/preference [39] Sugar-sweetened beverage consumption [24]	BMI [24,31] Cancer [24] Cardiovascular disease [24,30,53] Diabetes [28] Obesity [24,31,53] Overweight risk [24] Individual weight status [24]

		ground-truthing, store-auditing [24,31,40] Physical food environment [31] • Fast food + convenience + small food stores/(numerator + supermarkets + produce vendors) Proportion unhealthy outlets [31] • Unhealthy food outlets/(unhealthy food outlets + healthy outlets + non-fast food restaurants + grocery stores + fish markets + specialty food stores) Retail food environment index [1-2] • Fast food + convenience/ supermarkets + produce vendors Thrifty Food Plan (TFP) & Nutrition Environment Measures Survey for Stores (NEMS-S) indices [40] Sales records [40]			
Alcohol outlets [11,13,14,17,56–58]	**Environmental Measures**		**Health Measure**		
	Upstream/Indirect	*Direct*	*Socioeconomic Factors*	*Behavior*	*Outcome*
Convenience stores **Liquor stores**	Employment & economic activity [14,58] Per capita enforcement funding [14]	Alcohol sales to minors [57] Design/layout of venue [58] Density of outlets [11,13–15,17,30,58–60] Hot spots of high-risk niches [17,58]	Advertisements targeting youth, African Americans, Latinos, ethnic minorities, and low socioeconomic groups [11,17] Crowded housing [15] Enforcement disparities in alcohol laws [58]	Adolescent drinking [14] Alcohol use [17] Alcohol-impaired driving [57]	Assault injuries, emergency rooms [57] Assaults reported to police [5,57,58] Cardiovascular disease [49,58] Chronic stress [58] Domestic violence [5,49,58]

Bars & Nighttime venues	Violent crime [11,14,15,58]	Minimum drinking age [13] Noise pollution [61,62] Number of outlets [58] Point-of-sale: product placement [11]; product restrictions [15,58] Proximity to youth facilities [14,63] Restrictions on sales during certain hours or day(s) of week [13,57,58] Serving sizes [57,58] Site for social network interaction [17,64]	Family and peer alcohol-use [14] High poverty concentration [15,17] Neighborhood disorder [11], depravation [14], and disadvantage [17] Perception of alcohol laws enforcement [14] Residential mobility in past 5 years/High population turnover [14,15] Safety perception of community [14,17,58] Server training [57] Social capital [14,17]; social connections & norms [17,58]; and collective efficacy [58,65,66]	Anti-social behavior [58] Binge drinking [11] Past alcohol-use [14] Quantity consumed per occasion [14] High-risk sexual behavior [17] Self-reported drinking and driving [57] Substance abuse [17,58]	Emergency calls for assaults [57] Firearm homicide [58] HIV/AIDS [17] Liver disease [49] Mental illness [5,15,58] Miscarriages [49] Motor vehicle crashes [5,57] Sexually Transmitted Infections (STI) [17] Traffic crashes with driver who drank [57] Nighttime crashes with injuries [57] Traffic injuries and deaths [57]

Tobacco outlets [13,18–23,56]	**Environmental Measures**			**Health Measure**	
	Upstream/Indirect	*Direct*	*Socioeconomic Factors*	*Behavior*	*Outcome*
Convenience stores **Tobacco shops**		Density of outlets [23,49] Minimum distance between outlets [23] Number of retailers per capita [23] Number of outlets [23] Point-of-sale: health warnings [23], product placement [21], cap display area [21,22], age-restricted areas only [21–23], cessation information [21] Proximity to youth facilities [23,63] Secondhand smoke and vapors [18] Sales only at age-restricted establishments [23]	Advertising prohibition near youth facilities [21] Targeted advertising price reductions, coupons, and promotions [21,22]	Smoking/Tobacco use [23]	Cancer [49] Cardiovascular disease [49] Nicotine addiction [18] Pulmonary health [19] Stroke [49]
Vape shops		Access to outlets [19] Free sample prohibition [19] Point-of-sale health warnings [19] Smoke-free policies [19] Toxic aerosols and ultrafine particles [18] Vending machine sales prohibition [19]		E-cigarette use [19] Smoking cessation [19] Youth addiction to tobacco [19]	Cardiovascular inflammation [18] Microbiome depletion [18] Respiratory inflammation [18]
Waterpipe cafés		Carbon monoxide [20] Carcinogenic polyaromatic volatile aldehydes [20] Hydrocarbons [20] Secondhand smoke and vapors [20] Smoke-free policies [20]	Media portrayal of youth waterpipe use [20] Point-of-sale health warnings [20]	Smoking [20]	Cancer [20] Cardiovascular disease [20] Herpes simplex virus [20] Nicotine addiction [20] Respiratory viruses [20]
Marijuana outlets [13,56,63]	**Environmental Measures**			**Health Measure**	
	Upstream/Indirect	*Direct*	*Socioeconomic Factors*	*Behavior*	*Outcome*
	Property crime [63] Violent crime [63]	Co-location in high-density alcohol and crime clusters [63] Dispensary clusters [63] Proximity to youth facilities [63]	Access to pro-social resources (libraries, parks, places of worship, medical/social services) [56]	Arrests [63] Past month use [63]	Cardiovascular disease [56,63] Hospitalizations with marijuana code [63] Lower academic achievement [63]

	Spatial access to outlets [63]	Access to substance abuse treatment [56] High concentrations of poverty, racial/ethnic minorities, or youth [63] High residential mobility [56] Homeownership rate [56] Neighborhood depravation/disadvantage [56,63] Socioeconomic and racial inequality [56]	Managing chronic illness [56] Motor vehicle crashes [63] Mental illness [56,63] Pulmonary effects [63] Respiratory disease [63] Substance abuse and addiction [56]

Table 2: Summary of health influencing pathways linking the overall neighborhood retail environment to health.

Retail Exposure	Environmental Measures			Health Measure	
	Influences	*Variables*	*Socioeconomic Factors*	*Behavior*	*Outcome*
Overall neighborhood retail environment [5,12,15,30,49,51,54,55,64,67–74]	**Crime and Violence** [13,56,63]	Adult entertainment establishments [49] Convenience stores [15] Density of alcohol outlets [11,12,14,15,58] Environmental design (no lighting, dead-ends/alleys, no greenspace/tree canopy) [5,15,49] Eyes on the Street [49] Marijuana sales [12] Public facilities (schools, libraries, leisure facilities) [5] Vacant buildings & lots [15]	Academic opportunities [12] Adverse childhood experiences [12] Community disorder [12] Concentrated poverty [12] Crowded housing [15] Fear of violence [12] Neighborhood attachment [15] Residential segregation [12] Social capital [65,66] and cohesion [15]	Anti-social behavior [58] Drinking [12,49] Drunk driving [49] Drug use [12] Early initiation of smoking [12] Loitering [49] Prostitution [49] Utilitarian walking [12] Substance abuse [12]	Assaults [15] Life expectancy [49] Suicide [49] Depression [30] Domestic violence [49] Motor vehicle crashes [57] Resiliency [12] Sleep duration [30] Stress [30]
	Physical Activity [4–6,49,54,55,73–75]	Establishments with sports activities (bowling, dance, golf, racquet, swimming) [30] Life radius (network of home, work, school, faith, stores, and restaurants) [71] Neighborhood walkability [70–72,76] Retail/Commercial land use designation [51,68,77] Retail density [51] Seating, bicycle parking, sidewalk quality [78] Street-facing storefront [49] & concealed car parking [49] Street connectivity [30,51] Transportation access to outlet [39]	Perception of neighborhood safety [39]	Active transport [4,49]	Cancer [67] Cardiovascular disease [30,49,70] Diabetes [28,70] Life expectancy [49,71] Obesity [24,28,31,51]

Overall neighborhood retail environment [5,12,15,30,49,51,54,55,64,67–74]	**Social cohesion & vulnerable populations**	Distance to commercial destinations [5,70] Length of time at residence [72] Functional Mix [5,49] Gentrification [15] Neighborhood walkability [70–72,76] Number of chain stores [69] Number of specialty and ethnic stores [69] Spaces for civic engagement [49]	Social connections and support [5,30,69–72,76]	Diet [30] Lifestyle behaviors [71] Pro-social activities, identity formation [58] Utilitarian active travel [70]	Cardiovascular disease [30,49,70] Colon cancer [70] Diabetes [28,70] Depression [30,49] Dementia [70] Hypertension [70] Life expectancy [71] Lung function [70] Mental health [49] Osteoarthritis [70] Suicide [49] Telomere length [30]
	Noise [61,62,79]	Acoustic properties of sound: decibels, background noise, annual average noise equivalent, spectral variance [60] Bars and nighttime venues [61,80,81] Commercial activity sounds [61,62,79] Conversation sounds from outdoor patrons [79] Dense mix of commercial & residential land use [61] Environmental design: street furniture, seating orientation in relation to street, fences, walls, bus shelters [62] Sound buffers: vegetation, walls [62] Traffic and transport noise [62]	Age of study participants [62] Perception of soundscape [62]	Annoyance [62] Time to fall asleep [79]	Auditory impairment [61] Cardiovascular disease [61,62] Children's cognitive performance [61] Depression [61] Mental health [61] Metabolic disease [61] Psychophysiological restoration [62] Sleep disturbance [61,79] Sleep quality [79] Stress [61]

For this review we focused specifically on the physical retail environment, the brick-and-mortar locale, as the nexus of exposure and health. The research reviewed points to both direct and indirect pathways linking retail environments and health. Access and availability of certain food, alcohol, and tobacco outlets have been related to consumption and subsequent health outcomes such as obesity, diabetes, cardiovascular disease, and cancer.[13,28,30,31,39,56,67] Travel related to accessing outlets is thought to influence physical activity behaviors and traffic-injuries.[4,14,15,54] Social consumption of alcohol and hookah have been related to high-risk behaviors and transmission of sexually-transmitted infections and second-hand smoke.[17,20] Retail outlets can serve as important destinations for social activity, thought to improve mental health.[4,70,71,75] Contextual factors at multiple levels likely shape these linkages. Overall, these pathways are not fully understood. Most reviews focused on a specific product or retailer type, health behavior or outcome, or sub-population of interest. Fewer reviews adopted a wider lens examining the retail environment as a whole, such as retail mix and physical attributes of the retail district.[5,24,31,39,53,62,63,79] Reviews that considered multiple levels of analysis highlighted retail's effects on the social or built environment, namely crime, noise, physical activity, social cohesion and vulnerable populations.

Outlet-specific evidence

In this next section, we summarize the review literature on specific outlet types of food, alcohol, tobacco and vape, and marijuana establishments.

Food

With obesity rates in the U.S. holding steady at high levels of 38% of adults and 17% of youth, research has focused extensively on patterns of food and beverage consumption associated with retail environments.[24,44–47] Associations between dietary behaviors or weight status and access to healthy or unhealthy food outlets [24,31–38] have been studied the most. Healthy outlets are described as supermarkets, grocers, specialty food stores, and full-service restaurants. In contrast, unhealthy outlets are noted as convenience stores, corner stores, and fast food or over-the-counter restaurants.[24,31–38] Disparities in access to healthy food options for already underserved populations exist, with researchers attributing few healthy outlet options and saturation of corner stores and fast food outlets as driving disparities in rates of obesity,[24–27] diabetes,[28] and cardiovascular disease.[82] Greater access to fast food restaurants has been linked to increased BMI and convenience stores to higher obesity prevalence.[24–27]

Inconsistent evidence pervades the retail food environment literature. Despite being considered a healthy outlet type, grocery store proximity and availability has sometimes been associated with increased obesity risk and prevalence.[24,31,33,83] Conversely, supermarkets have been found to be negatively associated with obesity.[31]

Many of the food environment studies used distance or density as a proxy for access. Assumptions about proxies and other inaccuracies in measurement may underlie inconsistent findings. High-spending and farmer's market [24,84] shoppers had higher fruit and vegetable intake than low-spending shoppers.[24,41,85] An individual's activity space for food procurement can vary greatly across socioeconomic and demographic factors.[24,41,86–88] The review by Pitt et al. (2017) found that people preferred to travel outside their neighborhood to access a greater variety of affordable foods [39,89–91] with shopping frequency influenced by car ownership.[39,64,92,93] Addition of a full-service grocery store in an underserved area increased healthy dietary purchases in one study,[24,94] but not in another.[24,95] A systematic review of natural experiments on the food environment by MacMillan et al. (2018) described results across interventions as inconclusive though trending towards suggesting that built environment-level interventions did have some beneficial impact on individual health.[54]

Nearly all review authors commented on challenges in elucidating underlying mechanisms linking retail food environments, diet, consumption and health. They most often cited issues in data quality,[31] geographic context,[24] measurement methods,[24,40,96] or study design.[24,31] Cross-sectional study designs dominate, with few longitudinal studies to draw more reliable results.[24–27,31,33,34,36,37,86,96–102] In systematically reviewing 71 studies on food environments, Cobb et al. (2015) concluded that most food environment studies were low-quality with limited strength of associations between food environments and obesity.

Broader constructs like the community nutrition environment – a neighborhood level measure– and the consumer nutrition environment – an interior store level measure– aim to capture multiple dimensions affecting diet, but their use was rare and varied definitions in studies where used limited cross-study comparison. Use of standardized measures like U.S. Department of Agriculture (USDA) Thrifty Food Plan (TFP) and Nutrition Environment Measures Survey for Stores (NEMS-S) for benchmarking consumer nutrition environments across studies would improve evidence in this field.[40] Numerous authors [31,39,103] recommend more qualitative studies in this space to better map the potentially multi-level influences of an individual's perceptions and social environment on dietary behaviors and health risk.

Alcohol

Alcohol outlet density is associated with assaults and intimate partner violence.[15,59] Associations between alcohol-use and other environmental variables (high liquor store concentration, ease of buying alcohol, witnessing drug dealing, and peer-drinking) have also been reported.[11,17,104] Presence and density of alcohol outlets are widely accepted as crime and violence determinants [11,15,60] and reducing social capital.[65,66] Alcohol advertisements target vulnerable populations, normalize drinking, and are associated with increased consumption among ad viewers.[11]

Evaluations of interventions and natural experiments have illuminated some of the connections between alcohol sales outlets and health. Some reviews [15,57] reported on the

success or failure of point-of-sale interventions to reduce alcohol access within existing outlets. Natural experiments restricting alcohol sales in the retail environment have yielded mixed results.[15,57] A citywide licensing restriction on sales of 22-oz and 40-oz beer bottles resulted in a dramatic reduction in intentional injury-related ambulance trips from 19.6 per thousand to zero. After the licensing restriction was repealed, the intentional injury rate again rose to 11.6 per thousand.[15,105] Natural experiments in states where “blue laws”, restrictions of alcohol sales on Sundays, were relaxed observed no change in violent crime,[15,106] but did detect an uptick in total crimes within one-eighth miles of open outlets, primarily in low socioeconomic neighborhoods where crime was already increasing.[15,107]

The extent to which health effects are due to the retail environment or attributable to other social factors is a matter of debate. Authors cautioned that the well-known issues of social-stratification and social-selection could be underlying biases,[11] that existing studies insufficiently studied intermediary mediating variables [15] and were underpowered and utilized data with same source bias.[14(p19)] Neighborhood-level factors may influence alcohol-use in population subgroups differentially, meriting further study.[14(p19),15] Authors suggest that limitations to existing alcohol research should be addressed in future studies with propensity matching, well-defined controls, longitudinal data, and time-sensitive intervention variables.[11,15]

Tobacco & Vape Outlets

Efforts to curtail tobacco use have frequently focused on tobacco retail outlets. Use of tobacco products (cigarettes, smokeless-tobacco, e-cigarettes,[18,19] and hookahs [20]) leads to addiction and has damaging effects leading to many adverse outcomes, including cardiovascular and pulmonary diseases and cancer.[21,22] Tobacco products are traditionally sold at convenience stores, liquor stores, and tobacco shops. Evidence linking tobacco marketing (e.g. storefront signs and in-store ads) to smoking initiation and use has been well-established, with some studies supporting a dose-response relationship.[22] Smoking rates, and cigarettes smoked per day,[108] have been positively associated with density and number of tobacco retailers.[23] Retailer proximity to youth-oriented facilities is also associated with higher rates of smoking among youth.[109,110] Higher concentrations of tobacco retailers has been observed in low-income,[111] Black [112] and Hispanic communities.[23,112,113] Socioeconomic position may mitigate the relationship between smoking and convenience store density or proximity,[68] with smoking rates in higher socioeconomic neighborhoods less sensitive to these measures of access.[108]

The advent of e-cigarettes has changed the nature of tobacco retail. In recent years, electronic nicotine delivery systems (ENDS) — also known as e-cigarettes, e-hookahs or vapes — have expanded rapidly in U.S. markets. ENDS are sold in traditional tobacco outlets and in newer specialty outlets called “vape shops” where customers can try and use the products. Second-hand vapor in shops may be more benign than second-hand smoke from tobacco,[114]

but the combustion by-products deposit on local surfaces and react with atmospheric elements to generate carcinogenic nicotine products.[115–117] Toxic aerosols from ENDS contain ultrafine particles which could contribute to pulmonary and systemic inflammation in those exposed.[118] Vape shops may differ from traditional tobacco retailers in their targeted market expansion: majority black census tracts, for example, in New Jersey had lower odds of having a vape shop,[19,119] which differs from typical tobacco marketing that targets disadvantaged neighborhoods. Authors argue that more research on the health impacts of ENDS products and second-hand vapors is needed to formulate appropriate policies to protect the public, especially vulnerable youth and young adults.[18,19] In addition, more study on how the placement and density of these outlets affects consumption behaviors is also needed.

Waterpipes, or hookahs, are another tobacco delivery system with dedicated cafés where consumers smoke. Waterpipe smoking has similar health effects to smoking cigarettes, but is often associated with greater duration and volume of smoke inhaled than with cigarette smoking, due to the social aspect of waterpipe cafés encouraging patrons to lounge.[20] Waterpipe cafés are exempt from smoke-free regulations,[120] with indoor non-smoking patrons inhaling the equivalent of 10 cigarettes over a two-hour period.[121,122] Little U.S. research exists on users, marketing, or waterpipe regulations and merits deeper study to protect vulnerable targets such as young women and college students.[20]

Marijuana

With recent legalization of medical and recreational marijuana in 29 states, marijuana retailers have emerged as a new feature in the retail environment. Because initiation of use in adolescence can lead to chronic use and addiction, current control policies have focused on restrictive use in proximity to youth-facilities and age restrictions on sales.[63]

While marijuana, or cannabis, research in the U.S. is relatively new, it borrows ecological frameworks that connected addiction studies with environmental risk-factors for tobacco and alcohol use. Increased cannabis use is thought to stem from reduced search costs and more frequent environmental cues.[63] Marijuana dispensary density was associated with higher odds of past-month use among adults [123] and an increase of 6.8% in hospitalizations with a marijuana abuse/dependence code.[124] Age, race, and social factors likely moderate substance abuse, with risky environments potentially inhibiting recovery through environmental cues.[125]

Geographic studies have shown disproportionate concentration of marijuana dispensaries in neighborhoods dominated by poverty, racial/ethnic minorities, and youth.[56,63,126–128] Shi et al., (2016) observed propensity for marijuana retailers to co-locate in neighborhoods with a high-density of alcohol outlets.[56,126,128,129] The relationship between crime and cannabis, though hypothesized, is inconclusive with some studies showing no difference in property and violent crime rates in states with and without legalization,[130] and one study even showing legalization having a protective effect on homicide and assault rates.[131]

Overall retail environment

The retail environment may operate in concert with larger environmental constructs to influence health.[31,68] Because it operates within the context of the larger built and socioeconomic environments it is difficult to disentangle the independent effects of the retail environment from effects due to these broader contexts.[31,51,64,68] As with any complex system, effects can flow in multiple directions (i.e., healthy people may self-select into retail environments they perceive to be healthier or people may be adversely influenced by aspects of the retail environment). Many authors adopt a social ecological framework to theorize that social factors influence behavior of an individual within their environment, affecting their own health or the built and retail environments' composition.[30,67] A functional mix of land uses, verses sprawled single-uses, was repeatedly connected in the literature to weight status,[132] promoting social cohesion and its associated health benefits,[5,133] and reducing violence.[134] Evidence on general neighborhood retail environments' influence on health, presented below, was distilled from reviews that examined the built environment with retail as a functional destination or from reviews that examined pathways between the built environment and specific health outcomes. This following section summarizes review literature discussing the overall retail environment as influential on health outcome inputs of physical activity, social connections in vulnerable populations, crime and violence, and noise.

Physical activity

Retail outlets were often referred to as “destinations” or “resources” which draw consumers to them to meet basic needs.[5,55,73,74] How consumers reach destinations has been the focus of many mobility studies examining transportation-related air pollution and physical activity as mediators of chronic health conditions such as asthma,[6] cancer,[67] cardiovascular disease,[30] and obesity.[5,55,73,74] Utilitarian travel to destinations, many of which were likely retail establishments, via walking was especially important for older adults in maintaining physical health.[70,73,76] Walking has been associated with reduced risk of coronary disease, improved lung function, and improvements related to osteoarthritis, diabetes, colon cancer, hypertension, and dementia.[135]

An extensive body of literature has investigated the association between patterns of land-use and physical activity. Eleven studies in Schule, et al. (2015) assessed interactions between the individual health and health-related behaviors and distance to retail land uses.[68] Most of the studies reviewed by Schule et. al saw no association between retail land use and physical activity, but five studies showed that where associations did exist, they varied by sex and ethnicity.[68,136–138] One study reported preference for walkability as moderating walking behavior, showing that people who walked more were more educated and self-selected into those neighborhoods for perceived walkability and proximity to destinations.[139] Some 80% of the studies reviewed by Sugiyama et al. (2012) saw an association between distance to retail

services and utilitarian walking.[75] Saelens et al. (2012) only saw significant associations between food environments and obesity when physical activity variables were included,[140] a finding similar to Rundle et al. (2009)[98] and Diez Roux et al. (2016).[30] Stores that nearby residents perceive as unsafe due to loitering, trash, graffiti, or aggressive car traffic discourage them from walking, reducing their physical activity and opportunities for social interactions.[49,141]

Buettner and Skemp (2016), sought to identify environmental characteristics of communities with high concentrations of people over 100 years of age, dubbed “Blue Zones”.[71] They found the most common evidence-based characteristic to be ample opportunity for physical activity, through walking to destinations in their life radius. An individual’s life radius orbits around home, social networks, and purpose/volunteering with trips to stores, workplace, school, places of worship, and restaurants.[71] In city-wide applications of Blue Zone interventions, all through strategies targeting the built and food environment, the pilot city saw decreases in weight and a 3.2-year increase in life expectancy was observed.[71] Subsequent cities saw reductions in smoking rates and BMI as well as increases in healthy eating after Blue Zone interventions.[71] Kestens et. al (2017) argue for greater measurement of social networks as key environmental influences on health.[64] For example, some studies show that wealthy people have a greater range of destinations and travel farther than low-income people.[64,142]

Crime and violence

Specific types of retail and other characteristics of the built environment have been associated with higher rates of crime and violence. Neighborhood-level environmental risk factors (density of alcohol outlets,[11,12,14,15,58] convenience stores,[15] and marijuana outlets,[12] adult entertainment venues,[49] presence of vacant or blighted lots and buildings, and poor environmental design [15] have been linked to community-wide crime and violence rates.[12] Fear of violence has been shown to promote anti-social behavior,[58] reduce utilitarian walking,[12] and was linked to smoking and substance abuse for coping.[12] Nearby loitering, drug sales, alcohol-related violence, and parking lot safety were also found to influence food store choice.[39,143–145] A growing literature showed that violence is preventable and modifiable at the environmental level and is especially important given the disproportionate burden of risk factors in disadvantaged communities.[12,15,56]

Social Connections and Vulnerable Populations

Characteristics of the built environment, including retail location and access, are thought to affect social connections and quality-of-life by enabling independent living, particularly for vulnerable populations. The independence and mobility options for seniors, children and disabled people are directly linked to the built environment and what shops and services can be accessed by walking or public transport. Seniors were described as more dependent on their neighborhood environment and loss of neighborhood retail affects them especially through loss

of destinations, social connections, and the ability to "age in place".[70,72,73] The U.S. Centers for Disease Control and Prevention defines aging in place as "the ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or ability level.[10,70] Assuring retail destinations and environmental conditions conducive to aging in place may help older adults stay mobile and healthy longer and offset population-wide costs associated with disability and infirmity as the large cohort of American baby boomers age.[10,70,73] Established elements of walkability for able-bodied people are different than for seniors and disabled persons,[73,78] and urban planning needs to recognize these differences in designing retail environments to support all people.

Social connections can be influenced by gentrification, even without displacement. Formosa et al. (2010) posit that gentrification in a child's neighborhood may undermine the health protective factors stemming from social and institutional support.[69] They also describe the neighborhood change of gentrification as an in-migration of affluent neighbors and displacement of low-income residents, characterized in part by a change in retail offerings from generally low-cost specialty and ethnic shops to more expensive multinational chain stores.[69]

Noise

Commercial activities generate noise.[61,62,79] All sounds are not equally disturbing, though meaningful neighborhood sounds such as conversation or karaoke at bars were found to be

more disruptive than background noise.[79,81,146,147] Retail types and respective regulations can interact to influence noise: Nighttime venues like bars with smoke-free policies force patrons outside where talking and smoking pollute the neighborhood environment.[79,80]

Summary of evidence

Several types of retail reviewed here involve sales of substances — including alcohol, tobacco and marijuana — whose use or abuse has been linked to acute injury and chronic disease risk. Modifying environmental risk-factors, such as access and behavioral cues, has been shown to be more effective in reducing chronic disease risks than has targeting individual-level risk factors.[57] Environmental-level interventions are also necessary to support individual-level behavior change.[57] Examined through a social-ecological framework, behaviors like alcohol use to outcomes like cancer are influenced across a spectrum, from the individual to the macro or policy level.[11,67] Fragmented research agendas with little cross-discipline dialogue has produced incongruous interpretations of health and place with respect to these outlets.[58] Below we have summarized intersecting themes found across review papers.

Spatial availability and access mismatch

The predominant method of linking health to the built environment was through aggregate administrative health data tied to pre-determined geographic units (census tract, city, county,

etc.) corresponding to where people live.[31,67,72] Researchers have also used Euclidian and network buffers around the residential location to characterize access.[31,53] Proximity and density measures of access to and availability of outlets have generally been used to study and associate health-related behaviors to retail environments.[31] The underlying principle of proximity equating to access, use and consumption has come into question as better-quality studies found geographically larger individual activity spaces than previously conceived, with socioeconomic factors exerting significant influence on the size of the activity space for shopping.[31] Authors called for broader exploration of factors influencing access to outlets, to encompass more precise geographic proximity and to account for the influence of socioecological context, and social networks, on individual choice architecture.[39,64] Though fewer studies examined perceived neighborhood boundaries or individual activity spaces, those that did found that where people shopped was not necessarily in their home census tract.[14,31,72] With the increasing availability of cell-phone tracking applications, researchers can more accurately and objectively measure activity space and the emotional state of the person while shopping through ecological momentary assessment (EMA) which prompts users to answer temporally and geographically-oriented surveys about mood and behaviors in distinct environmental contexts.[56,64,148] Engagement from cross-sector collaborators in social sciences could also help to disentangle questions surrounding access and availability.[40]

Individual-level and longitudinal data

Nearly all reviews called for better evidence establishing individual use patterns within retail environments. The overwhelming majority of research in this space has been cross-sectional and utilized aggregate population health data in standard regression modeling,[24,40,67,68] with the notable exception of the multi-ethnic study of atherosclerosis (MESA) neighborhood study that followed individuals for 10 years across six cities and quantified participant's neighborhood social, built, and retail environments.[30,74,149,150] While much more costly and complicated to obtain, individual-level data collected in diverse populations over time is needed to understand mediating and moderating factors across multiple levels of influence.[24,30,67] Natural experiments are proposed as a potent study design to address this shortcoming,[31] particularly if appropriate control populations can be identified.[54] Qualitative studies are needed to better understand individual motivations within varied socioecological contexts.[39] Smartphone tracking [31] and EMAs could aid in collecting data to meet this need.[40,54,62]

Mediating and Moderating factors

Not enough is understood about internal and external factors that mediate, moderate or modify a person's engagement with and exposure to retail environments. Early life experiences, family and cultural norms, marketing, and perceptions of the environment are thought to greatly influence behavior, though little high-quality evidence is available to understand which factors

exert influence in which individuals.[24] Many authors point to the problem of accurately measuring individual-context in terms of historical, social, and cultural processes in geographic research as a major limitation.[14,30,58,151] In studies examined by Schule et al. (2015), race, gender and socioeconomic status appeared to underlie inconsistent results across studies, with twenty-one studies finding cross-level or within-level interactions between individual characteristics, neighborhood socioeconomics, and built environment.[68] Findings from the MESA neighborhood study showed differential effects on health between men and women from the neighborhood food, physical activity, and social environments.[74,149,150] Authors also recommend incorporating local policy variables, such as limitations on sales during certain hours, that affect retailers [152] and the neighborhood environment.[67] Hierarchical models and causal inference methods were proposed to address the multiple levels of influence and contextual variables in studies.[67]

Standardized measures of retail environments

One factor prohibiting cross-study comparison is the heterogeneity of methods used to measure retail environments, a sentiment echoed in nearly every paper we reviewed.[5,68] Glanz et al. (2016) conclude that "standardization of measurement across studies and reports of measurement quality (e.g., reliability, validity) may better inform practice and policy changes" and will allow for benchmarking across studies.[40] Survey-based measures of the food and

physical activity environments had stronger association with diabetes and hypertension compared to GIS measures.[67,74,153] Shier et al., (2012) found that the type of measure used to quantify the food environment (density, ratios, or indices) affected associations with BMI in children.[24,96] Objective versus perceived measures of the retail environment likely exert influence population subgroups' behavior differentially and needs further study.[24,72] After systematically reviewing effects of neighborhood-level natural experiments on physical activity and diet, MacMillan et. al (2018) described the heterogeneity in study methods, outcome measures, and reporting as a major challenge to drawing conclusions for making policy recommendations and suggest future research use consistent measurement approaches that allow for pooled analysis.[54] Reliability and validity of retail database listings has been reported [31] and heterogeneity of outlet groupings using name, standard industrial classification (SIC) or North American industrial classification system (NAICS) code, and excessive adaptations to existing indices limit cross-study comparisons.[53] Similar challenges in heterogeneity of noise measures and related health effects were also reported.[79]

Composite retail mix

Very few reviews referenced papers that considered more than one outlet type concurrently. In the forty-five review papers included, only seven [5,71,31,63,53,39,79] described a study that evaluated more than one retail type concurrently. Interventions described in Buettner and Skemp, (2016)

targeted food and tobacco outlets and physical activity environments within residents' life radius to motivate health improving behavior.[71] Food environment studies that used indices to compare healthy to unhealthy food ratios had stronger associations than those that evaluated single outlet types alone.[31] Further, findings from index-based studies were in agreement with expected health associations, unlike contradictory results found in much of the other food environment research.[31,39,53] A recent study on marijuana outlets in Colorado found them more likely to be sited in neighborhoods with high-densities of alcohol outlets,[63,129] potentially further worsening health inequalities. Exposure to noise from leisure outlets (e.g., bars, music venues, sports events) were found to affect neighbors sleep.[79]

Attempts to assess multiple levels of influence at the retail and neighborhood environment levels were rare, but had stronger associations with health outcomes and allowed for analysis of mediating and moderating pathways.[68] When the food environment was assessed along with the physical activity environment, stronger associations with obesity were observed.[31,140,154,155] Similarly, MESA participants who lived in neighborhoods with healthier food outlets and physical activity-inducing environments had a lower associated incidence of obesity.[30,156] Another study of MESA participants found that greater healthy food outlet density and recreational facilities were associated with lower coronary artery calcium, but that the strength of the association was different for women and men.[74,149] A similar finding was

described associating healthy food outlets, recreational facilities, and walkable environments with ideal cardiovascular health, though results also varied between men and women.[74,150]

1.4 Discussion

In seeking to answer the question of how retail environments influence health for those why live near or frequent them, we learned that the pathways are not fully understood. Retail outlets explored in the review literature generally fell into places that sold food, addictive substances, and nighttime entertainment. There is evidence that neighborhood retail outlets influence health through health behaviors and health exposures. Health behaviors linked to retail are patterns of consumption, substance use, physical activity, sleep, criminal activity and social interaction. Health exposures from retail are thought to be indirectly governed via larger policy, social, and neighborhood contexts, but occur directly through access to outlets, density and proximity of outlets, point of sale marketing, second-hand smoke and noise pollution. Through these health behaviors and environmental exposures, certain types of retail outlets have been linked to acute injuries, like traffic crashes, suicides, and assaults, and chronic conditions like stress, depression, obesity, and cardiovascular disease (Figure 1).

To approach the question of what constitutes a healthy retail environment and for whom, with the aim of developing a framework for evaluating retail environments, we synthesized indicators and variables across multiple levels of influence in Table 2 - Table 3. Key challenges

to understanding retail environments and health emerged across reviews: a mismatch between geographic availability and access; the need for individual-level longitudinal data; need for better understanding mediating and moderating factors at multiple levels of influence; need for standardized measures of retail environments and related-health indicators.

We argue that the siloed approach to analyzing retail outlets individually misses the effects that the composite retail environment may exert on populations. Focus on the overall retail environment was rare in reviews, with little consideration given to interactive and cumulative effects across outlet types. The concept of risky retail environments,[12,17,49,56] evolved from early alcohol and tobacco research,[13] has grown to include marijuana [63] and novel tobacco products.[19,20] However, the research in reviews on risky environments still tended to focus predominantly on one product or outlet type at a time, despite evidence that risky retailers co-locate and target vulnerable populations.[13,56,63] Research also tended to focus more on the health harm potential of certain retail outlet types, rather than health promoting attributes of other outlet types.

A closer analysis of the evidence associating health and retail environments reveals its inconsistency, reflecting an overarching heterogeneity of study aims, methods, findings, and quality. As Figure 4 shows, the literature exploring retail and health approaches the issue from not only health and medicine, but law, policy, urban planning, violence prevention and environmental justice. We found the greatest body of literature concerned with measuring the

retail food environment.[24,31,39,40,53] But even this extensive body of work cannot conclude, due to inconsistent results, the food environment's direct and indirect pathways on consumption behaviors and related health outcomes. The overarching conclusion from systematic reviews across this space was the need for better quality longitudinal study designs, data collected at multiple levels of influence through standard measures, control populations in natural experiments, and a broader conception and more precise measurement of individual activity space with special attention paid to how individual perception influences interaction with retail environments. Better cross-discipline engagement in research is needed, with current knowledge reflecting the siloed nature of research questions and funding streams. Drawing from our synthesis of findings across reviews and reflecting on our scoping review objectives, we recommend the following actions for improving understanding of linkages between retail environments and health.

Recommendations for future research

To resolve the spatial availability and access mismatch and improve individual-level longitudinal data, future research should capture data with higher geographic specificity of activity spaces and social networks, which can be captured through GPS and smartphones.[39,64] EMAs in research studies and citizen science applications could better define notions of access and objectively quantify context-based variables that may mediate or modify retail's influence on

health. Big data streams, smartphone application data and proprietary data from cell-phone providers hold promise for quantifying an individual's activity space and daily exposures.[56,64,148] Engagement from cross-sector collaborators in social sciences could also help to disentangle questions surrounding access and availability.[40]

Hierarchical models, causal inference methods, longitudinal data, propensity matching, well-defined controls, and time-sensitive intervention and policy variables [152] will aid in modeling multiple levels of influence and contextual variables.[67] Still, qualitative studies are needed to better understand individual motivations within varied socioecological contexts [39] as age, race, and social factors are thought to moderate consumption patterns.[31,39,103,125] To supplement high-cost individual level longitudinal data and elucidate mediating and moderating factors, future research should consider historic records and qualitative data sources. A wealth of historic and qualitative data exists in news, social media, and other archives that may explain how people interpret and interact with neighborhood retail.

Standardized and consistent measures of retail and related-health are needed for benchmarking across studies [40] and for pooled analyses.[54] A community retail environment index should be developed to facilitate researchers' quantification of retail environments and aid in multi-site studies. A catalog of business types relevant to health, their NAICS and SIC codes, and standard groupings for analyses is needed.[53] Given evidence that perceptions of the retail and neighborhood environment moderate relationships between objective environmental

measures and health outcomes,[24,67,72,74,153] surveys will still be a necessary complement to empiric analyses.

Given how many researchers saw more significant associations between food environments and obesity, diabetes and cardiovascular disease when neighborhood-level physical activity variables were included [30,30,31,74,98,140,140,149,154,156] and that index-based measures of the community nutrition environment had stronger associations with health outcomes than single-outlet based measures,[31,39,53] we recommend the cumulative retail environment and neighborhood-level variables be considered concurrently in studies. Interactive and cumulative effects between outlet types should also be explored.[63,79,129]

A comprehensive measure for evaluating retail environments is needed. Future reviews should build upon our syntheses in Table 2 - Table 3 and draw from international examples to further develop an operational framework for studying retail and health. Despite the established linkages between noise and health in other countries (sleep disturbance, annoyance and cardiovascular disease), we found relatively few studies on neighborhood commercial noise and health in the U.S.[61,62,79] Furthermore, there are retail outlet types with documented consumer health effects (e.g., UV-tanning salons [157] and payday lenders [158,159]) which were not present in reviews relating to the physical retail environment. Endemic socio-economic factors across countries would likely influence relationships between outlet types and population health differently, but outlining these relationships and pathways could also be instructive for

understanding cultural enclaves in the U.S. While we did not include online shopping in the scope of this review, we recommend future study on this area consider how the growing shift to online shopping will influence retail's influence on health.

Strengths and Limitations

This scoping review has several strengths. We reviewed papers from many different disciplines in seeking to understand holistically how retail environment connect to health in contrast with most of the existing literature that either focused narrowly on one type of outlet, a targeted sub-population, or examined broader influences of retail environments as destinations or sources of neighborhood environmental externalities. We provide a synthesis for potential pathways linking outlet-specific and larger neighborhood retail factors to health.

In limiting our scoping to review papers published between January 2008-2019, however, seminal works published prior and emerging or understudied topics may have been missed. Table 2 and Table 3 synthesis of data items is representative, not exhaustive, of measures and outcomes that link retail environment to health, as many reviews repeated similar topics. We constrained this review to a focus on patrons of retail environments, as their short-term exposure to health modifying factors present in retail environments differ greatly from workers' long-term exposures. For example, dry cleaners and cosmetic (e.g., hair and nail) salons use toxic products (e.g., perchloroethylene and formaldehyde) in their services resulting

in dangerous indoor air pollution for workers [160], with potential for fugitive emissions into neighboring buildings [161]. Yet no review papers we found discussed these types of retailers, so they are not represented here. Further, we did not include reviews representing the vast field of healthcare-related products and services, as it was deemed outside the scope of the retail environment. Finally, this review was conducted before and therefore does not include literature since the global novel coronavirus pandemic (COVID-19) which prompted many changes to retail environments in the United States.

We did not search grey literature, as our aim was to summarize peer-reviewed evidence. Nor did we empirically assess the quality of the reviews or the studies within them, as review paper topic heterogeneity prohibited such an approach. Retail marketing practices have a broad scope of literature, but we restricted our discussion of retail marketing practices such that labeling practices,[162–165] pricing strategies,[28,166] and supply chain issues [167] are not included in our discussion even if touched upon in articles we reviewed. Noise articles were not focused on the U.S., but contained U.S. studies so were included so as to have representation of noise in this review despite sparse American research attention to the topic.

1.5 Conclusion

Through this review we synthesized fields of study surrounding retail environments and health in the United States. Much of the research on specific types of retail establishments remains siloed without connection to the broader retail and built environment milieu. Shortcomings of this kind

limit researchers' ability to link retail environments and health. While we could not definitively identify what constitutes a healthy retail environment, we did outline an initial framework for describing common health pathways influenced by the retail environment that can be used for bringing together findings from diverse disciplines and in diverse communities. As the field of retail and health evolves from a narrow cross-sectional lens to adopt a wider longitudinal and socio-ecologic view, systems approaches to studies, quantitative and qualitative data, and analyses will be necessary to appropriately understand and influence multiple levels.[168]

In conducting this review, new types of research questions also emerged: What are the minimum essential retail and services needed, universally and in specific contexts or populations? Does level of income modify the response to healthy or unhealthy retail environments? If risky retail environments are improved in a low-income neighborhood, is the health effect different than it would be in a high-income neighborhood? To what extent will improving retail environments in disadvantaged neighborhoods reduce health inequities? In the fallout of retail closures from the COVID-19 pandemic, what should retail recovery and redevelopment priorities be? The years to come offer opportunity for natural experiments as recovery policies are enacted and new retailers open their doors.

Answering the kinds of questions above will be important and necessary contributions to improving understanding of and actions for healthy neighborhood retail. Most importantly, a standard framework for understanding how individual outlets alone and in combination affect

diverse U.S. communities is needed to adequately guide polices, practices and preventive environmental health measures. Engagement of diverse communities in discussions to weight perceived risks and benefits of retail types for environmental assessment could engender local change of retail, neighborhood, and policy environments. A focus on multi-level approaches to promote healthy communities versus merely regulating unhealthy outlets could potentially yield broader health impacts when implemented at the environmental level.

CHAPTER TWO: Developing a GIS-based method to identify retail areas in cities across the U.S.

2.1 Introduction

To test relationships between retail environments and health using a standard method we sought a nationally available database of retail areas containing both geographic information and outlet specifics. There is no standard method for defining retail districts across cities in the United States, making national comparative studies difficult.[169] No universal definition for business districts with a complimentary dataset could be found for the United States. Different definitions are used across disciplines.[169,170] Scholars, business leaders, and urban developers apply unique scopes and datasets, both public and proprietary, depending on their purpose and may not regularly updated.[169,171] Retail trade areas, conceived by the business community, are defined as "that area, typically around the store, from which the store derives most of its patronage",[172,173] and are helpful for marketing and siting new locations. Business improvement districts and their proxies are as much political as they are geographic, and operate under differing criteria from state to state and country to country.[174]

Retail and health studies often focus on only one outlet-type (e.g., food, alcohol, or tobacco vendors), generally employing either a place-based or person-based approach. Place-based methods quantify the number, density and relative addition of an outlet in a pre-determined geographic area (e.g., a 1 km buffer around a school).[11,24,31,40,51,58,175] Person-centric methods quantify similar metrics in an individual-determined area near (e.g., a 1 km buffer around individual residences).[14,23,39,176–181] This aim will employ a place-based approach.

Urban development in the United States has followed a different pattern than much of the world, with the last fifty years characterized by urban sprawl facilitated by automobiles and an abundance of land.[182] While the last decade has seen a resurgence in downtown revitalization, the remnants of sprawled services remain for a majority of cities and regions.[183,184]

Thus, it was not possible to look solely at historic downtowns or central business districts in our study, as many U.S. cities also have numerous satellite retail areas that serve habitants that live in decentralized areas. So, we diverged from conceptions of financial centers, historic main streets, or central business districts in our attempt to capture outlets in proximity to where people actually live.

2.2 Methods

We stratified the U.S. Census listing of 29,321 places into five regions – the four census regions with the West divided into California and “other west.” Hawaii and Alaska were excluded since their patterns of urban development are so different from the rest of the U.S. We randomly sampled cities from each census region in five population size categories, ranging from 25,000 to 999,999 people. We also included Los Angeles, a city of 3.99 million people. In the northeast region, there was only one city in the largest population category, so we were unable to include a second. We excluded cities with less than 25,000 people since we expected larger communities to yield a higher quantity and larger sized business districts. We excluded the largest cities with populations of over 1 million, with the exception of Los Angeles, as the number of business districts in each large city could overshadow data from districts in other communities sampled in that census region. We selected fifty cities to study. Their geography and size are described in Table 3 below, though names of cities with population below one million are not provided due to sponsor requirements.

Table 3: City size by region included in a random sample of fifty places in the U.S.

	Census Region				
Population Size	*Northeast*	*Midwest*	*South*	*West (excludes CA, AK, HI)*	*California*
(1 million+)					Los Angeles
(500,000-999,999)	n/a •	• •	• •	• •	• •
(250,000-499,999)	• •	• •	• •	• •	• •
(100,000-249,999)	• •	• •	• •	• •	• •
(50,000-99,999)	• •	• •	• •	• •	• •
(25,000-49,999)	• •	• •	• •	• •	• •

Business District identification

Business location information was included with the Environmental Systems Research Institute, Inc. (ESRI) Business Analyst package and was provided to ESRI by InfoUSA.[185] This business dataset included geocoded points with fields of interest such as the business name, address, Standard Industrial Code (SIC) designation, number of employees, and square footage. ESRI ArcGIS Desktop and ESRI Business Analyst (using 2018 data) served as the basis for our analysis.[185] Specific steps used to identify districts are below:

1. We used the U.S. Census jurisdictional boundary of each city selected for study city provided in ESRI Demographic Data > Census Places.
2. We screened for neighborhood-type businesses of interest within the city, excluding SIC codes < 40 and 50-52 (ie: Agriculture, Forestry, Fishing, Mining, Construction, Manufacturing, and Wholesale Trade).[186]
3. We ran kernel density spatial analysis on business locations within study city. Parameters for the density analysis included: 400m search radius around each point

(assuming a ¼ mi walking distance to the business) and bound the extent of the analysis to the city's jurisdictional boundary.

4. We selected the densest clusters of businesses within each city (areas with three standard deviations from the mean greater density of businesses than the rest of the city) to be designated as business districts.

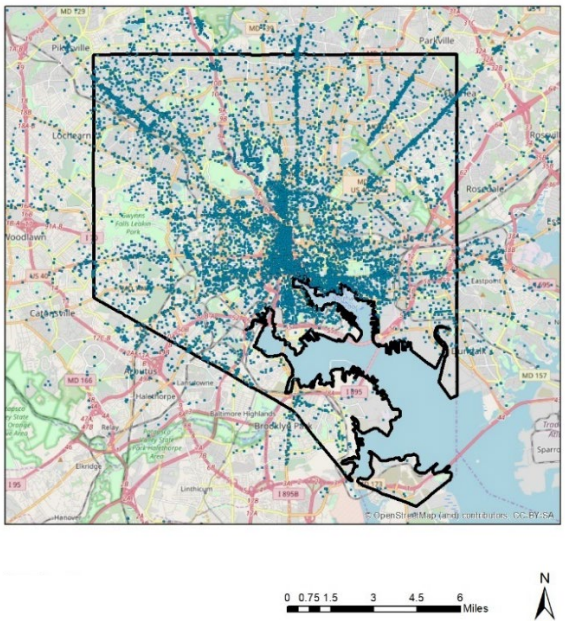


Figure 5: Business points in a region (blue) and major city boundary (black)

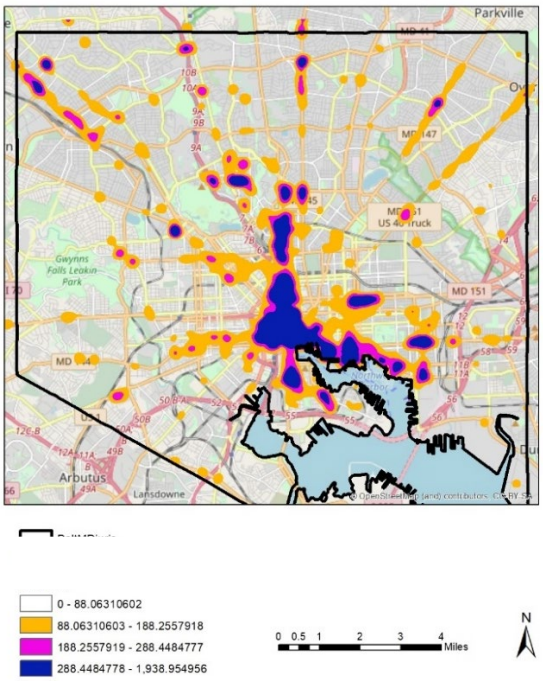


Figure 6: Kernel density output, classified by standard deviation (densest areas in blue)

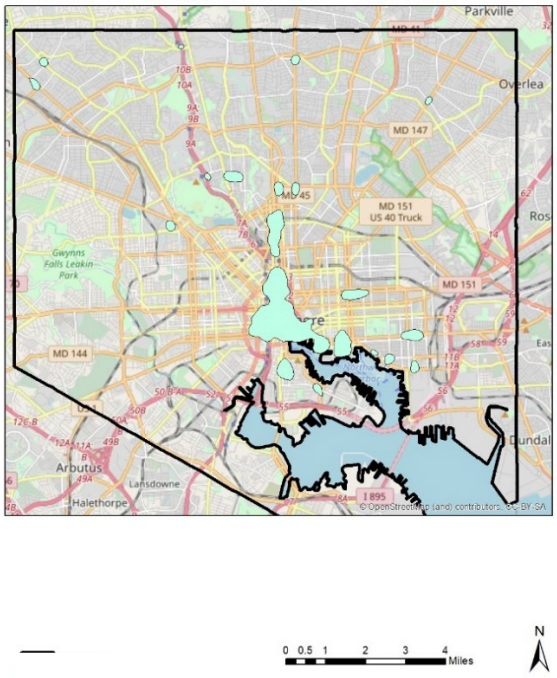


Figure 7: Kernel density reclassified into densest areas only, yielding business district polygons (mint green)

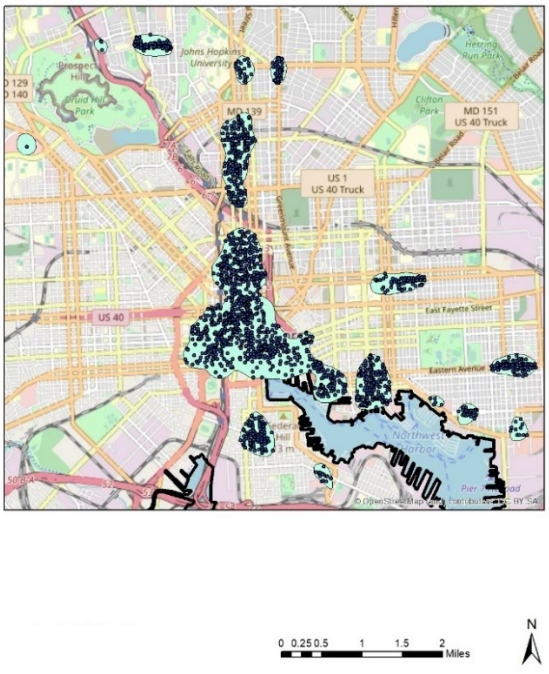


Figure 8: Business points (black) joined to district polygons (mint green) for analysis

Some manual data cleaning was needed to improve the accuracy of our GIS-identified districts, especially with respect to very small districts. We eliminated small districts with fewer than three businesses per cluster total (for cities under 499,000) or fewer than five total businesses (for cities with more than 500,000 people). We did this recognizing that for some small towns or neighborhoods, a corner with only a few businesses may well be the only local services available. We also eliminated office building clusters that had no main street presence when examined in Google Street View and were thought to be primarily for private access only, for example corporate office parks. Finally, we eliminated clusters that appeared to be mailing box addresses instead of actual brick and mortar places. Using these inclusion and exclusion criteria, we identified 1,416 business districts across our fifty study cities.

2.3 Results

Analysis of fifty cities produced a total of 1,416 districts, with the total number of business districts per city varying depending largely on underlying city size. Our method identified as few as two business districts in small communities (Figure 9 below), and up to 210 districts in the largest city of Los Angeles (Figure 10). With this method there were congruent and incongruent findings. Congruent findings relatively aligned with politically defined geographies of business districts, as demonstrated in Figure 11 of the sensitivity analysis in the next section. Incongruent findings had two categories: (1) Detecting an area as a business cluster: however, upon examination in Google Street View there were no visible shops on the street, likely indicating mail drop boxes or head offices with no public or street-facing presence. We eliminated these incongruently detected during data cleaning; and (2) Not detecting a retail area where business clusters exist but are not relatively concentrated enough to be detected by our kernel-density method in that city, though in fact the area has an official business district designation or are known districts, just not as dense as other areas in the same city studied.

In the largest city example, Los Angeles, we began with two-hundred ten (210) districts but in data cleaning removed incongruently detected findings bringing the total down to one-hundred fifty-five (155) districts. After consolidating small satellite districts with their larger neighbors the total was reduced down to one-hundred and forty-six (146). The manual data cleaning for all fifty cities was conducted under my supervision by graduate student researcher Anissa Raja.

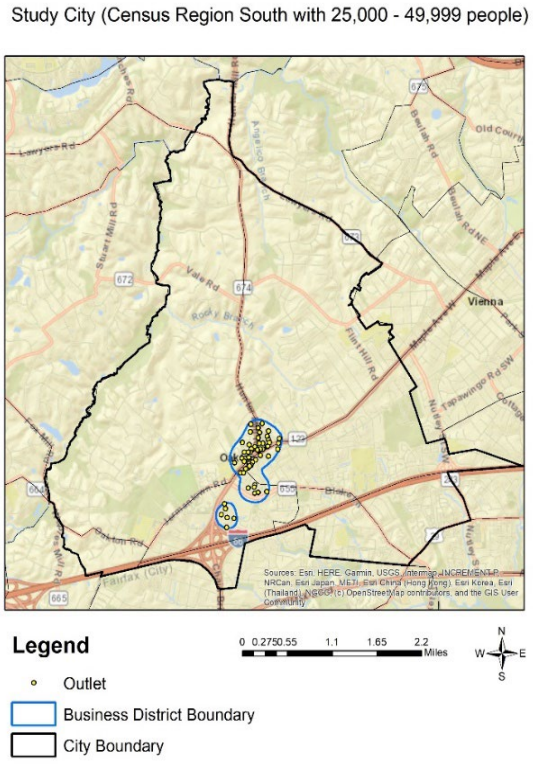


Figure 9: Businesses clustered within two districts of a small city

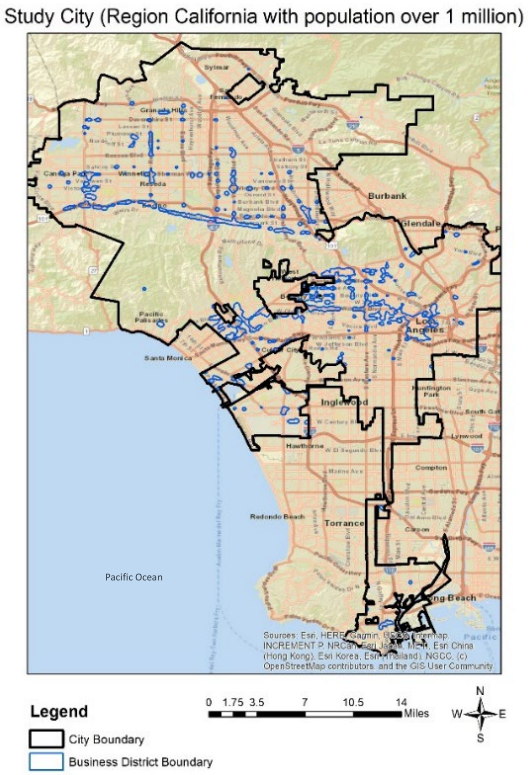


Figure 10: More than one-hundred and fifty districts across the City of Los Angeles

Kernel-density sensitivity analysis

For each of the forty-two (42) business improvement districts (BIDs) registered in the City of Los Angeles, our kernel-density method identified a district for thirty-six (36), or 86%, of them. While the geographic boundaries did not exactly match, they were remarkably close in shape in many cases (Figure 11). In general, our method defined an area larger than the official area defined by BID boundaries. Our method also detected another one-hundred and four (104) districts that did not have a corresponding official district designation from the city (Table 4).

Table 4: Comparison of politically defined and kernel-density defined business districts

Business District Geography	**Number of Districts**	**Area (square meters)**
Business Improvement Districts (BIDs)	42	30,241,032
Kernel-density defined districts overlapping BIDs	36	55,959,496
All Kernel-density defined districts	146	83,126,312

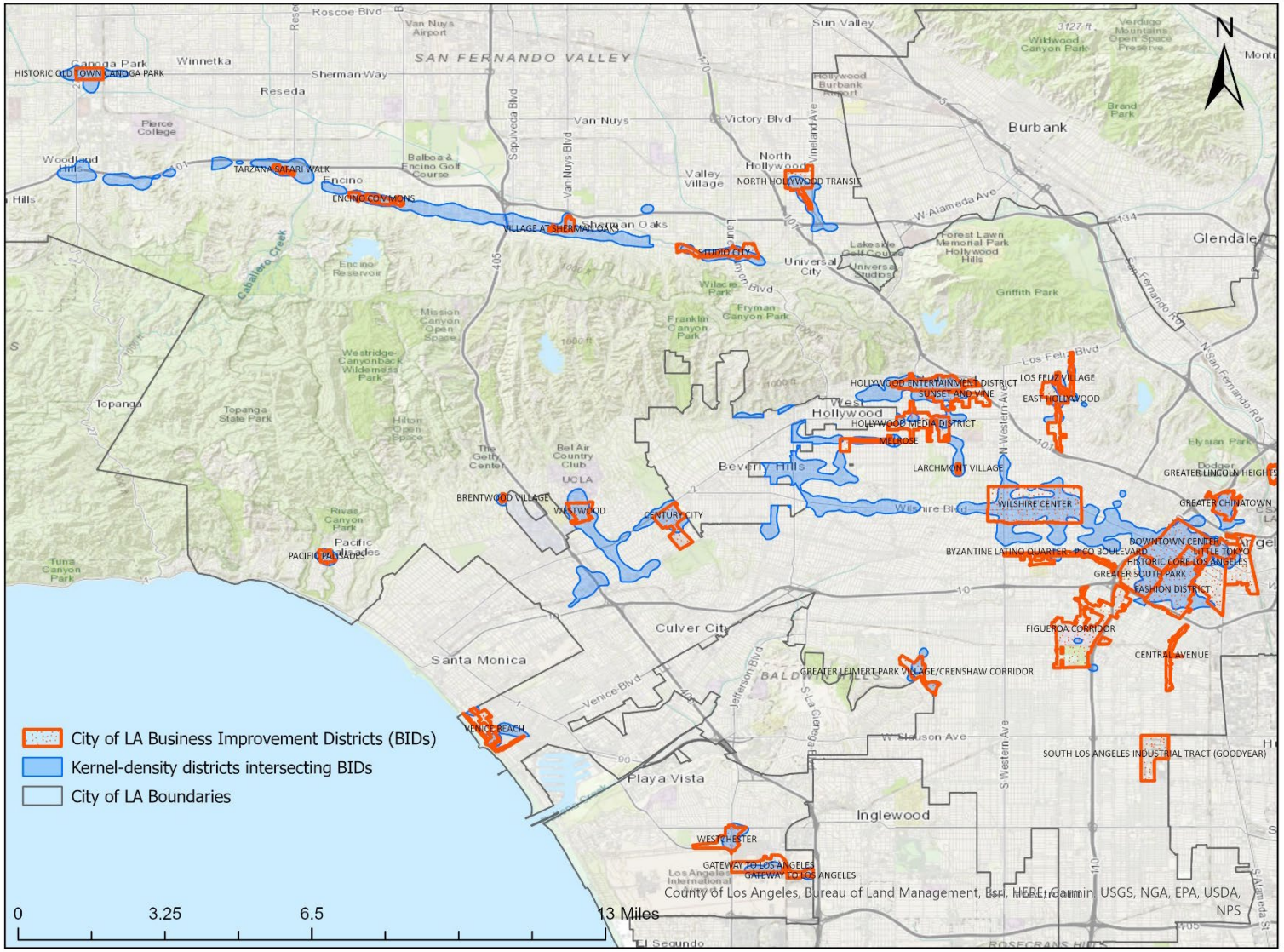


Figure 11: Map showing intersection of kernel-density derived districts with politically defined business improvement district (BID) locations in L.A.

Outlet Type Selection and Scoring

The following section will not be explored in depth in this dissertation, as it will be published separately by Brian L. Cole, DrPH, however it is necessary context for the final chapter.

We followed a systematic process to identify and assign health scores to a subset of business types to characterize the healthfulness of business districts, using "The Richter Scale of Health"[1,2] that was developed by the Royal Society of Public Health in 2015 as a guide. We adapted the "The Richter Scale of Health"[1,2] to include outlet types identified as having strong connections with health in Chapter 1 and that were frequently present in our sample of fifty cities. These outlet types were then put before a nationally representative panel of Americans to assess their opinions on how the following types of businesses and community facilities might impact health in six different domains. We also sought input from the technical advisory committee (TAC) who completed a private poll similar to the national survey. For each domain of health effects (e.g. mental well-being), respondents were asked to rank the effect of each type of business as "very positive," "somewhat positive," "somewhat negative," "very negative," or "no effect." To discourage a reflexive "no effect" response, the "no effect" response option was offered last. For our analysis, these response categories were assigned values from 10 (very positive) to -10 (very negative) with "somewhat positive" and "somewhat negative" being scored as 5 and -5, respectfully.

Selected Outlet Types

We selected the following types of outlets and facilities to include in a nationally representative opinion poll condcuted by National Opinion Research Center (NORC) at University of Chicago. Summary results of the poll are narrated below and fully elaborated in a forthcoming publication from study collaborator and committee-member Brian L. Cole, DrPH. In conducting the opinion

poll, we sought terms and definitions that could be understood and interpreted by diverse groups of Americans.

1. **Grocery Stores**
2. **Convenience Stores** (such as 7-11 or Circle-K)
3. **Liquor Stores** (including beer, wine, liquor stores)
4. **Tobacco/Cigarette Shops** (including “vape” shops)
5. **Fast food restaurants**
6. **Restaurants** (i.e. Full-service restaurants)
7. **Coffeeshops**
8. **Bars**
9. **Physical Activity Spaces**: Fitness and recreation spaces, such as gyms, YMCAs & parks and recreation facilities
10. **Pharmacies**
11. **Public Facilities** (libraries, museums, etc.)
12. **Healthcare Facilities** (i.e. hospitals and clinics)
13. **Payday Loans** and Advance Check Cashing (companies that provide short-term paycheck loans, not banks or credit unions)

Domains of Health Effects

We divided the perceived health effects of retail and institutional outlets into six domains, listed below:

1. **Health Behaviors**: healthy lifestyle behaviors, including any products and services sold, as well as other effects such as increased physical activity, diet or tobacco consumption.
2. **Mental Well-being**: how people feel and their ability to cope with day-to-day life.
3. **Social Interaction**: encouraging people meeting, talking, working, and enjoying leisure time together.
4. **Health Services**: learning about and accessing physical and mental health care, medications and counselling services.
5. **Safety**: community members’ sense of personal safety.
6. **Perceived Environmental Quality**: overall environmental quality in the community including clean air, water and land free of hazards.

Table 5 below shows the average health score given to outlet types by respondents in the national opinion poll.

Table 5: Average health score by outlet type, derived from national opinion poll (courtesy of Brian L. Cole, DrPH)

Outlet Type	Health Behaviors Domain	Mental Wellbeing Domain	Social Interaction Domain	Health Services Domain	Safety Domain	Environ. Quality Domain	Composite (Avg. All Domains)
Physical Activity Space	7	7	7	5	5	5	**6**
Public facilities	7	6	6	4	5	4	**5**
Healthcare facilities	7	6	3	6	5	3	**5**
Pharmacy	5	4	2	5	3	2	**3**
Grocery stores	5	4	4	2	3	2	**3**
Restaurants	3	4	5	1	3	2	**3**
Coffee/Tea shops	3	4	6	1	3	2	**3**
Convenience store	-1	0	1	0	-1	-1	**0**
Fast food	-3	-1	2	-1	1	-1	**-1**
Bars	-3	-3	2	-2	-3	-2	**-2**
Liquor	-4	-3	-1	-2	-3	-3	**-2**
Payday Lending	-4	-4	-2	-2	-3	-2	**-3**
Cigarette/Tobacco	-6	-4	-3	-3	-3	-4	**-4**

Scores based on respondents' ratings of health effects in each domain: 'very positive' = +10, 'somewhat positive' = +5, 'somehat negative' = -5, 'very negative' = -10

We then computed a health score for each outlet type using a combination of national opinion poll derived weights shown in Table 5 above and using poll responses and guidance from our technical advisory committee (TAC).

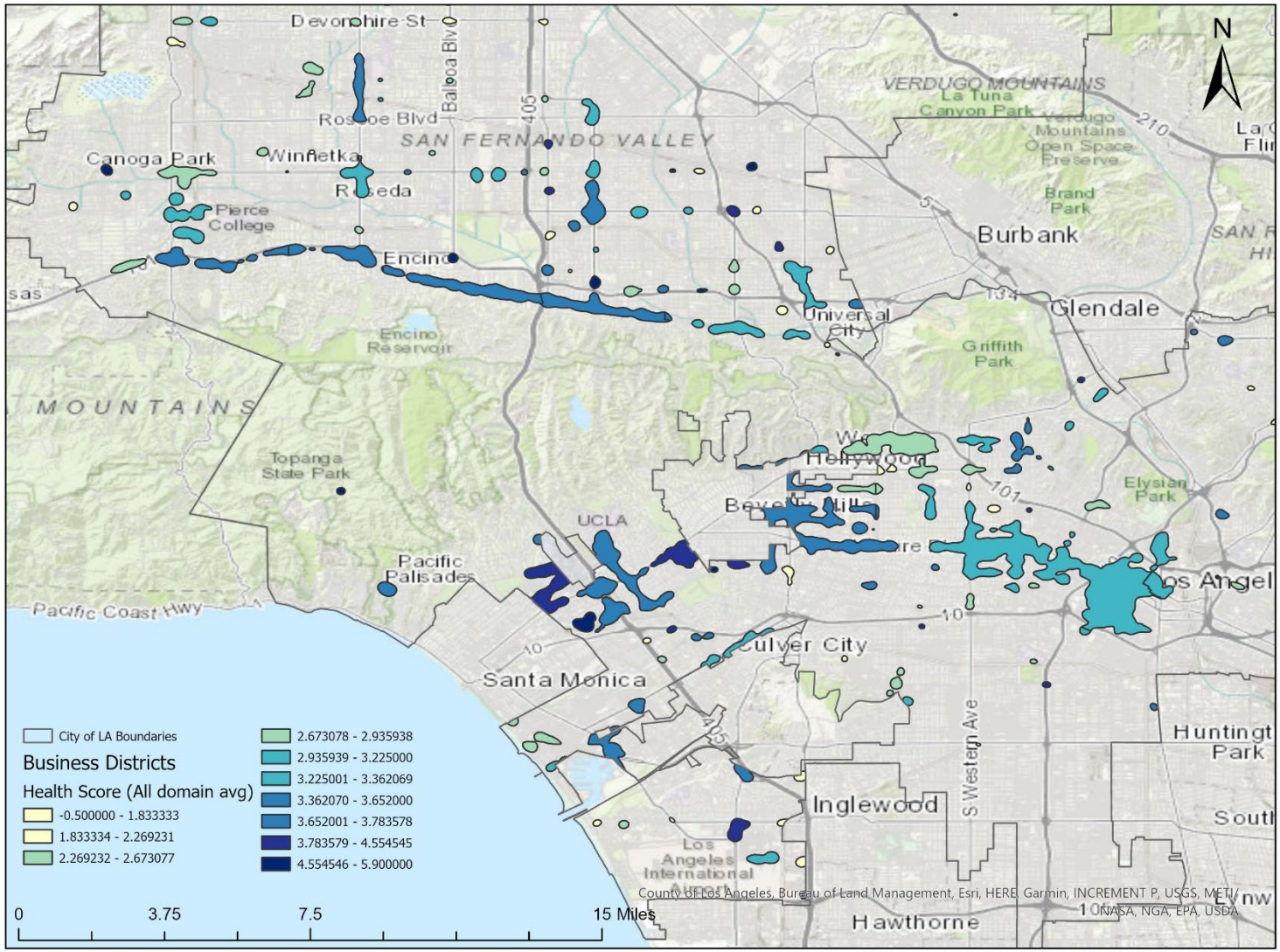


Figure 12: Map showing business districts in Los Angeles and their overall health score (average across all domains)

Health Scores of Business Districts by Study City

I computed the number of types of outlets within the GIS-defined business district (see Table 6 for summary and Appendix 1 for full list of scored outlets by SIC and NAICS codes). Each type of outlet described in Table 5 was assigned its health score by domain.

Table 6: Frequency of scored outlet types in fifty city sample with 1,416 business districts

Outlet Type	Frequency in 50 city sample
Grocery	1773
Fitness & Recreation spaces (Private & Public)	2722
Pharmacy/Drug Store	1655
Convenience stores	991
Beer, Wine, Liquors-retail	730
Cigarette (Tobacco and Electronic) stores	736
Fast Food (includes fast food & fast casual)	1694
Bars	1343
Public Facilities/services	1286
Health Services (all-inclusive)	20159
Payday Lenders (Fringe banking)	574
Full-service restaurants	19575
Coffee, Tea & Juice shops	1768

We then summed the scores of outlets in each business district, and divided by the total number of outlets. This yielded a health score for each business district, in each study city across the country.

Figure 13 shows that range of business district health scores in our fifty study cities. The average health score range is 2.5 points across U.S. cities studied (in red below), whereas the range of scores between districts in a city can be as much as 9.5 points (blue bars below).

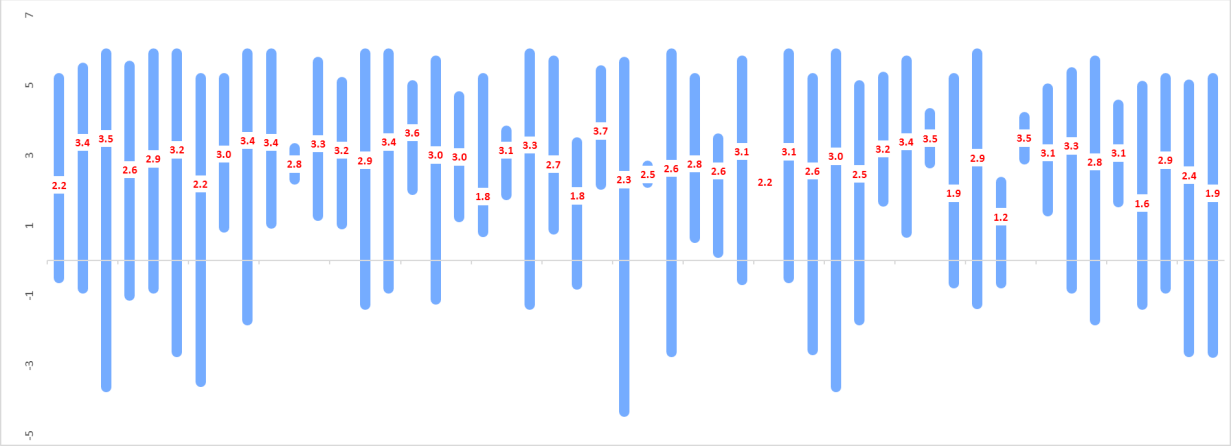


Figure 13: Average score (in red) and range of business district health scores within each study city (courtesy of Brian L. Cole, DrPH)

2.4 Discussion

Here we have described how we developed and demonstrated a novel kernel density-based approach[187,188] for identifying and quantifying contents of business districts across the U.S. which will facilitate multi-jurisdictional and national analyses for public health and built environment research. A limitation of this and similar research is that business records provided by InfoUSA and hosted by ESRI Business Analyst can be outdated or inaccurate[169] and does not account for mobile vendors. The best way to study brick and mortar locales is to verify them in-person[19] or via remote data sources such as Google Streetview; however, this method was not feasible with such geographically diverse and numerous study sites. There is a need to address the occasional incongruent detection of retail areas produced by this method. To address incongruent detection, or missed retail areas, in cities with extremely high-density areas that skewed the kernel density analysis, we recommend additional sensitivity testing on geographic area inputs and the classification of kernel density outputs to assess the best scale for further analyses using this method under different scenarios.

An advantage of this method is that it draws from a nationally available dataset which is accessible through a Business Analyst from ESRI.[185] The kernel density-based approach we describe was sufficiently sensitive to detect 86% of business districts in the largest city we studied. This method was so sensitive that it also detected 104 additional retail areas not formally defined as a business improvement district, yet where retail activity clearly occurs. This could assist researchers in defining neighborhood microenvironments for future research.

2.5 Conclusion

This chapter describes development, demonstration, and sensitivity analysis of a novel kernel-density based method for defining retail areas in public health and built environment research using a national dataset that does not rely on municipal zones or political boundaries. We described successes and promises of this approach and suggest strategies for its improvement. The kernel-density approach successfully detected a range of sizes of business districts in cities across the U.S., making it a useful tool for use in future built environment epidemiologic research.

CHAPTER THREE: Investigating associations between local health and neighborhood retail composition

3.1 Introduction

The “Health on High Street” studies conducted in 2015 and 2018 in the U.K. found significant associations between the health scores assigned to commercial areas and the life expectancy and social depravity of neighboring residents.[1,2] Our research team conducted the first national study replicating methods and comparing findings from the U.K. studies.

3.2 Methods

To gauge the association of our healthiest and unhealthiest business districts with local health, we analyzed each health-scored retail district derived in Chapter 2 by matching with neighborhood-level health [189] and life-expectancy [190,191] data. For each of the 1,416 business districts, I selected the census tracts intersecting and neighboring them. These census tracts for each district were then spatially matched with health outcomes data from U.S. Small-area Life Expectancy Estimates Project (USALEEP) data from the 2010-2015 period;[190,191] Social Vulnerability Index (SVI) data from 2016;[192,193] and US Centers for Disease Control and Prevention (CDC) 500 Cities Data 2018 release.[189]

The Social Vulnerability Index (SVI) [192,193] uses U.S. Census data to determine the social vulnerability of every census tract in the U.S. The SVI ranks each tract on fifteen (15) social factors, including poverty, lack of vehicle access, and crowded housing, and groups them into four related themes: socioeconomic status, household composition, race/ethnicity/language, and housing/transportation. CDC 500 Cities data [189] was available for three-quarters of our study cities, but not for those with the smallest total population. CDC 500 Cities data uses small area estimation methods to derive estimates for census tracts, reporting on twenty-seven chronic disease measures for the five-hundred American cities. These models estimate key

local health behaviors and health outcomes shown to have a neighborhood-level linkage, such as smoking-status, obesity, and diabetes prevalence.[189]

Health and life expectancy data from each census tract was aggregated by category, averaged, and assigned as a new field to its corresponding business district in both SPSS and ArcGIS. In total, we identified 1,416 business districts with an associated 2,103 census tracts in 50 cities across the U.S. Prior to conducting our final statistical analyses, we eliminated outlier districts:

- that were very small (less than 5 scored businesses), n=52
- that were very large (more than 1,000 scored business), n=5
- that had a majority concentration (more than 50%) of health care services, n=269

The data linking business districts with averaged health outcomes in neighboring census tracts serve the basis of Chapter 3 analysis.

For the first step in analysis, I explored unadjusted associations between business district health scores and local health behaviors and health outcomes. Second, I normalized data for comparative analyses. I normalized health scores and health outcomes for easier interpretation of results. Specifically, I transformed health scores into a positive scale (all values above zero) and normalized the value of each domain by its interquartile range, thus standardizing domains for cross-comparison. Instead of using raw values for health outcomes (age in years or percentage of population with a health condition), we calculated the residuals from regressing each health outcome against our control variables ‘city size’ and ‘census region’. We then adjusted the health outcome’s regression residuals to positive values (above zero). I regressed health outcomes (continuous dependent variable), on business district health scores (continuous independent variable) while controlling for U.S. Census region and city size. In Table 10 below I show the effect size when regressing health outcomes on business district health scores. I further examined results by stratifying the models into city size strata, business

district size and count strata, and high or low social vulnerability, comparing strength of associations in each strata.

Controls

I conducted categorical analyses to determine whether stratification or matching should be used and which control variables were important. I explored the SVI index and found it to be a strong control, although it was highly correlated with U.S. Census region and likely would introduce confounding if used as an additional control. I also found stronger associations of health scores to SVI in more affluent populations compared to those who were more socially vulnerable. Though we ultimately excluded SVI as a control, it merits further exploration as described in the Results section “Relationship of social vulnerability to district health outcomes and scores.”

I found that controlling for U.S. Census region and city size influenced the size and significance of the correlation, which is not surprising given how regional and city-level variables are likely related to both the health outcomes and to the retail and service environments. No other strata or controls were found to affect our results. After satisfactorily exploring controls, and selecting U.S. Census region and city size as the control for analyses, I ran a series of statistical tests on associations between district health scores and health outcome data from USALEEP and CDC 500 Cities, summarized in Table 7.

3.3 Results

Relationship between Health Scores and Health Outcomes

Overall, our analyses consistently showed mild but significant associations between business district health scores and life expectancy, obesity, diabetes, chronic obstructive pulmonary disease (COPD), and other health outcomes in the census tracts traversed by the business district. All correlations had the expected sign, indicating that while the influence on the health outcomes was mild, it was in agreement with the hypothesized effects (see Table 7). A

correlation with a positive value suggests that as the district's health score increases, so too does the health outcome value (life expectancy, for example). A correlation with a negative value suggests that as the health score increases, the health outcome value (prevalence of obesity in the population, for example) decreases. The social interaction domain of scores consistently had the strongest correlation with health outcomes and behaviors.

Table 7: Partial Correlation between district health score and select health outcomes

	Life Expectancy	% adults obese BMI ≥ 30	% adults w/ COPD	% adults w/ Diabetes
Overall Health Score	0.1174**	-0.1906**	-0.1503**	-0.127**
Social Interaction Score	0.2287**	-0.271***	-0.2969**	-0.2659**
Health Behaviors Score	0.0983**	-0.1645**	-0.1286**	-0.1032**
Mental Well-being Score	0.1299**	-0.1977**	-0.1631**	-0.1388**
Safety Score	0.1266**	-0.2027**	-0.1563**	-0.1331**
Environmental Quality Score	0.1057**	-0.1685**	-0.1352**	-0.1107**
Health Services Score	0.050	-0.1356**	-0.0667*	-0.057

* significant at P <= 0.05 (95% CI)
** significant at P <= 0.01 (99% CI)
Controlled by US Census Region and City Size

Relationship of social vulnerability to district health outcomes and scores

Results when controlling by SVI alone (Table 8) yielded similar partial regression results as our main controls (U.S. Census Region and City Size, shown in Table 7) though results for diabetes were largely insignificant.

Table 8: Partial correlation between select health outcomes and district scores with SVI as only control

	Life Expectancy	% adults obese BMI ≥ 30	% adults w/ COPD	% adults w/ Diabetes
Overall Health Score	.120**	-.102**	-.111**	-.052
Social Interaction Score	.133**	-.159**	-.204**	-.156**
Health Behaviors Score	.108**	-.085*	-.101**	-.039
Mental Well-being Score	.128**	-.109**	-.122**	-.065
Safety Score	.145**	-.128**	-.123**	-.060
Environmental Quality Score	.103**	-.077*	-.093*	-.034
Health Services Score	.082*	-.056	-.027	.014

* significant at P <= 0.05 (95% CI)
** significant at P <= 0.01 (99% CI)
Controlled by SVI Overall Vulnerability

Because socioeconomic indicators are generally associated with neighborhood environmental conditions, I explored the relationship between the top and bottom percentiles of the CDC's social vulnerability index (SVI) socioeconomic status theme, the minority status & language theme, and the overall social vulnerability index. The socioeconomic theme bases its vulnerability index on the proportion of population below the poverty line; unemployed; income; and no high school diploma. The minority status & language theme bases its vulnerability index on minority status and speaking English "less than well". The overall SVI score is a composite of all SVI sub themes. While the minority status & language theme did not yield interesting associations, the SVI overall and socioeconomic themes did, especially when stratified into high and low percentiles.

As Table 9 demonstrates, correlations between business district scores and health outcomes are stronger in less socially vulnerable areas. Overall health scores and those in specific domains for the lower vulnerability group generally displayed higher correlations with the SVI than those in the higher vulnerability groups, with most of the correlations being twice as

large in the low vulnerability groups compared the higher vulnerability groups. This could indicate that social vulnerability is an endogenous variable driving the structure of district services. An example of this phenomenon is when grocery chains use median income floors for determining where to site and continue operating stores [194–197]. In more socially vulnerable neighborhoods, thresholds for outside investment may act in an exclusionary manner. Or vice-versa, a lack of social vulnerability drives and incentivizes healthier retail and service activities. It may also suggest that the higher vulnerability groups lack essential services such as grocery stores or health services. It could also suggest our method missed important outlets, services, or other variables that drive health outcomes in these areas.

Table 9: Partial correlation between SVI themes (high and low vulnerability) and mean district scores

	SVI Socioeconomic – most vulnerable	**SVI Socioeconomic – least vulnerable**
Overall Health Score	-.113*	-.250**
Avg district score (-10 to +10)	*2.24*	*2.73*
Social Interaction Score	-.076	-.202**
Avg district score (-10 to +10)	*3.34*	*3.76*
Health Behaviors Score	-.091	-.247**
Avg district score (-10 to +10)	*2.20*	*2.85*
Mental Well-being Score	-.108*	-.244**
Avg district score (-10 to +10)	*2.69*	*3.26*
Safety Score	-.126**	-.233**
Avg district score (-10 to +10)	*2.46*	*2.95*
Environmental Quality Score	-.094	-.243**
Avg district score (-10 to +10)	*1.23*	*1.60*
Health Services Score	-.149*	-.240**
Avg district score (-10 to +10)	*1.64*	*2.12*

* significant at P <= 0.05 (95% CI)
** significant at P <= 0.01 (99% CI)
Controlled by US Census Region and City Size
SVI 'most vulnerable' refers to 50th percentile and above, and 'least vulnerable' below 50th percentile of national CDC rankings

Health Score effect size in relation to Health Outcomes

The relationship between U.S. retail districts and local health for 1,416 business districts in 50 U.S. cities are shown in Figure 14 – 17 and Table 10. Figure 17 scatterplots illustrate change in average life expectancy, obesity prevalence, diabetes prevalence, and chronic obstructive pulmonary disease (COPD) prevalence in census tracts adjacent to business districts with health scores ranging from 0 - 10. Models displayed only mild predictive capacity as evidenced by low R^2 values and the broad scatter around the prediction line. For every one-unit increase in district health scores (x-axis) we see an associated increase of 0.78 years of life expectancy (y-axis), an associated decrease of 1.34% in adults with obesity, a decrease of 0.67% in diabetes prevalence, and a decrease of 0.41% in COPD prevalence.

Table 10 below presents results from regressing normalized district health scores on health outcomes' residuals after controlling for census region and city size. For 1,416 districts across the U.S., Table 10 shows that in census tracts around the top quartile of business district health scores, life expectancy is approximately 1.4 years greater and % of adults with obesity, COPD, and diabetes is up to 2% lower than in census tracts around the lowest scoring districts.

Life expectancy is 1.395 years higher in census districts within the top quartile of business district health scores compared to business districts with scores in the lowest quartile. The percent of adults with obesity (BMI ≥ 30) is 2.411 percent lower in census districts within the top quartile of business district health scores than in business districts with scores in the lowest quartile. The percentage of adults with chronic obstructive pulmonary disease (COPD) is 0.73 percent less in the top quartile of district scores compared to districts in the lowest quartile. Adults diagnosed with diabetes is 1.209 percent lower in the top quartile of district scores compared to districts with scores in the lowest quartile. We caution, however, that most of the regression models had mild predictive accuracy, which may lead to high uncertainty in these effects (see Figure 17 below for R^2 values and scatterplots).

Table 10: Effect size of health score by domain on health outcome

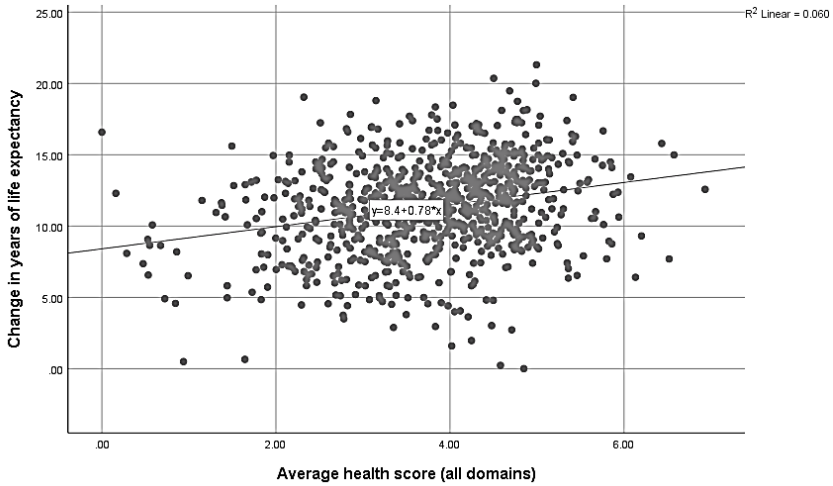
	Life Expectancy	% adults obese BMI ≥ 30	% adults w/ COPD	% adults w/ Diabetes
Overall Health Score	1.395**	-2.411**	-0.730**	-1.209**
Social Interaction Score	0.982**	-2.042**	-.717**	-1.182**
Health Behaviors Score	1.002**	-1.636**	-0.504**	-0.804**
Mental Well-being Score	1.084**	-1.872**	-0.580**	-0.958**
Safety Score	1.127**	-1.994**	-0.584**	-0.992**
Environmental Quality Score	0.968**	-1.607**	-0.496**	-0.809**
Health Services Score	0.927**	-1.486**	-0.355**	-0.634**

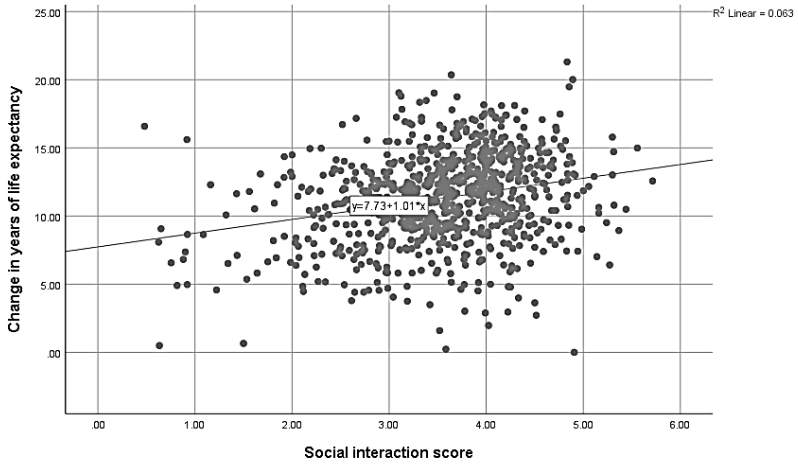
* significant at P <= 0.05 (95% CI)
** significant at P <= 0.01 (99% CI)
Controlled by US Census Region and City Size

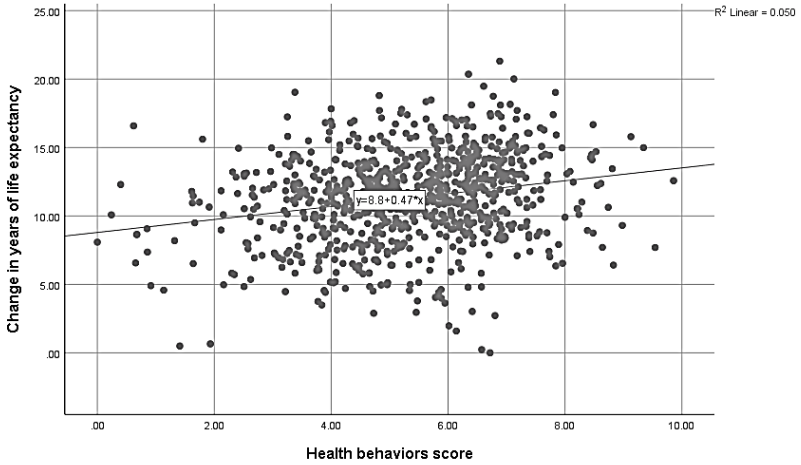
Life Expectancy

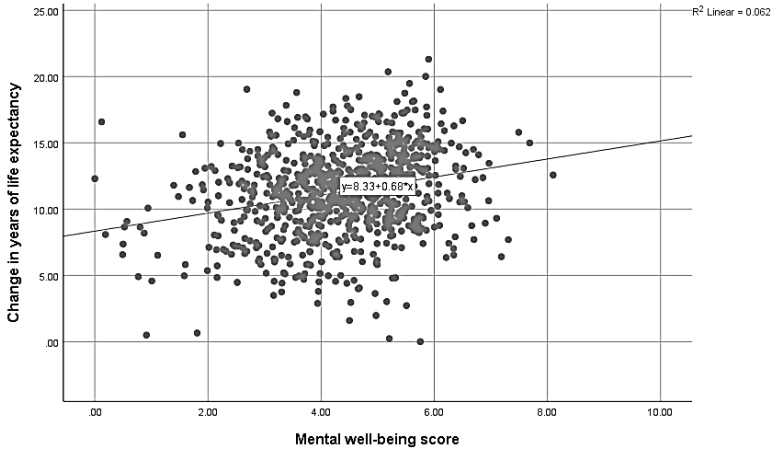
The scatterplots in Figure 14 below illustrate change in average life expectancy in census tracts surrounding the business district associated with a one-unit change in the district health score by domain. Models displayed only mild predictive capacity as evidenced by low R^2 values and the broad scatter around the prediction line. For every one-unit increase in the health score domain (x-axis) we see an associated increase of 0.78 years of life expectancy (y-axis). Coefficients on other health domains range from about 0.47 to 1.1 years. Comparing two districts (one with average health score = 2 and the other score = 4), we could expect to see a difference of 1.56 years of life expectancy between them.

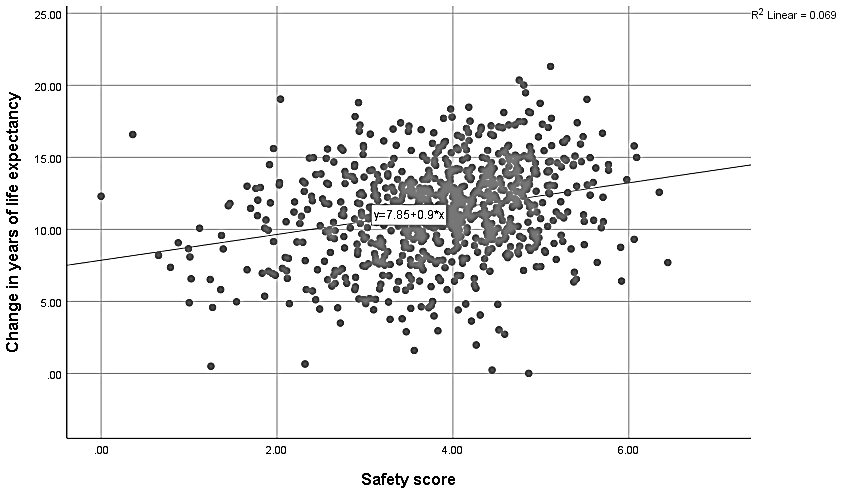
Figure 14: Years of life expectancy associated with business district scores by domain

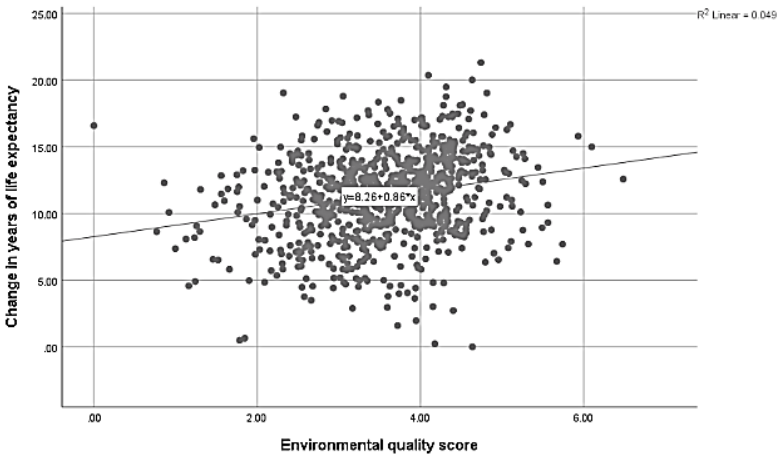


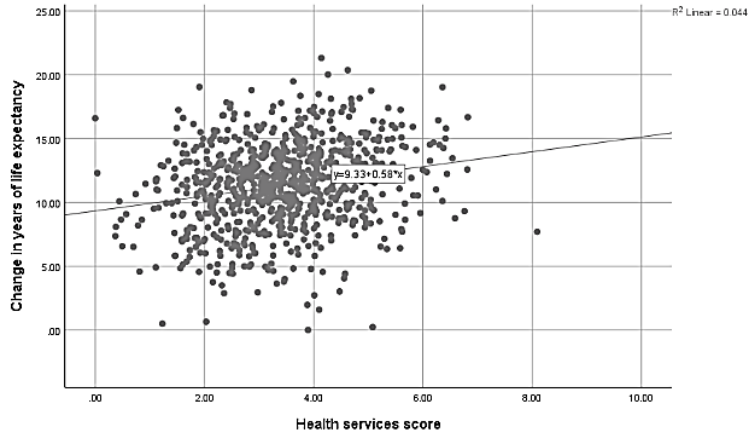







R² Linear = 0.069
Change in years of life expectancy
y=7.85+0.9*x
25.00
20.00
15.00
10.00
5.00
.00
.00
2.00
4.00
6.00
Safety score

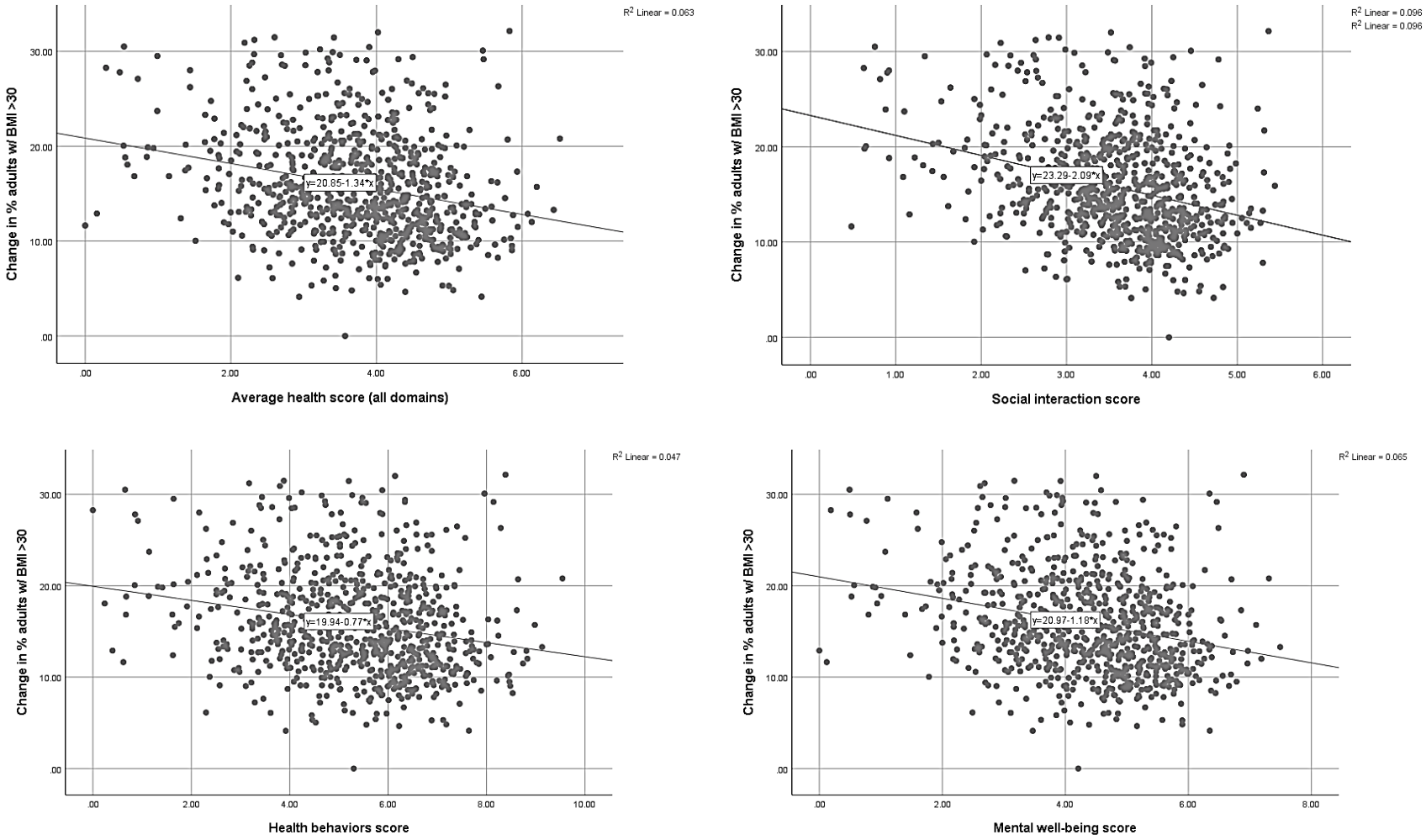

R² Linear = 0.049
Change in years of life expectancy
y=8.26+0.86*x
25.00
20.00
15.00
10.00
5.00
.00
.00
2.00
4.00
6.00
Environmental quality score

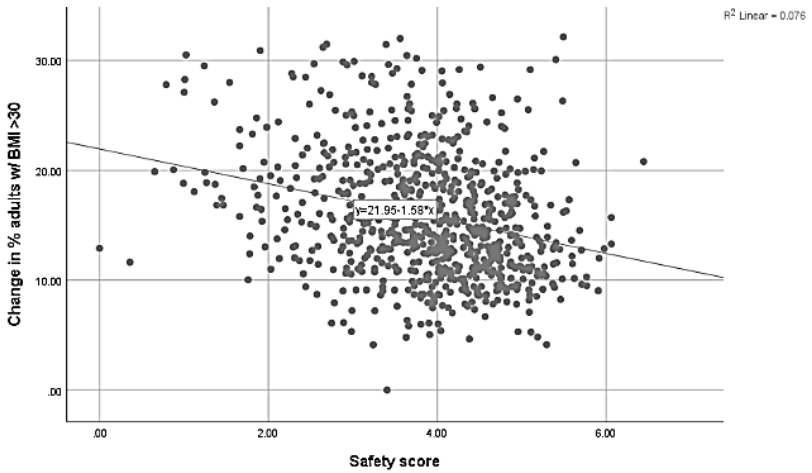

R² Linear = 0.044
Change in years of life expectancy
y=9.33+0.58*x
25.00
20.00
15.00
10.00
5.00
.00
.00
2.00
4.00
6.00
8.00
10.00
Health services score

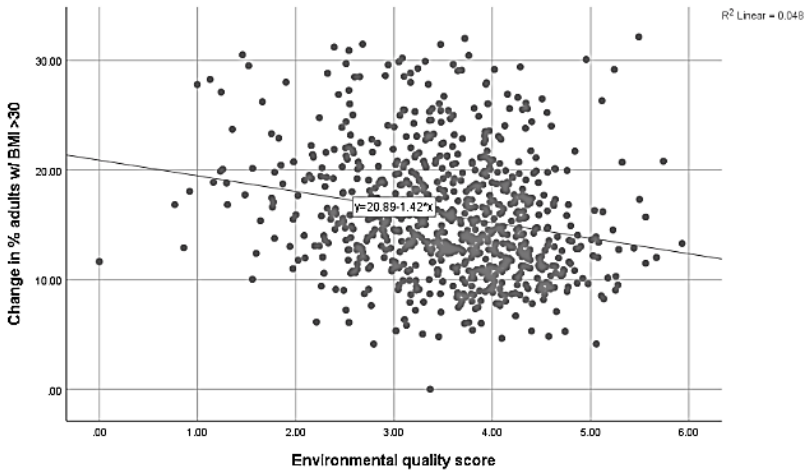
Obesity (BMI >30) prevalence

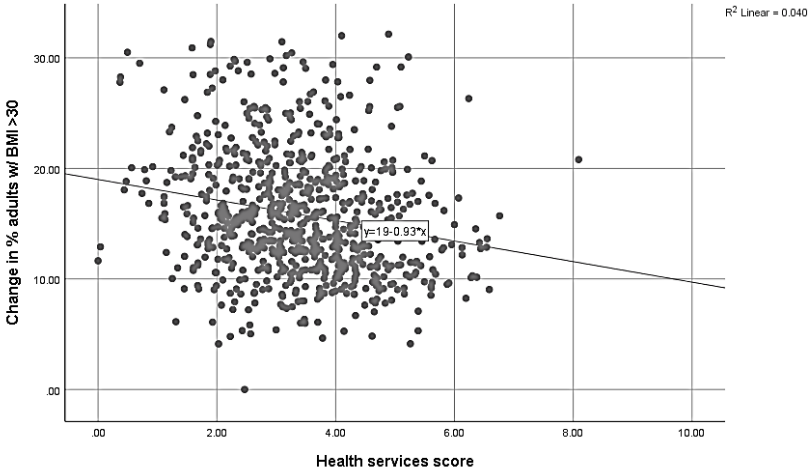
The scatterplots in Figure 15 below illustrate obesity prevalence in census tracts surrounding the business district plotted against the district health scores by domain. For every one-unit increase in the average health score (all domains) we see an associated decrease of 1.34% of adults with obesity. Coefficients on other health domains range from about 0.77 to 2.09%, with social interaction being the highest.

Figure 15: Prevalence of obesity associated with business district scores by domain




R² Linear = 0.076
Change in % adults w/ BMI >30
30.00
20.00
10.00
.00
y=21.95-1.58*x
.00
2.00
4.00
6.00
Safety score

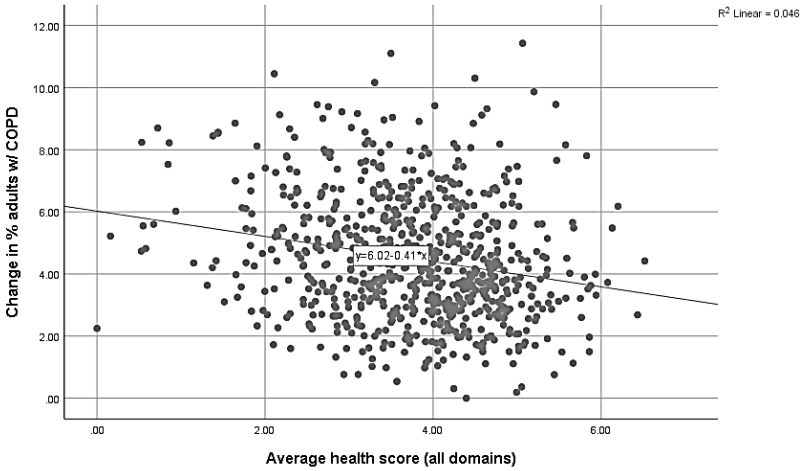

R² Linear = 0.048
Change in % adults w/ BMI >30
30.00
20.00
10.00
.00
y=20.89-1.42*x
.00
1.00
2.00
3.00
4.00
5.00
6.00
Environmental quality score

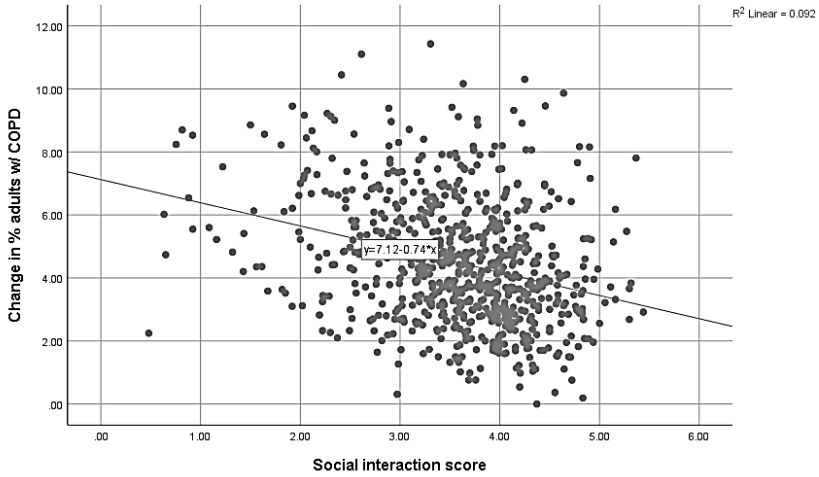

R² Linear = 0.040
Change in % adults w/ BMI >30
30.00
20.00
10.00
.00
y=19-0.93*x
.00
2.00
4.00
6.00
8.00
10.00
Health services score

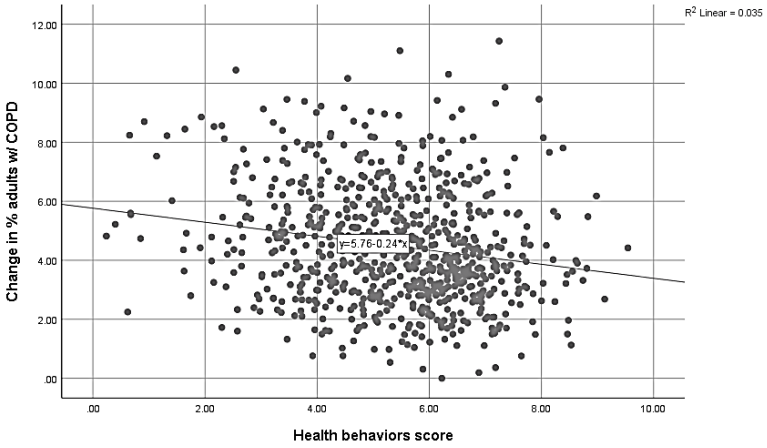
Chronic obstructive pulmonary disease (COPD)

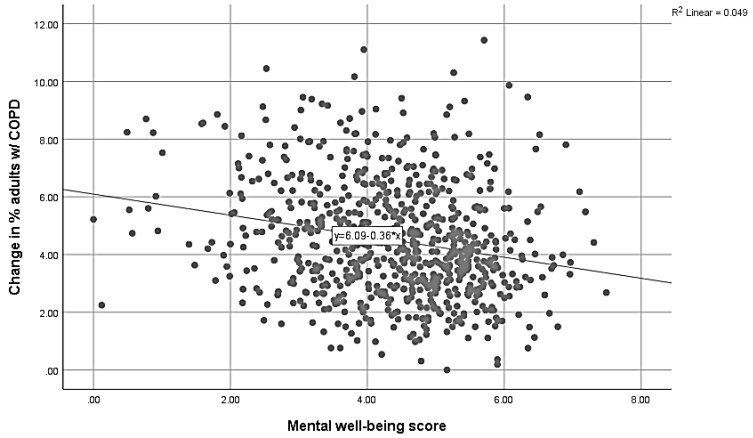
The scatterplots in Figure 16 below illustrate COPD prevalence in census tracts around the business district plotted against the district health scores by domain. For every one-unit increase in the overall health score (all domains) we see an associated decrease of 0.41% fewer adults with COPD. Coefficients in other domains ranged from 0.22 to 0.74%, with again social interaction being the highest.

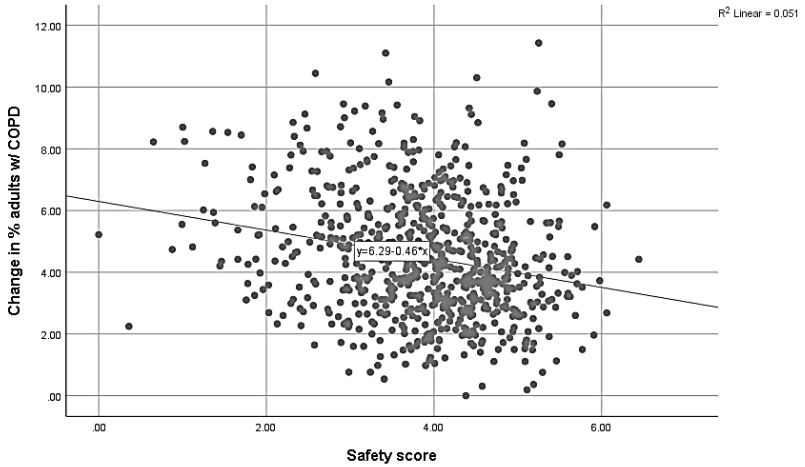
Figure 16: Prevalence of COPD associated with business district scores by domain

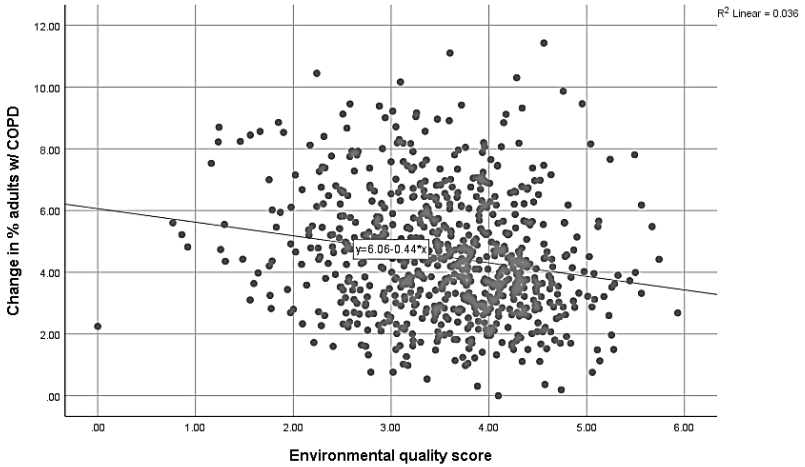


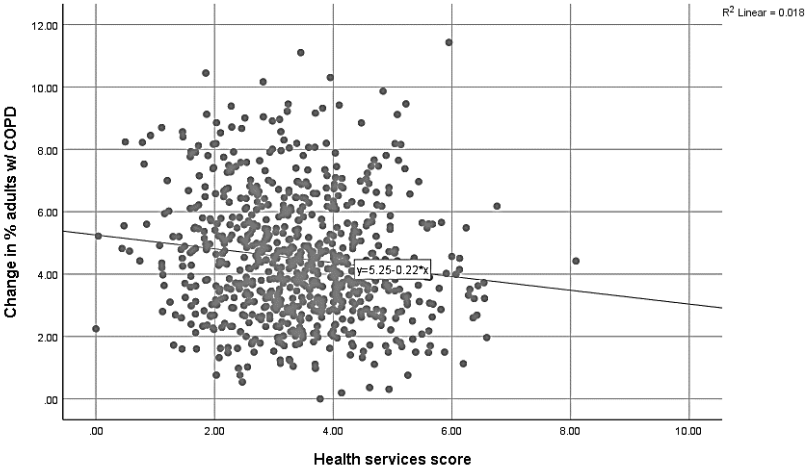







R² Linear = 0.051
Change in % adults w/ COPD
Safety score
y=6.29-0.46*x
12.00
10.00
8.00
6.00
4.00
2.00
.00
.00
2.00
4.00
6.00

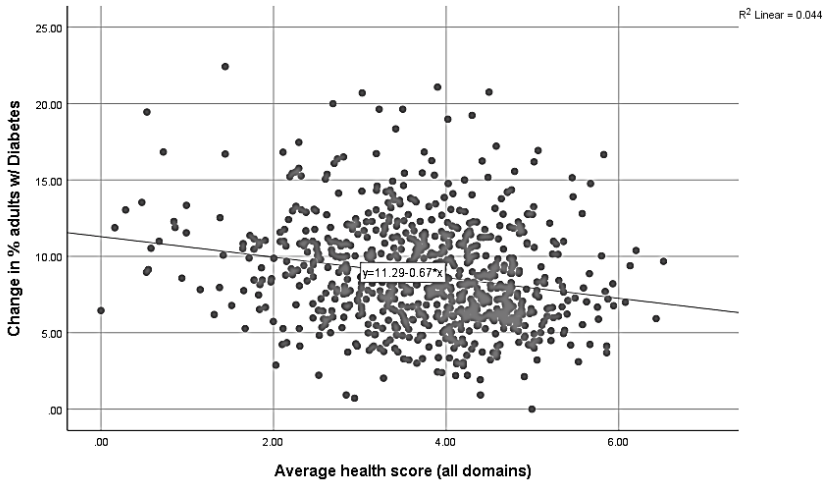

R² Linear = 0.036
Change in % adults w/ COPD
Environmental quality score
y=6.06-0.44*x
12.00
10.00
8.00
6.00
4.00
2.00
.00
.00
1.00
2.00
3.00
4.00
5.00
6.00

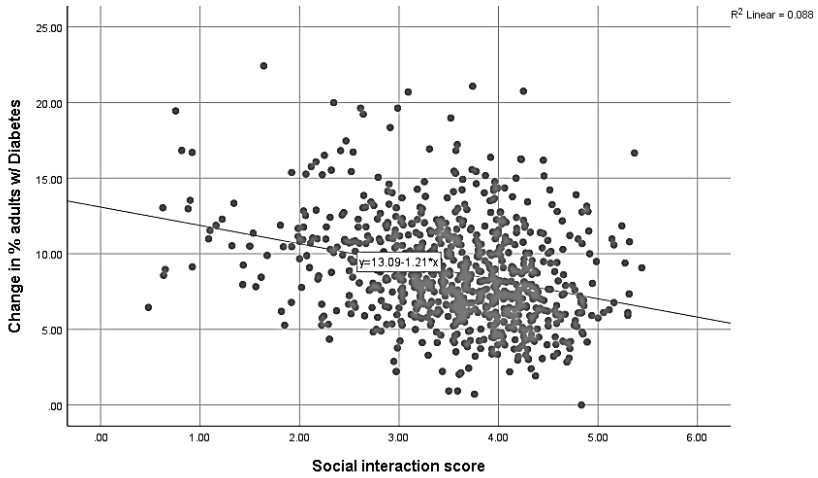

R² Linear = 0.018
Change in % adults w/ COPD
Health services score
y=5.25-0.22*x
12.00
10.00
8.00
6.00
4.00
2.00
.00
.00
2.00
4.00
6.00
8.00
10.00

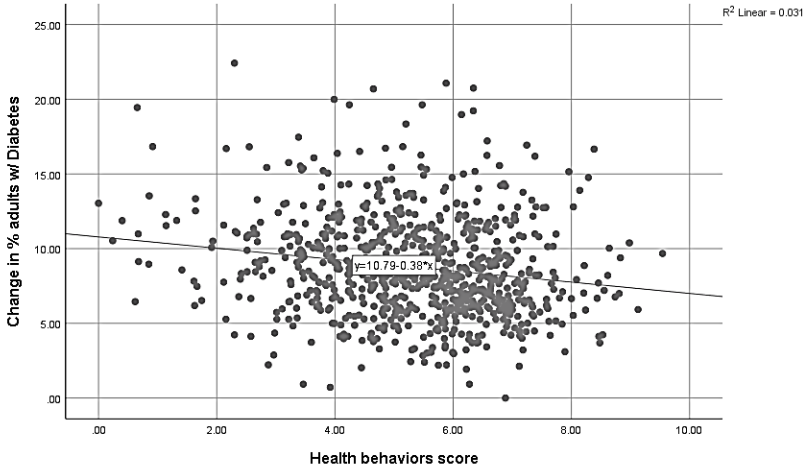
Diabetes

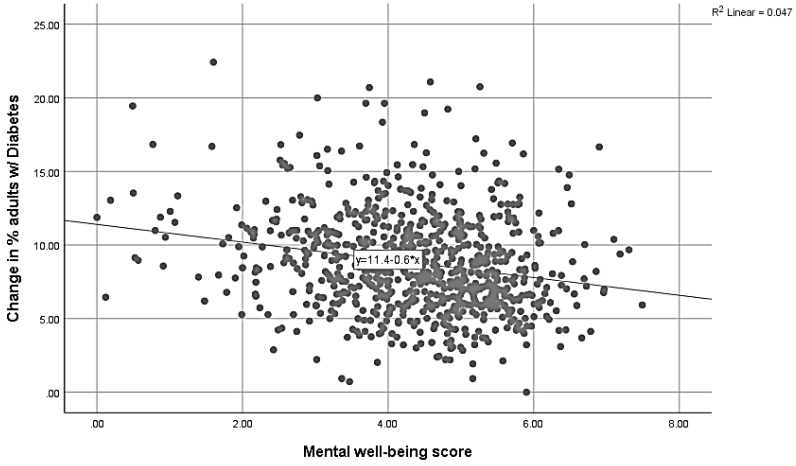
The scatterplots in Figure 17 below illustrate diabetes prevalence in census tracts around the business district plotted against the district health scores by domain. For every one-unit increase in the average health score (all domains) we see an associated decrease of 0.67% fewer adults with diabetes. Coefficients in other domains ranged from 0.38 to 1.21%, with social interaction again with the largest.

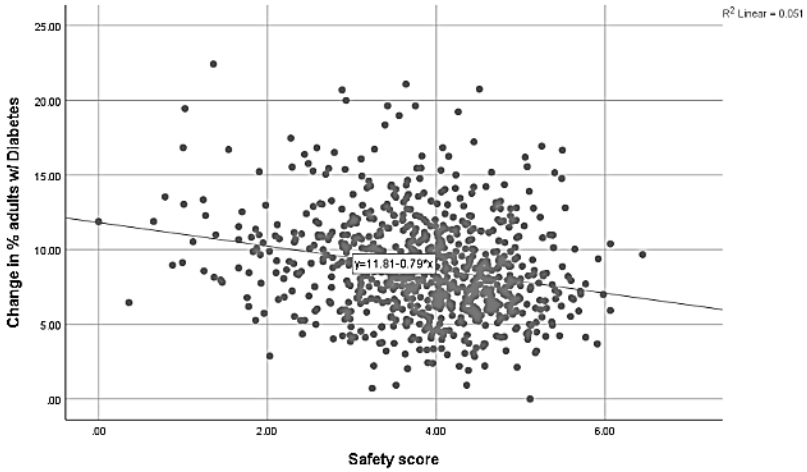
Figure 17: Prevalence of diabetes associated with business district health scores by domain

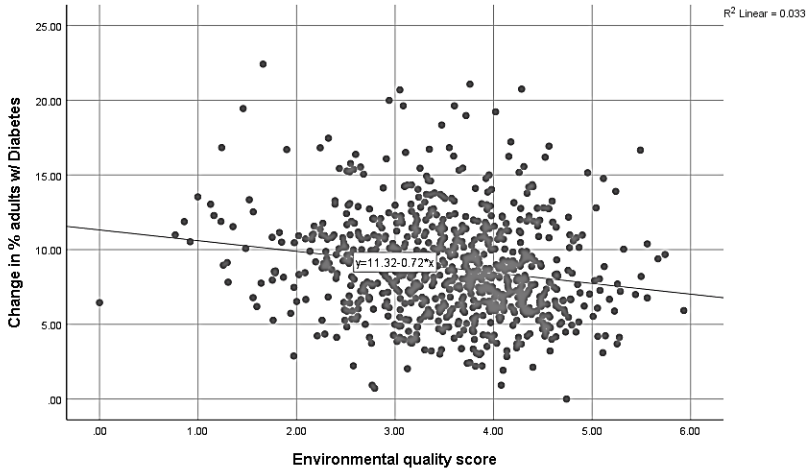


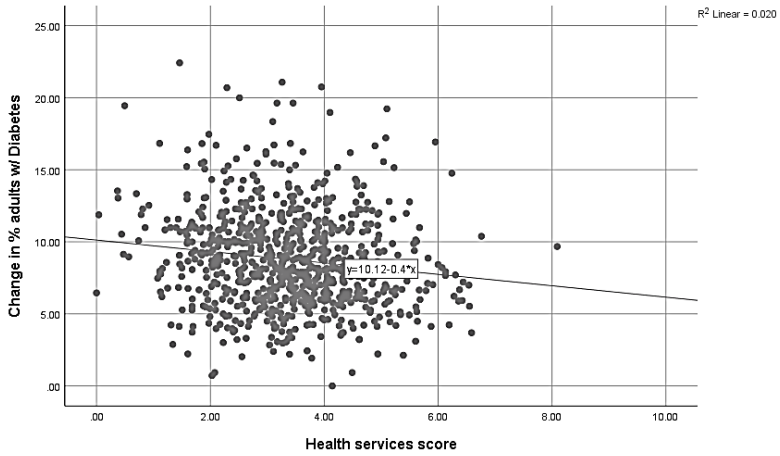







R² Linear = 0.051
Change in % adults w/ Diabetes
Safety score
y=11.81-0.79*x
25.00
20.00
15.00
10.00
5.00
.00
.00
2.00
4.00
6.00


R² Linear = 0.033
Change in % adults w/ Diabetes
Environmental quality score
y=11.32-0.72*x
25.00
20.00
15.00
10.00
5.00
.00
.00
1.00
2.00
3.00
4.00
5.00
6.00


R² Linear = 0.020
Change in % adults w/ Diabetes
Health services score
y=10.12-0.4*x
25.00
20.00
15.00
10.00
5.00
.00
.00
2.00
4.00
6.00
8.00
10.00

3.4 Discussion

We found business district health scores to be mildly, but significantly, associated with local health outcomes and life expectancy. District scores had a stronger effect on health outcomes in the least socially vulnerable communities, indicated other underlying social factors in disadvantaged communities could be driving health more than retail factors or that retail's influence is diminished by social disadvantage. There are sparse and inconsistent examples of retail areas assessed in composite, with social factors appearing to influence the relationship between retail and health.[82,177,180,198–202] By utilizing records data, we cannot confirm that individuals who live near a business district can necessarily access it. There is a rich literature on exposure misclassification based on residential address alone.[169,203–205] Yet, in studying fifty cities of varying sizes across the United States, we reveal a significant trend in the association between local health and neighborhood retail composition in the United States. This approach can be replicated in other cities in the U.S. and expanded to other countries as well.

Our findings align with work conducted by Royal Society for Public Health in 2015, who found relationships between retail mix and local life expectancy and social deprivation.[1] Their follow-up study in 2018 expanded the types of outlets analyzed and saw improvements to the least healthy districts from their 2015 study with local population health metrics improving in stride.[2] We further expanded upon their work by including additional health outcomes adapted to U.S. context, thus strengthening the evidence on the relationship between composite outlet mix and local health. Future research could expand the Health on Main Street U.S.A. work using the same methods, comparing our pre-pandemic results to current retail environments and community health. Future research should also seek to disentangle local relationships to retail areas, to better understand which relationships could be universal and which are mediated or moderated by social factors.

3.5 Conclusion

We have demonstrated a significant relationship between retail environments and a number of health conditions in a sample of fifty cities across the United States. While the strength of the relationship is mild, it holds across regions, city sizes, and socioeconomic groups, with the relationship stronger in higher socioeconomic groups. Given the variety of cities studied and variation of retail environments within them, the consistency of findings across health outcomes merits attention and further exploration. A better understanding of this socioeconomic moderation we observed in strength of associations should be explored in future research, both empirically and qualitatively in local contexts.

DISCUSSION

In Chapter 1, our scoping and synthesis of literature reviews revealed siloed areas of study with respect to retail environments and health, often focused on only one category of retail (e.g. food outlets) and one health outcome (e.g. obesity). The primary health-influencing pathways linked to retail are consumption patterns, physical activity (PA), crime and violence, social connection, and noise.[3,49–51] But the literature lacks cohesion and a standard framework compared to research into other aspects of the built environment such as housing,[3] opportunities for physical activity,[4] air quality,[5,6] noise,[5,7] heat,[5,8] and access to greenspace.[5,9] Other areas of built environment research have shown that modifying environmental risk-factors, such as access and behavioral cues, can be more effective in reducing chronic disease risks than targeting individual-level risk factors.[57] Environmental-level interventions are also necessary to support individual-level behavior change.[57] Examined through a social-ecological framework, everything from health behaviors like tobacco use to health outcomes like cancer are influenced across a spectrum, from the individual to the macro or policy level.[11,67] Given the

numerous established health exposures and behavior-influencing pathways related to retail environments, the area merits more comprehensive analysis.

Peer-reviewed literature lacked a cohesive framework for studying the composition of retail environments in relation to multiple health outcomes. Many studies and reviews point to relationships between retail outlets and neighborhood health, though inconsistent evidence underscores the need for further study. Limitations in this area of research are: 1) lack of a unified framework for analyzing retail and health; 2) a mismatch between spatial availability of retail outlets and measurable access to them; 3) very few studies that utilize individual or longitudinal data;[206] 4) insufficient understanding of mediating and moderating factors along health influencing pathways; 5) no standard measures for retail environments that allow for cross-study comparison; and 6) the narrow focus on single outlet types over composite mix.[24–27,31,33,34,36,37,86,96–102]

In Chapter 2, I demonstrated a novel kernel-density based GIS method for identifying the presence and outlet mix of retail areas, or business districts, across the United States. We identified 1,416 business districts and assigned a health score to each, based on presence of thirteen types of outlets known to influence health, standardized by total number of all outlets in the district. An advantage of this approach is it lends itself to a standardization by utilizing a place-based definition of the retail environment using a national database, over an individual and widely varied activity space.[199]

In Chapter 3, I found business district health scores to be mildly, but consistently, and significantly associated with life expectancy, obesity, diabetes, and COPD, controlling for census region and city size. The social interaction domain of health scores had the strongest association across health outcomes. Relationships between health outcomes and district scores were stronger in communities with the least social vulnerability, indicating additional variables may be needed for assessing retail areas in socially vulnerable communities and addressing

health inequities. All models showed associations in expected directions. Given the robustness of results across outcomes in a large national sample, these results underscore the need for further study of the composite retail environment, or mix of outlet types, on health. Future research should seek to understand the ideal composition of a business district for health in a variety of populations across the lifespan, from youth to seniors of all abilities.

Several limitations are inherent to using GIS and health records for the analyses presented in Chapter 3. A limitation of GIS-based methods discussed in Chapters 2 and 3 is the Modifiable Areal Unit Problem (MAUP) [207,207] that acknowledges how changes to shapes of GIS-defined areas have capacity to greatly influence study results. I attempt to mitigate MAUP through documentation of methods in Chapter 2.2 using the geo-FERN criteria, so that they may be replicated.[169] Temporal misalignment between datasets was present in this analysis, though is not uncommon in environmental epidemiology where multiple sources are combined. U.S. Small-area Life Expectancy Estimates Project (USALEEP) data were from the 2010-2015 period,[190,191] Social Vulnerability Index (SVI) data were from 2016,[192,193] while US Centers for Disease Control and Prevention (CDC) 500 Cities Data was the 2018 release [189] and ESRI Business Analyst data from InfoUSA was also from 2018.[185] However, changes to the physical retail environment and hypothesized changes to health would generally take much longer than the few years disparity in these data.

Since the conduct of the literature review guiding this research, the U.S. and world underwent a massive shift in how consumers access their retail environments, stemming from both the rise of online shopping [208] and the novel coronavirus (COVID-19) pandemic.[209] Both these forces have transformed the retail environment. The GIS-based health scoring method developed in this project could potentially help communities, researchers, and businesses understand COVID-19 impacts and make recommendations for filling vacancies and recovery by prioritizing outlets that meet the needs of their communities.

Due to the continuous nature of records, future research could replicate this work, study changes in business district mix, monitoring for any associated changes in surrounding population health. Future iterations of this work could expand the types of outlets used to characterize healthiness of business districts. Additional outlet types that were important to our technical advisors but were not included in this analysis were barber shops, beauty salons, bookstores, casinos, youth/family services, guns/ammo/firing ranges, nail salons, and religious/social organizations. Finally, farmers markets and street vendors, important elements of local foodscapes, were not captured in this scoring system due to lack of reliable and readily available national records on their locations.

Researchers can also build on our measures of healthy retail, incorporating more information about context and amenities, to create more holistic measures of "storescape" and their impact on health. Beyond considering simply whether a particular type of business is "healthy" or "unhealthy", a more comprehensive investigation into business district variables and conditions would consider pedestrian infrastructure, greenspace, racial/ethnicity, housing segregation, local inequality in storescapes, and how that contributes to health inequalities at the city/regional scale. To what extent are persistent racial/ethnic health disparities reflected in the storescape? Which is the dominant direction of causation: Do neighborhood conditions determine the character of business districts or do business district determine neighborhood conditions? The answer of course is "both," but can the effects be disentangled to support planned change? Multi-level or hierarchical modeling will be a key analytic tool, as will be documenting time-series data from natural experiments. Another important but understudied topic is the role of social capital/cohesion, both how it is affected by the storescape in a business district but also its role in promoting individual and community well-being. Additional attention should be given to socioeconomic moderation of retail area composition and relationships with health outcomes.[199] Engagement from cross-sector collaborators in social

sciences could also help to disentangle questions surrounding access and availability.[40] Future research should attempt to contextualize findings by engaging multiple stakeholder types to study local cases and examine results from local perspectives, as this process could yield more effective study and interventions.[210]

Hierarchical models, causal inference methods, longitudinal data, propensity matching, well-defined controls, and time-sensitive intervention and policy variables [152] will aid in modeling multiple levels of influence and contextual variables.[67] Still, qualitative studies are needed to better understand individual motivations within varied socioecological contexts [39] as age, race, and social factors are thought to moderate consumption patterns.[31,39,103,125] To supplement high-cost individual level longitudinal data and elucidate mediating and moderating factors, future research should consider historic records and qualitative data sources. A wealth of historic and qualitative data exists in news, social media, and other archives that may explain how people interpret and interact with neighborhood retail.

Standardized and consistent measures of retail and related-health are needed for benchmarking across studies [40] and for pooled analyses.[54] A community retail environment index should be developed and standardized to facilitate researchers' quantification of retail environments and aid in multi-site studies. A catalog of business types relevant to health, their NAICS and SIC codes, and standard groupings for analyses is needed.[53,169,211] Given evidence that perceptions of the retail and neighborhood environment moderate relationships between objective environmental measures and health outcomes,[24,67,72,74,153] surveys will still be a necessary complement to empiric analyses.

Given the number of studies who found more significant associations between food environments and obesity, diabetes and cardiovascular disease when neighborhood-level physical activity variables were included [30,30,31,74,98,140,140,149,154,156] and that index-based measures of the community nutrition environment had stronger associations with health

outcomes than single-outlet based measures,[31,39,53] we recommend the cumulative retail environment and neighborhood-level variables, such as greenspace and walkability, be considered concurrently in studies. Interactive and cumulative effects between outlet types should also be explored.[63,79,129]

A comprehensive measure for evaluating retail environments is needed at the practical level. The Royal Society for Public Health 'Richter Scale for Health' was developed around U.K. outlets and culture, accounts for presence and clustering of food and alcohol outlets, gyms, libraries, museums, health services, gambling establishments, payday lenders, and tanning salons [1,2] and has been adapted twice in the U.S.[212,213] Further research and refinement is merited, especially with respect to differential associations across the social vulnerability spectrum. One could envision use of this method by various countries and communities who adjust weights applied to retail types in the health scoring index, providing a way of benchmarking healthy or unhealthy retail environments in accord with local values. Caution should be taken that these methods not be used to justify exacerbation of inequities, such as gentrification for example. Refinement of such methods could also reveal connections that develop new knowledge of how health is influenced by local retail.

CONCLUSION

We have demonstrated a novel place-based approach to characterizing business districts for public health research. We made methodologic improvements to previous retail environment studies, by accounting for more outlet types and utilizing an advanced gravity-based density analysis of all business types to identify retail clusters. Using this environmental characterization method, we have demonstrated a relationship between the business mix in retail areas and local health outcomes. This is important as it transcends the majority of current retail environment and health literature that looks at single classes of retail types (e.g. food, tobacco,

physical activity spaces, etc.) by exploring multiple outlet types simultaneously through a weighted health score. The findings that outlet composition of retail areas is significantly associated with a number of health outcomes and life expectancy is a call to built environment and public health researchers and practitioners to better understand the mechanisms underlying these relationships. Other areas of built environment research, such as transport and health, have established relationships between complete streets and improved physical activity levels with reduced gender disparity, and reduced vehicle miles traveled and associated emissions.[214–217] This work encourages future research to explore place-based complete retail areas as an influential factor in community health. Understanding what composes a minimum health mix of businesses could drive local policy or investment in outlet types that promote health equity, utilitarian physical activity, social connections, and aging in place.

APPENDIX 1 – Outlet type categories and frequency of scored outlet types in fifty city sample, by SIC and NAICS codes

Outlet **Name** for Study	**SIC code**	**Freq**	**SIC Desc**	**NAICS Desc**
Grocery		**(n=1773)**		
Grocery, Supermarkets	541105	1411	GROCERS-RETAIL	SUPERMARKETS/OTHER GROCERY (EXC CONVENIENCE) STRS
	541104	95	FOOD PRODUCTS-RETAIL	SUPERMARKETS/OTHER GROCERY (EXC CONVENIENCE) STRS
	541110	13	GROCERY PICKUP-CURBSIDE	SUPERMARKETS/OTHER GROCERY (EXC CONVENIENCE) STRS
	541102	8	SNACK PRODUCTS	SUPERMARKETS/OTHER GROCERY (EXC CONVENIENCE) STRS
	541101	109	FOOD MARKETS	SUPERMARKETS/OTHER GROCERY (EXC CONVENIENCE) STRS
	541108	5	GROCERS-HEALTH FOODS	SUPERMARKETS/OTHER GROCERY (EXC CONVENIENCE) STRS
	543101	115	FRUITS & VEGETABLES & PRODUCE-RETAIL	FRUIT & VEGETABLE MARKETS
	549909	9	FOODS-NATURAL	FOOD (HEALTH) SUPPLEMENT STORES
	549999	8	MISCELLANEOUS FOOD STORES	ALL OTHER SPECIALTY FOOD STORES
Fitness & Recreation spaces (Private & Public)		**(n=2722)**		
Fitness club/studio/gym	799101	726	HEALTH CLUBS STUDIOS & GYMNASIUMS	FITNESS & RECREATIONAL SPORTS CENTERS
	799105	229	HEALTH SPAS	FITNESS & RECREATIONAL SPORTS CENTERS
	799949	223	YOGA INSTRUCTION	ALL OTHER MISCELLANEOUS SCHOOLS & INSTRUCTION
	799106	138	PERSONAL TRAINERS-FITNESS	FITNESS & RECREATIONAL SPORTS CENTERS
	799102	74	GYMNASIUMS	FITNESS & RECREATIONAL SPORTS CENTERS
	729995	27	YOGA	DIET & WEIGHT REDUCING CENTERS
	799978	16	BOXING INSTRUCTION	SPORTS & RECREATION INSTRUCTION
	799108	7	CHILDREN'S FITNESS	FITNESS & RECREATIONAL SPORTS CENTERS
	799711	1	SQUASH COURTS-PRIVATE	FITNESS & RECREATIONAL SPORTS CENTERS

	799707	1	CURLING CLUBS	FITNESS & RECREATIONAL SPORTS CENTERS
	799935	70	HALLS & AUDITORIUMS	FITNESS & RECREATIONAL SPORTS CENTERS
	799107	56	PILATES	FITNESS & RECREATIONAL SPORTS CENTERS
	799704	3	SWIMMING POOLS-PRIVATE	FITNESS & RECREATIONAL SPORTS CENTERS
Physical activity/Recreation	799701	66	RECREATION CENTERS	FITNESS & RECREATIONAL SPORTS CENTERS
	703301	7	CAMPGROUNDS	RV (RECREATIONAL VEHICLE) PARKS & CAMPGROUNDS
	799951	188	PARKS	NATURE PARKS & OTHER SIMILAR INSTITUTIONS
	799999	147	AMUSEMENT & RECREATION NEC	ALL OTHER AMUSEMENT & RECREATION INDUSTRIES
	799969	18	SWIMMING POOLS-PUBLIC	FITNESS & RECREATIONAL SPORTS CENTERS
	799901	15	SKATING RINKS	FITNESS & RECREATIONAL SPORTS CENTERS
	799932	14	GOLF INSTRUCTION	SPORTS & RECREATION INSTRUCTION
	799979	12	SPORTS INFORMATION	ALL OTHER AMUSEMENT & RECREATION INDUSTRIES
	729950	6	JAZZERCISE	DIET & WEIGHT REDUCING CENTERS
	799967	12	SWIMMING INSTRUCTION	SPORTS & RECREATION INSTRUCTION
	799939	12	PAINT BALL GAMES	ALL OTHER AMUSEMENT & RECREATION INDUSTRIES
	799956	7	PLAYGROUNDS	NATURE PARKS & OTHER SIMILAR INSTITUTIONS
	799731	7	OUTDOOR SPORTS	ALL OTHER AMUSEMENT & RECREATION INDUSTRIES
	842205	6	AQUARIUMS-PUBLIC	NATURE PARKS & OTHER SIMILAR INSTITUTIONS
	799726	1	CHESS CLUBS	ALL OTHER AMUSEMENT & RECREATION INDUSTRIES
	799908	11	BASEBALL BATTING RANGES	FITNESS & RECREATIONAL SPORTS CENTERS
	842202	2	NATURE CENTERS	NATURE PARKS & OTHER SIMILAR INSTITUTIONS
	794102	45	SOCCER CLUBS	SPORTS TEAMS & CLUBS

	799945	424	MARTIAL ARTS INSTRUCTION	SPORTS & RECREATION INSTRUCTION
	729906	151	EXERCISE & PHYSICAL FITNESS PROGRAMS	DIET & WEIGHT REDUCING CENTERS
Pharmacy/Drug Store		**(n=1655)**		
	591205	1640	PHARMACIES	PHARMACIES & DRUG STORES
	804939	15	PHARMACISTS	OFFICES-MENTAL HEALTH PRACTITIONERS (EXC PHYSCNS)
Convenience stores		**(n=991)**		
	541103	991	CONVENIENCE STORES	CONVENIENCE STORES
Beer, Wine, Liquors-retail		**(n=730)**		
	592102	592	LIQUORS-RETAIL	BEER, WINE & LIQUOR STORES
	592101	2	COCKTAIL MIXES	BEER, WINE & LIQUOR STORES
	592103	136	WINES-RETAIL	BEER, WINE & LIQUOR STORES
Cigarette (Tobacco and Electronic) stores		**(n=736)**		
Cigarette, tobacco dealer	599301	541	CIGAR CIGARETTE & TOBACCO DEALERS-RETAIL	TOBACCO STORES
	599302	64	SMOKE SHOPS & SUPPLIES	TOBACCO STORES
	581255	33	HOOKAH BARS & LOUNGES	SNACK & NONALCOHOLIC BEVERAGE BARS
	599304	2	CIGAR & CIGARETTE LIGHTERS-RETAIL	TOBACCO STORES
	599305	1	CIGARETTE OUTLET	TOBACCO STORES
Vape shop, electronic cigarettes	599306	95	ELECTRONIC CIGARETTES	TOBACCO STORES
Fast Food (includes fast food & fast casual)		**(n=1694)**		
Fast-casual restaurants	581214	181	CAFES	CAFETERIAS, GRILL BUFFETS & BUFFETS
	581254	9	RESTAURANTS-CYBER CAFES	CAFETERIAS, GRILL BUFFETS & BUFFETS

	581213	10	CAFETERIAS	CAFETERIAS, GRILL BUFFETS & BUFFETS
	596316	14	COFFEE & FOOD SVC-MOBILE	MOBILE FOOD SERVICES
	581219	82	SANDWICHES	LIMITED-SERVICE RESTAURANTS
Fast food restaurants	546105	369	DOUGHNUTS	SNACK & NONALCOHOLIC BEVERAGE BARS
	544101	228	CANDY & CONFECTIONERY-RETAIL	CONFECTIONERY & NUT STORES
	545102	161	YOGURT	ALL OTHER SPECIALTY FOOD STORES
	546107	54	COOKIES & CRACKERS	SNACK & NONALCOHOLIC BEVERAGE BARS
	546108	59	PRETZELS-RETAIL	SNACK & NONALCOHOLIC BEVERAGE BARS
	546101	111	BAGELS	SNACK & NONALCOHOLIC BEVERAGE BARS
	546109	2	COOKIE SHOPS	SNACK & NONALCOHOLIC BEVERAGE BARS
	581205	1	HAMBURGER & HOT DOG STANDS	SNACK & NONALCOHOLIC BEVERAGE BARS
	581221	1	REFRESHMENT STANDS	SNACK & NONALCOHOLIC BEVERAGE BARS
	581203	409	ICE CREAM PARLORS	SNACK & NONALCOHOLIC BEVERAGE BARS
	581218	1	SODA FOUNTAIN SHOPS	SNACK & NONALCOHOLIC BEVERAGE BARS
	544104	2	CANDY MAKING SUPPLIES	CONFECTIONERY & NUT STORES
Bars		**(n=1343)**		
	581301	973	BARS	DRINKING PLACES ALCOHOLIC BEVERAGES
	581303	184	COCKTAIL LOUNGES	DRINKING PLACES ALCOHOLIC BEVERAGES
	581304	152	NIGHT CLUBS	DRINKING PLACES ALCOHOLIC BEVERAGES
	581305	27	PUBS	DRINKING PLACES ALCOHOLIC BEVERAGES
	581308	7	NIGHT CLUBS INFORMATION SERVICE	DRINKING PLACES ALCOHOLIC BEVERAGES

Public Facilities/services		**(n=1286)**		
Public Facilities/services	841201	313	MUSEUMS	MUSEUMS
	823106	253	LIBRARIES-PUBLIC	LIBRARIES & ARCHIVES
	841202	159	ARTS ORGANIZATIONS & INFORMATION	MUSEUMS
	738979	129	NOTARIES-PUBLIC	OFFICES OF NOTARIES
	799940	18	HISTORICAL PLACES	HISTORICAL SITES
	841203	18	ART CENTERS	MUSEUMS
	832240	12	FOOD BANKS	COMMUNITY FOOD SERVICES
	823109	62	LIBRARIES-INSTITUTIONAL	LIBRARIES & ARCHIVES
	841204	2	PLANETARIUMS	MUSEUMS
Family & youth services	832294	16	COMMUNITY CENTERS	CHILD & YOUTH SERVICES
	832222	304	YOUTH ORGANIZATIONS & CENTERS	CHILD & YOUTH SERVICES
Health Services (all-inclusive)		**(n=20159)**		
Health/Medical Offices & Misc Health Services	801101	5261	PHYSICIANS & SURGEONS	OFFICES OF PHYSICIANS (EXC MENTAL HEALTH SPECS)
	802101	3447	DENTISTS	OFFICES OF DENTISTS
	804301	208	PODIATRISTS	OFFICES OF PODIATRISTS
	802106	16	DENTAL SURGEONS	OFFICES OF DENTISTS
	804205	2	OPTOMETRISTS OD-THERAPY VISUAL TRAINING	OFFICES OF OPTOMETRISTS
	804920	16	PHYSICIANS ASSISTANTS	OFFICES OF ALL OTHER MISC HEALTH PRACTITIONERS
	801111	15	OPHTHALMOLOGISTS	OFFICES OF PHYSICIANS (EXC MENTAL HEALTH SPECS)
	804917	14	DIETITIANS	OFFICES OF ALL OTHER MISC HEALTH PRACTITIONERS
	804910	15	OCCUPATIONAL HEALTH & SAFETY SERVICES	OFFICES-PHYSICAL, OCCPTNL/SPEECH THRPSTS/AUDLGSTS
	801127	13	NEPHROLOGY	OFFICES OF PHYSICIANS (EXC MENTAL HEALTH SPECS)

	804923	14	SPEECH & HEARING THERAPY	OFFICES-PHYSICAL, OCCPTNL/SPEECH THRPSTS/AUDLGSTS
	804903	11	HEALTH & NUTRITION CONSULTANTS	OFFICES OF ALL OTHER MISC HEALTH PRACTITIONERS
	804942	11	HEALING ARTS	OFFICES OF ALL OTHER MISC HEALTH PRACTITIONERS
	801112	11	PATHOLOGISTS	OFFICES OF PHYSICIANS (EXC MENTAL HEALTH SPECS)
	804974	57	MEDICAL SPAS	OFFICES-PHYSICAL, OCCPTNL/SPEECH THRPSTS/AUDLGSTS
	804912	63	AUDIOLOGISTS	OFFICES-PHYSICAL, OCCPTNL/SPEECH THRPSTS/AUDLGSTS
	801119	61	DERMATOLOGISTS	OFFICES OF PHYSICIANS (EXC MENTAL HEALTH SPECS)
	804925	84	SPEECH PATHOLOGISTS	OFFICES-PHYSICAL, OCCPTNL/SPEECH THRPSTS/AUDLGSTS
	804909	100	NUTRITIONISTS	OFFICES OF ALL OTHER MISC HEALTH PRACTITIONERS
	804908	116	NURSES & NURSES' REGISTRIES	OFFICES OF ALL OTHER MISC HEALTH PRACTITIONERS
	804924	143	PSYCHOTHERAPISTS	OFFICES-MENTAL HEALTH PRACTITIONERS (EXC PHYSCNS)
	804922	430	PSYCHOLOGISTS	OFFICES OF ALL OTHER MISC HEALTH PRACTITIONERS
	804201	605	OPTOMETRISTS OD	OFFICES OF OPTOMETRISTS
	801113	2	PSYCHIATRY-ADULT CHILD & ADOLESCENT	OFFICES OF MENTAL HEALTH PHYSICIANS
	832221	101	SOCIAL WORKERS	OFFICES-MENTAL HEALTH PRACTITIONERS (EXC PHYSCNS)
	804206	6	EYES-HUMAN PROSTHETIC	OFFICES OF OPTOMETRISTS
	804963	6	PHYSICIANS-ORIENTAL MEDICINE	OFFICES OF ALL OTHER MISC HEALTH PRACTITIONERS
Miscellaneous health services	729934	188	WEIGHT CONTROL SERVICES	DIET & WEIGHT REDUCING CENTERS
	832233	12	SUPPORT GROUPS	OTHER INDIVIDUAL & FAMILY SERVICES
	832225	17	DOMESTIC ABUSE INFORMATION & TREATMENT	TEMPORARY SHELTERS

	809936	11	HEALTH EDUCATION	ALL OTHER MISC AMBULATORY HEALTH CARE SERVICES
	729988	2	ELECTRO BODY SCULPTING	DIET & WEIGHT REDUCING CENTERS
	729901	42	HEALTH & FITNESS PROGRAM CONSULTANTS	DIET & WEIGHT REDUCING CENTERS
	809921	191	WELLNESS PROGRAMS	ALL OTHER MISC AMBULATORY HEALTH CARE SERVICES
	809909	65	HOLISTIC PRACTITIONERS	ALL OTHER MISC AMBULATORY HEALTH CARE SERVICES
	599504	117	OPTICIANS	OPTICAL GOODS STORES
	599505	116	SUNGLASSES & SUN GOGGLES	OPTICAL GOODS STORES
	806906	69	CANCER TREATMENT CENTERS	SPECIALTY (EXC PSYCHIATRIC/SUBSTANCE ABUSE) HSPTL
	807111	71	PAIN CONTROL	MEDICAL LABORATORIES
	599922	54	ARTIFICIAL LIMBS	ALL OTHER HEALTH & PERSONAL CARE STORES
	832204	92	COUNSELORS-LICENSED PROFESSIONAL	OTHER INDIVIDUAL & FAMILY SERVICES
	832215	514	MARRIAGE & FAMILY COUNSELORS	OTHER INDIVIDUAL & FAMILY SERVICES
	832204	92	COUNSELORS-LICENSED PROFESSIONAL	OTHER INDIVIDUAL & FAMILY SERVICES
	832215	514	MARRIAGE & FAMILY COUNSELORS	OTHER INDIVIDUAL & FAMILY SERVICES
	832282	90	COUNSELORS	OTHER INDIVIDUAL & FAMILY SERVICES
Hospitals/clinics	806202	170	HOSPITALS	GENERAL MEDICAL & SURGICAL HOSPITALS
	801104	2133	CLINICS	FREESTANDING AMBULATORY SURGICAL & EMERGENCY CTRS
	809907	1457	HEALTH SERVICES	ALL OTHER MISC AMBULATORY HEALTH CARE SERVICES
	806201	322	MEDICAL CENTERS	GENERAL MEDICAL & SURGICAL HOSPITALS
	809968	1	TRANSPLANT-ORGANS	BLOOD & ORGAN BANKS
	809916	50	BLOOD BANKS & CENTERS	BLOOD & ORGAN BANKS
	806301	385	MENTAL HEALTH SERVICES	PSYCHIATRIC & SUBSTANCE ABUSE HOSPITALS
	801105	111	PHYSICIANS & SURGEONS-EMERGENCY SERVICE	FREESTANDING AMBULATORY SURGICAL & EMERGENCY CTRS

	809203	110	DIALYSIS	KIDNEY DIALYSIS CENTERS
Outpatient/therapy/home health care	808201	1441	HOME HEALTH SERVICE	HOME HEALTH CARE SERVICES
	809301	1	EYESIGHT TRAINING	ALL OTHER OUTPATIENT CARE CENTERS
	832201	332	COUNSELING SERVICES	CHILD & YOUTH SERVICES
	809312	2	HAIR CLINICS	ALL OTHER OUTPATIENT CARE CENTERS
	805908	196	HOSPICES	NURSING CARE FACILITIES (SKILLED NURSING FCLTS)
	805198	13	SKILLED NURSING CARE FACILITIES	CONTINUING CARE RETIREMENT COMMUNITIES
	809305	15	MENTAL HEALTH CLINICS	OUTPATIENT MENTAL HEALTH & SUBSTANCE ABUSE CTRS
	805905	13	HEALTH FACILITIES	NURSING CARE FACILITIES (SKILLED NURSING FCLTS)
	805101	91	NURSING & CONVALESCENT HOMES	NURSING CARE FACILITIES (SKILLED NURSING FCLTS)
	809974	65	SLEEP DISORDERS-DIAGNOSTIC/TREATMENT	ALL OTHER MISC AMBULATORY HEALTH CARE SERVICES
	836105	164	RESIDENTIAL CARE HOMES	ASSISTED LIVING FACILITIES FOR THE ELDERLY
	808202	2	HOME MANAGING SERVICES	HOME HEALTH CARE SERVICES
Payday Lenders (Fringe banking)		**(n=574)**		
	614113	322	PAYDAY LOANS	CONSUMER LENDING
Pawn shop	593229	252	PAWNBROKERS	ALL OTHER NONDEPOSITORY CREDIT INTERMEDIATION
Full-service restaurants		**(n=19575)**		
	581208	17951	RESTAURANTS	FULL-SERVICE RESTAURANTS
	581211	2	CHICKEN DINNERS	FULL-SERVICE RESTAURANTS
	581202	2	GREEK FOOD PRODUCTS	FULL-SERVICE RESTAURANTS
	581215	1	BOX LUNCHES	FULL-SERVICE RESTAURANTS
	581233	1	JEWISH FOODS	FULL-SERVICE RESTAURANTS
	581227	7	ITALIAN FOOD PRODUCTS	FULL-SERVICE RESTAURANTS

	581201	1	LUAUS	FULL-SERVICE RESTAURANTS
	581224	61	BARBECUE RESTAURANT	FULL-SERVICE RESTAURANTS
	581222	1549	PIZZA	FULL-SERVICE RESTAURANTS
Coffee, Tea & Juice shops		**(n=1768)**		
	581228	1397	COFFEE SHOPS	SNACK & NONALCOHOLIC BEVERAGE BARS
	549938	17	ESPRESSO & ESPRESSO BARS	SNACK & NONALCOHOLIC BEVERAGE BARS
	549915	109	COFFEE & TEA	ALL OTHER SPECIALTY FOOD STORES
	581236	18	TEA ROOMS	SNACK & NONALCOHOLIC BEVERAGE BARS
	581248	151	JUICE BARS	SNACK & NONALCOHOLIC BEVERAGE BARS
	543104	76	JUICES-RETAIL	FRUIT & VEGETABLE MARKETS

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