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Walkable and resurgent for whom? The uneven geographies of walkability in Buffalo, NY

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ABSTRACT

Planners and policymakers are increasingly calling for investment into walkable neighborhoods as a means for creating new social, economic, and cultural value in cities. Such calls are often for the kind of high density, mixed-use urbanism that existed prior to the automobile era. Notably, many older industrial cities once exhibited this style of urbanism, and were characterized as "walking cities". More recently, these cities have battled persistent population loss, economic contraction, physical deterioration, and auto-oriented development. As such, their landscapes of walkability may now be fractured or uneven. Moreover, redevelopment efforts that champion "walkability" in such places are regularly targeted toward stable and gentrifying neighborhoods, rather than more distressed areas where resident mobility is comparatively limited. This paper engages with these and related themes for Buffalo, NY—a classic American "shrinking city"—to understand if/how walkability varies for different socioeconomic and demographic groups. We use WalkScore® data measured at the census block group-level to study the geographies of walkability relative to selected socioeconomic attributes. We find that walkable block groups are highly clustered in certain parts of the city, that housing values in walkable areas are increasing, and that individuals in poverty and members of certain minority groups live in block groups with disproportionately low WalkScore®. Crucially, the city features several clusters of limited mobility wherein walkability is poor and residents have insufficient access to automobiles. These results suggest that social justice must be a prominent element in urban redevelopment strategies that call for investments into "walkability".

1. Introduction

Living in a neighborhood where it is safe and easy to walk to essential retail, institutional, and recreational opportunities is associated with various health (e.g., Wang, Wen, & Xu, 2013), social (e.g., Leyden, 2003; Talen & Koschinsky, 2014), environmental (e.g., Bechle, Millet, & Marshall, 2011), and economic (e.g, Leinberger & Alfonzo, 2012) benefits for individuals compared to life in an automobile-dependent community. So-called "walkable" neighborhoods are therefore thought to be more equitable, sustainable, and economically generative living spaces relative to the disconnected, automobile-dependent land use patterns found in a typical suburban development (Speck, 2012). However, recent research (Riggs, 2014; Tighe & Ganning, 2016) and media coverage (DiNatale, 2014) suggests that, due to rising demand for homes in walkable neighborhoods, and the attendant escalation of housing costs in such locations (Pivo & Fisher, 2011), the geographies of walkability within a given city are likely to be highly uneven. Perhaps more problematically, though, is that patterns of public and private investment into designing or enhancing walkability tend to reinforce these fragmented landscapes. Indeed, planning and decision-making in the name of "walkability" has been said to "invisibilize" underrepresented peoples and locations, as investments flow into those intra-city spaces that are already thriving, stable, or "gentrifying", rather than more distressed areas where resident mobility is comparatively limited (e.g., Zavestoski & Agyeman, 2015).

In light of such observations, there is an urgent need to further explore geographic patterns of urban walkability, and to uncover the spatial relationships that might exist between walkability and local housing, socioeconomic, and demographic characteristics within cities (e.g., Quastel, Moos, & Lynch, 2012). More precisely, given the prominent place of walkability on contemporary urban planning and policy agendas (e.g., Aguilar, 2016; Formby, 2016), it is critical for planning practitioners and applied researchers to begin to focus as much (or more) on "the social" as on "the physical" (i.e., layout and design) dimensions of urban walkability (Quastel et al., 2012).

The current paper contributes to this stream of research by adopting the lens of an American postindustrial, "shrinking" city. Shrinking cities in the U.S. are those that have experienced prevalent, persistent, and

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severe population loss since at least the 1950s (Beauregard, 2003), due in part to suburbanization, southward and westward migration, and relocation of manufacturing operations to areas with lower production costs (e.g., Schilling & Mallach, 2012). Crucially, many of these places were largely built out prior to the advent of the automobile, and were thus originally thought of as “walking cities”—so named because at the time of development, they were compact in size and shape and lacked alternative modes of transportation (Kaplan, Wheeler, & Holloway, 2004, p. 222). In other words, they exhibited the type of high-density, mixed-use urbanism so coveted by the preponderance of today's urban planners, designers, and policymakers (e.g., Weaver, Bagchi-Sen, Knight, & Frazier, 2016). Potentially more importantly, recent research suggests that patterns of walkability in shrinking cities might be more equitable than in growing cities (Bereitschaft, 2017), perhaps owing to lower cost housing. Along these lines, using the shrinking city of Buffalo, NY, USA as a case study—in part because of the city's increasingly celebrated “resurgence” and prevalence of walkable neighborhoods, as claimed in some corners of the news media (e.g., DiNatale, 2014)—we seek to answer the following questions:

1. What is the current geographic distribution of walkability in the former “walking city” of Buffalo, NY?
2. Do socioeconomic and demographic composition differ in areas with different levels of walkability in Buffalo? And,
3. Does Buffalo contain any spaces in which resident mobility is severely constrained by a combination of low walkability and low access to automobiles? (The existence of such spaces would not only be an artifact of uneven geographies of walkability; but should also be flagged as a pressing concern and have immediate relevance for local planners and policymakers.)

To answer these questions, we rely on WalkScore® (http://walkscore.com) and U.S. Census socioeconomic and demographic data measured at the census block group-level in Buffalo, NY. While it is helpful to note up front that WalkScore® measures walkable *access* to daily amenities (Gilderbloom, Riggs, & Meares, 2015, p. 13), and not the more holistic concept of ***walkability per se***, ample research has “validate[d] [WalkScore®] as an appropriate proxy for walkability and the propensity for walking behavior” (Gilderbloom et al., 2015, p. 14; also see; Carr, Dunsiger, & Marcus, 2011; Duncan et al., 2012, 2013; Leinberger & Alfonzo, 2012). With that being said, we find that (1) walkable block groups are highly clustered in stable and gentrifying parts of Buffalo, (2) housing values in walkable areas are increasing, and (3) Black residents and unemployed residents are most likely to live in block groups with disproportionately low WalkScores®. Additionally, Buffalo features several clusters of isolation wherein walkability is poor and residents have insufficient access to automobiles. These results demand that considerations of social justice play more prominent roles in urban redevelopment strategies and policies that are aimed at creating walkable neighborhoods.

2. Research context: benefits of walkable neighborhoods

Neighborhood walkability is associated with numerous positive human health, environmental, and economic outcomes. For instance, urban environments with walkable access to potential destinations, mixed land use, high population density, and built environment features that promote walking behavior, such as the presence of sidewalks and street connectivity, have been linked to increased physical activity by walking, which is associated with improved health outcomes including reduced obesity rates (Frank, Andresen, & Schmid, 2004; Saelens & Handy, 2008; Wang et al., 2013). With growing levels of social inequality and increasing class and race-based health disparities in the U.S., addressing transportation equity across racial and income groups by expanding access to walkable neighborhoods offers an opportunity to improve individual health outcomes for low-income and minority residents (Sallis, Frank, Saelens, & Kraft, 2004).

American consumers commit on average 17% of their annual budgets to transportation (U.S. Bureau of Labor Statistics, 2017), intimating that the individual-level economic benefits to living in a walkable neighborhood can be quite substantial (Center for Neighborhood Technology, n.d.). Shifting consumer expenditures away from automobile-related transportation costs has also been linked to increases in neighborhood-level economic benefits (Litman, 2017). The upshot is that spaces characterized by walkable access to jobs, food, services, and other household necessities, and to public transportation that facilitates access goods and services which may not be located within walking distance, can provide numerous benefits to residents and their local economies. Neighborhoods that provide these location advantages are said to be location-efficient (Koschinsky & Talen, 2016), which is especially important for low-income households because they are less likely to own a private vehicle and more likely to rely heavily on public transportation (Hess, 2005; Pollack, Bluestone, & Billingham, 2010).

The manifold benefits associated with walkability are further implicated by housing market activity, where rising demand for walkable, mixed-use neighborhoods gets capitalized into residential home prices. For instance, a recent study on resident groups' neighborhood preferences found that householders strongly prefer neighborhoods everyday necessities are located within walking distance from their homes (Brookfield, 2016). Other research supports this notion more directly, by documenting that residents tend to pay more for homes in neighborhoods possessing characteristics associated with increased walkability, connected street networks, smaller blocks, mixed land uses, and proximity to light rail (Matthews & Turnbull, 2007; Song & Knaap, 2003). Studies that employ WalkScore® as a proxy for walkability have found that walkability has a positive association with housing values, and negative links to crime and foreclosure rates (Gilderbloom et al., 2015). Further, increases in walkability have been linked to increases in office, retail, and apartment property values (Pivo & Fisher, 2011). These walkability premiums in real property transactions are most evident in urban neighborhoods that are already walkable (Li et al., 2015; Song & Knaap, 2003).

Given the documented benefits of living in walkable neighborhoods, as well as evidence for rising housing costs and demand for walkable neighborhoods, researchers have begun to evaluate whether some segments of the population enjoy unequal access to walkable neighborhoods. An investigation into the spatial relationships between socioeconomic and demographic characteristics and WalkScore® in Boston found no statistically significant association between neighborhood socioeconomic and demographic characteristics and access to walkable amenities (Duncan et al., 2012). Another study focusing on the inclusiveness of walkable neighborhoods in San Francisco found that neighborhoods with a higher concentration of black residents tend to be less walkable (Riggs, 2014). This study suggests that high housing prices in walkable neighborhoods may force minorities to move to inaccessible areas outside of the urban core, and that cost may be a barrier to moving out of isolated neighborhoods that suffer from a lack of investment in the built environment. Bereitschaft (2017) mapped walkability alongside indicators of social vulnerability for three U.S. cities with distinct physical and socioeconomic environments: Charlotte, NC; Pittsburgh, PA; and Portland, OR. While the spatial patterns of walkability and social vulnerability varied widely across the cities, Pittsburgh, a Rust Belt city that exhibits many of the same socioeconomic trends as Buffalo, exhibited the greatest *equity* in terms of access to walkable environments (Bereitschaft, 2017). With respect to Bereitschaft's (2017) study in particular, then, there may be reason to believe that walkability is more equitably distributed in the U.S. in shrinking (Pittsburgh) relative to growing (Charlotte) cities. Accordingly, this article aims to study patterns of walkability in the shrinking city of Buffalo, NY, and to look for associations between those patterns and patterns of selected socioeconomic and demographic variables.

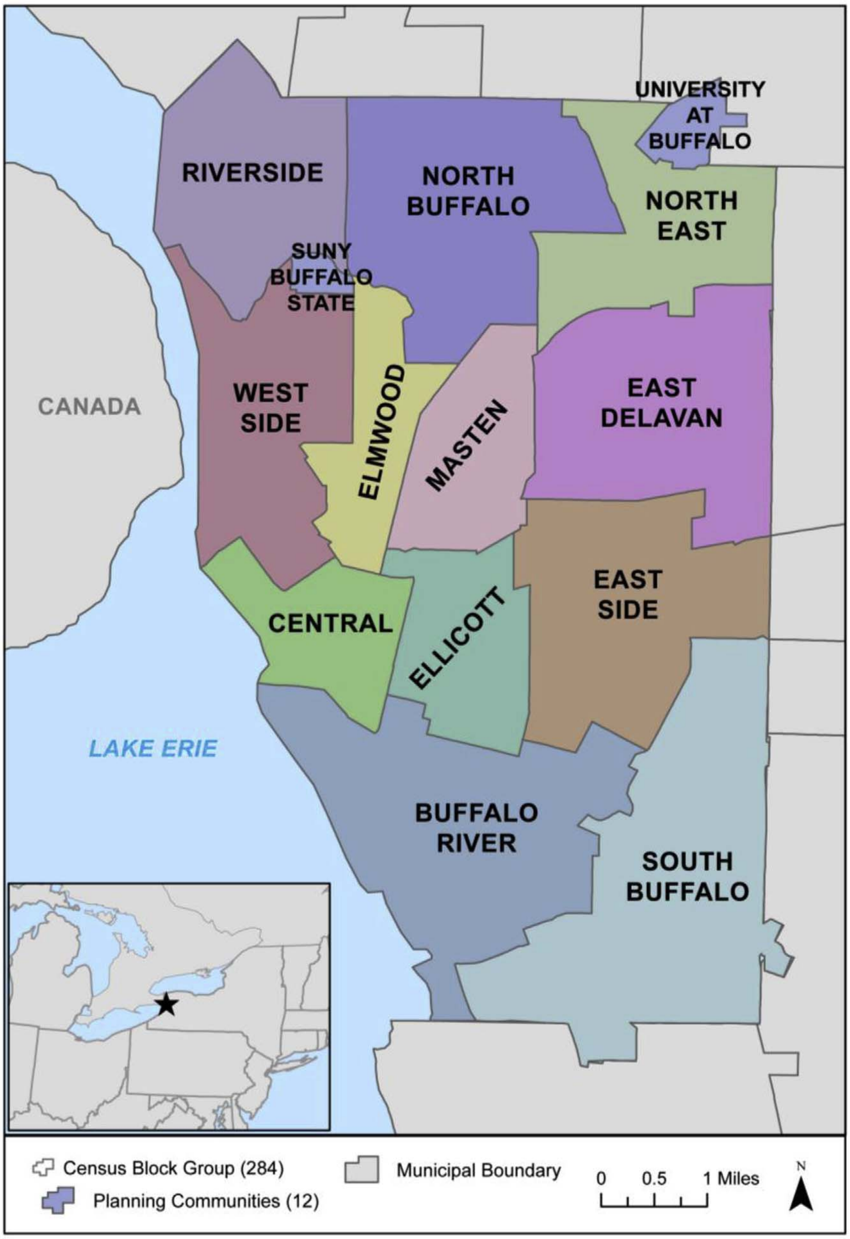

Fig. 1. City of Buffalo planning communities and regional context.

3. Study area context: shrinkage and resurgence (?) in Buffalo, NY

Buffalo, New York is a mid-sized Great Lakes city located in Erie County in western New York State (Fig. 1). Situated at the terminus of the Erie Canal and Lake Erie, Buffalo rose to prominence as an important transshipment and break-of-bulk point connecting Midwest raw materials and finished goods to Eastern seaboard ports and markets while also producing many manufactured goods of its own, eventually becoming a major center for steel production (Crandall, 2002). Manufacturing jobs eventually shifted away from the Rust Belt, and as with many industrial Rust Belt cities, Buffalo's population has decreased decade over decade since it peaked at 580,132 persons in 1950. A slow transition to a new service-oriented economy, coupled with suburbanization of the surrounding region and post-World War II federal policies which expanded suburban homeownership opportunities and improved infrastructure to facilitate commuting to central city jobs from suburban residences, fueled the city's economic decline and residential out-migration (Weaver et al., 2016).

Buffalo remains persistently racially and ethnically segregated, especially on the city's East Side, where Main Street acts as a clear Black-White divide between affluent, predominantly white residents in the Elmwood and North Buffalo neighborhoods and poor, predominantly Black residents in the Masten, East Delevan, East Side, and Delevan neighborhoods (Figs. 1 and 2). The segregation evident on the East Side stands in contrast to the city's West Side, which appears to be a diverse neighborhood that includes a fast-growing Southeast and South Asian immigrant and refugee population (Fig. 2).

Just as Cleveland and other shrinking cities have seen investment and redevelopment in their downtown cores result in population growth in those areas (CBRE, 2015; Miller, 2016), such circumstances hold true for Buffalo (Sommer, 2016). Since the adoption of the City's comprehensive plan in 2003 (City of Buffalo, 2003), with the help of state and local economic development programs, hundreds of new apartment units have been added and the downtown population has increased from practically zero to nearly 2000 persons (Sommer, 2016). Additionally, massive public-private investment in the downtown Buffalo Niagara Medical Campus (BNMC) has resulted in thousands of new downtown jobs that have supported growth in downtown housing.

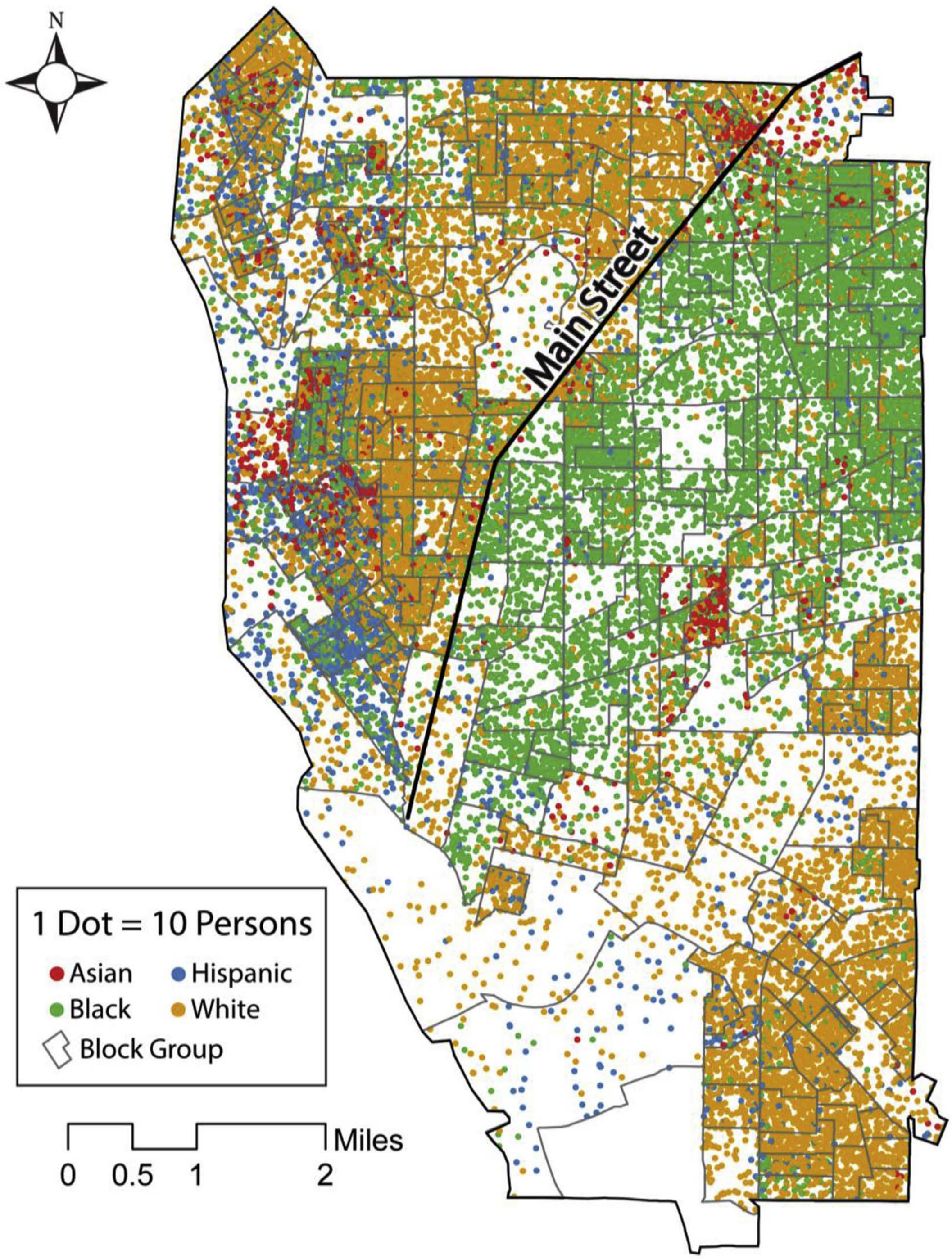

Fig. 2. Racial and ethnic groups in Buffalo by census block group.

However, the gains have come with cries of gentrification from nearby residents in historically African American neighborhoods, where rents are up, on-street parking is being gobbled up by BNMC employees, vacant lots and properties are being purchased by investors, and the City has sat idly by while residents and community organizations have called for policies to protect residents and give them a stake in its future land use decisions (Abello, 2016; Watson, 2015).

While large-scale public, private, and public-private efforts are taking shape in the urban core of many shrinking downtowns, the mixed-use, walkable, amenity-rich neighborhoods that were the hallmark of these cities' past represent current and future targets for revitalization. In particular, the unfolding “back-to-the-city” movement across the U.S. is finding its way to declining urban neighborhoods (Ehrenhalt, 2012). As urban living becomes ever more chic, hip, and cool, the potential infiltration of investors and buyers into low-priced, high-potential, walkable, and amenity-rich neighborhoods presents both opportunity and challenge. On one hand, this movement represents potential opportunities for cities to reinvigorate neighborhoods in need of investment. On the other, it brings the possibility that incoming residents will drive up prices and push existing residents to less walkable, amenity-rich neighborhoods in worse off parts of the city.

In Buffalo, this issue is evident on the West Side (Fig. 1): a neighborhood that, despite population loss, declining incomes, and high poverty, has managed to avoid issues of large-scale vacancy and abandonment that plague neighborhoods east of Main Street (Fig. 2; see Yin & Silverman, 2015). The West Side is the City's most culturally diverse neighborhood (Fig. 2), with a commercial corridor running through the heart of the neighborhood. At the same time, it is adjacent to the Elmwood neighborhood (Fig. 1), an American Planning Association "Top 10 Great Neighborhood" (APA, 2007) and the City's most affluent, mainly white, neighborhood where property values have skyrocketed, pushing prices beyond the limit of all but the most well-heeled owners and renters. Those seeking the urban lifestyle are now looking to the West Side, as well as areas just east of Main Street near the BNMC, where prices and the number of transactions rose from 2000 to 2014 (Epstein, 2015).

In sum, Buffalo holds a reputation as a shrinking city that is characterized by issues of chronic vacancy, abandonment, and segregation. Yet, the success of its established neighborhoods and several revitalizing areas (notably downtown), which have been on the receiving end of recent large-scale investments, are giving rise to claims of a citywide resurgence (Epstein, 2014). Importantly, these latter claims are tightly stitched to implications that throughout the City of Buffalo one can find neighborhoods with the sort of urbanism and urban lifestyle that come from walkable access to an array of consumption and recreational opportunities (e.g., Kaminer, 2016). The analyses described and carried out in the following sections evaluate the veracity of such notions.

4. Data and methods

To operationalize neighborhood-level walkability, x-y point data were collected from WalkScore® in November 2016. WalkScore® was chosen to represent walkability for this study for three reasons. First, it is primarily a measure of walkable access to amenities, meaning that it describes the degree to which residents are embedded in spaces that feature various retail, institutional, and recreational opportunities. Second, the measure is available throughout the U.S., which allows future research to replicate this study. And, third, ample research has established that WalkScores® are valid and reliable measures of the construct of *walkability* (Carr et al., 2011; Duncan et al., 2013). With respect to the measure itself, the WalkScore® algorithm grades a location's suitability for walking by analyzing walking routes to nearby amenities. It uses a distance decay function to award points to locations based on the road network distance from a starting address to nearby destinations in various categories, with multiple amenities in each category resulting in an improved score (Klein, 2011). Destinations within a five-minute walk, or 0.25 miles, receive the highest possible score, and no points are awarded after 1.5 miles. Scores are standardized from 0 to 100, with the highest scores indicating that most daily errands can be accomplished on foot and do not require a vehicle, and the lowest scores indicating car-dependence with almost all daily trips requiring a vehicle (Walk Score, 2014).

WalkScores® were obtained for the geographic coordinates of the mean centers of U.S. Census block groups, weighted by 2010 census block-level population. Block groups were chosen for the analyses insofar as they are the smallest units for which U.S. Census socioeconomic data can be obtained. Importantly, block groups are not perfectly representative of "neighborhoods" *per se*, but they are widely, and relatively serviceably, used as proxy boundaries for neighborhoods (see Weaver, 2014). An R script (http://r-project.org) from the package *walkscoreAPI* (Whalen, 2015) was used to pull the WalkScore® data from the website's application programming interface. Two of Buffalo's 287 total block groups were removed from the analysis because they are home to university campuses, and an additional block group was removed because it consists of largely industrial land use and contains no residents; hence, 284 block groups are used in the analysis. Selected socioeconomic and demographic data were obtained from the 2012–2016 U.S. Census American Community Survey (ACS) 5-year estimates. A key variable hereinafter referred to as "poor automobile access" was computed from ACS data as the percentage of occupied housing units with zero vehicles available.

4.1. Detection of spatial clustering with local Moran's I

A common concern for researchers studying spatial patterns is to determine whether those patterns deviate from expectations under the hypothesis of complete spatial randomness. Statistical tests for identifying clusters that are not consistent with spatial randomness can be performed at either global or local scales (Rogerson & Yamada, 2009). Global tests are useful for determining whether overall patterns are clustered, random, or dispersed; but they do not provide information on the locations or sizes of clusters (Ord & Getis, 1995). Thus, when the size, location, and significance of clusters within a study area are important and must be identified, local tests are necessary (Rogerson & Yamada, 2009). One local test commonly used in spatial analyses to identify the locations and sizes of clusters of numerical variables it the local Moran's *I* test (Anselin, 1995).

The local Moran's *I* statistic was implemented using GeoDa 1.10.0.8 to identify clustering in WalkScore® values at the block group-level. Local Moran's *I* belongs to the class of spatial statistics called local indicators of spatial association (LISA). By definition, LISA statistics provide an indication of local clustering of similar values around an observation and an assessment of the statistical significance of the clustering (Anselin, 1995). In addition, the sum of all local indicators is proportional to a global indicator of spatial association (Anselin, 1995). The second requirement allows the researcher to evaluate the LISA at each location as a component of its related global indicator. Local values that deviate significantly from the global indicator are outliers that contribute more than their expected share to the value of the global mean (Anselin, 1995). Local Moran's *I* statistics were calculated in GeoDa for each block group using a spatial weights matrix based on queen contiguity.

4.2. Measuring the population composition of cluster types

One output of a cluster analysis based on the Local Moran's *I* is a typology—that is, block groups are classified as spatial clusters, spatial outliers, or areas for which the null hypothesis cannot be rejected, based on the values of their local *I* statistics. To address one of the main objectives of this paper, we selected a few representative variables from the 2012–2016 ACS to explore differences in socioeconomic and demographic composition in different categories of block groups based on the walkability cluster analysis. Demographic composition was proxied by the percentage of non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, and Hispanic residents. Selected socioeconomic conditions included the percentage of individuals below poverty, the percentage of vacant housing units, the percentage of owner-occupied housing units, the percentage of occupied units with no vehicle available, and the percentage of the civilian labor force characterized as unemployed.

To measure the degree to which the demographic and/or socioeconomic composition in each block group type deviates from the city as a whole, *location quotients* were calculated for each of these indicators. A location quotient is a ratio of ratios—the concentration of a phenomenon in a given geographic unit divided by the presence of the same phenomenon within a larger study area. It is essentially a measure of how concentrated a given phenomenon is within smaller units that compose a larger study area. The location quotient, LQ_i, was calculated for socioeconomic and demographic indicators for each block group cluster type as:

$$LQ_i = \frac{x_i}{y_i}\bigg/\frac{X}{Y}$$

For percentage Black population, for example, x_i/y_i is the number of Black residents in a given cluster type (x_i) divided by the total number of residents in that cluster type (y_i), and X/Y is the number of Black residents in all block groups in the city (X) divided by the total population in the city (Y). LQ_i for the Black population would then be the fraction of Black population in a given cluster type (i) relative to the Black population in all block groups in the city. An LQ_i equal to 1 means that the fraction of Black residents within that cluster type is exactly equal to the concentration of Black residents among all of the city's block groups. Values other than 1 imply that the distribution of Black residents is not spread evenly across the city. A value less than 1 indicates that cluster type has a lower than expected percentage of Black residents, and a value greater than 1 indicates a higher than expected percentage. Location quotients were calculated for all of the demographic and socioeconomic indicators mentioned above.

Finally, to assess the relationship between walkability and the neighborhood housing market, the mean assessed value for single-family residential parcels within each block group cluster type and the percentage change in their assessed value during the years 2010–2016 was calculated from the City's parcel files, obtained from the New York State Geographic Information Systems (GIS) Clearinghouse (https://gis.ny.gov/).

4.3. Detecting clusters of limited mobility with bivariate local Moran's I

The final objective of this paper is to identify the locations, if any, of clusters of limited mobility. We define *clusters of limited mobility* as spaces characterized by low walkability, and wherein residents have poor access to automobiles. To detect such clusters, we rely on the bivariate local Moran's I statistic, which is a measure of spatial cross-correlation. More precisely, it measures the relationship between a variable at one location (here, fraction of households without access to a vehicle) with the average value of a second variable at neighboring locations (here, walkability via WalkScores®). The objective is to understand whether households with poor (good) access to vehicles are embedded in spatial neighborhoods characterized by low (high) walkability. Where access to vehicles is poor *and* walkability is low, residents presumably have limited mobility and limited opportunities to meet everyday needs. Bivariate local Moran's I statistics were computed in GeoDa to detect such clusters, if they exist.

5. Results and discussion

The results of the univariate and bivariate local Moran's I tests are visualized below with cluster maps to show the locations of statistically significant ($p < 0.05$) spatial clusters and outliers. The univariate map (Fig. 3) describes spatial patterns of walkability across Buffalo, by classifying block groups into one of: (1) high walkability clusters, wherein local WalkScores® are higher than expected by chance; (2) low walkability clusters, wherein local WalkScores® are lower than expected by chance; (3) high walkability outliers, where a block group's own WalkScore® is higher than, but the WalkScores® of its neighbors are lower than, what is expected by chance; or (4) not significant, whereby local WalkScores® are no different from what is expected by chance alone.[1] In the bivariate map (Fig. 4), the spatial relationship between vehicle access and walkability in Buffalo is illustrated by classifying block groups into one of: (1) high vehicle access-high walkability clusters, wherein residents presumably have the highest mobility; (2) poor vehicle access-high walkability clusters, wherein walkable access to amenities might offset some of the disadvantages that are linked to lack of automobility; (3) high vehicle access-low walkability clusters, wherein residents rely primarily on automobiles to meet their daily needs; (4) poor vehicle access-low walkability clusters (which have been refereed to throughout this article as *clusters of limited mobility*), where resident mobility is severely constrained by lack of walkable access to amenities *and* lack of access to vehicles; or (5) not significant, where the spatial relationship between vehicle (non-)ownership and local walkability is no different than what would be expected by chance alone.[2]

5.1. Walkable access to amenities

Fig. 3 shows that the distribution of walkability in Buffalo, measured as access to walkable amenities via WalkScore®, is highly clustered. Specifically, we identified a large hotspot of walkable neighborhoods in the western-central part of the city. This cluster of high walkability contains the Elmwood (stable, established), West Side (gentrifying), and Central (downtown) communities that were discussed above. Isolated pockets of additional walkable areas are found in the northern part of the city and in South Buffalo. Table 1 shows that Asian and Hispanic residents are overrepresented in clusters of high walkability, with location quotients much greater than one. This finding is seemingly a reflection of the racial and ethnic diversity of the city's walkable West Side neighborhoods (Fig. 2). On average, the high walkability neighborhoods from Fig. 3 feature much lower owner-occupancy rates and slightly higher poverty levels relative to the city as a whole. These findings are consonant with Bereitschaft's (2017) study of Pittsburgh, a shrinking Rust Belt city in which walkability was found to be more accessible to disadvantaged social groups compared to growing cities. Nevertheless, perhaps the most alarming characteristic of the high walkability clusters in Buffalo is their exclusion of Black residents. Specifically, despite accounting for 36.60 percent of the City's population, non-Hispanic Black residents make up only 20.60 percent of the high walkability clusters—for a location quotient of 0.56. This result supports existing evidence of a spatial dissociation between Black populations and walkable spaces (Riggs, 2014); and it acts as an important qualifier on the idea that walkability may be more equitably distributed in shrinking relative to growing cities (e.g., Bereitschaft, 2017).

Consistent with studies that argue for walkability's economic benefits (Gilderbloom et al., 2015; Leinberger & Alfonzo, 2012; Li et al., 2015; Litman, 2017; Pivo & Fisher, 2011; Song & Knaap, 2003), we find much lower unemployment rates in high walkability clusters relative to both the city as a whole and the remaining cluster types (Table 1). Similarly, high walkability clusters have the highest mean single family residential home values, as well as the fastest appreciating home values in Buffalo.

The largest cluster by size is a low walkability cluster that stretches from the City's western limits in the Buffalo River community, to parts of South Buffalo and through nearly all of the East Side and East Delavan communities. These areas are characterized by low walkability, high unemployment (LQ = 1.32), high vacancy (LQ = 1.18), low home values (mean = 54,271), and slightly above average poverty levels (LQ = 1.02). Hence, low walkability clusters are arguably more economically (in terms of unemployment) and physically (in terms of vacancy and home value) distressed than the typical City neighborhood. Not coincidentally, these spaces contain a disproportionate share of the City's Black population (LQ = 1.18)—thereby supporting earlier claims that Black residents in Buffalo, as elsewhere (e.g., Riggs, 2014), tend to occupy less walkable neighborhoods relative to other demographic groups. Finally, note that, while homeownership is higher in low walkability clusters than almost anywhere else in the City (LQ = 1.20), the average single-family home in these spaces is assessed nearly $18,000 lower than the mean single-family home in Buffalo. In short, residents own less valuable homes.

[1] At a global level, the distribution of WalkScores® in Buffalo is clustered. The global Moran's I statistic is 0.67, with a pseudo p-value (obtained via 9999 random permutations) < 0.0001.

[2] Globally, there is a slight, positive spatial cross-correlation between vehicle non-ownership and local walkability. The bivariate Moran's I statistic is equal to 0.05 with a p-value of $0.02 < 0.05$ (alpha for a 95% level of confidence).

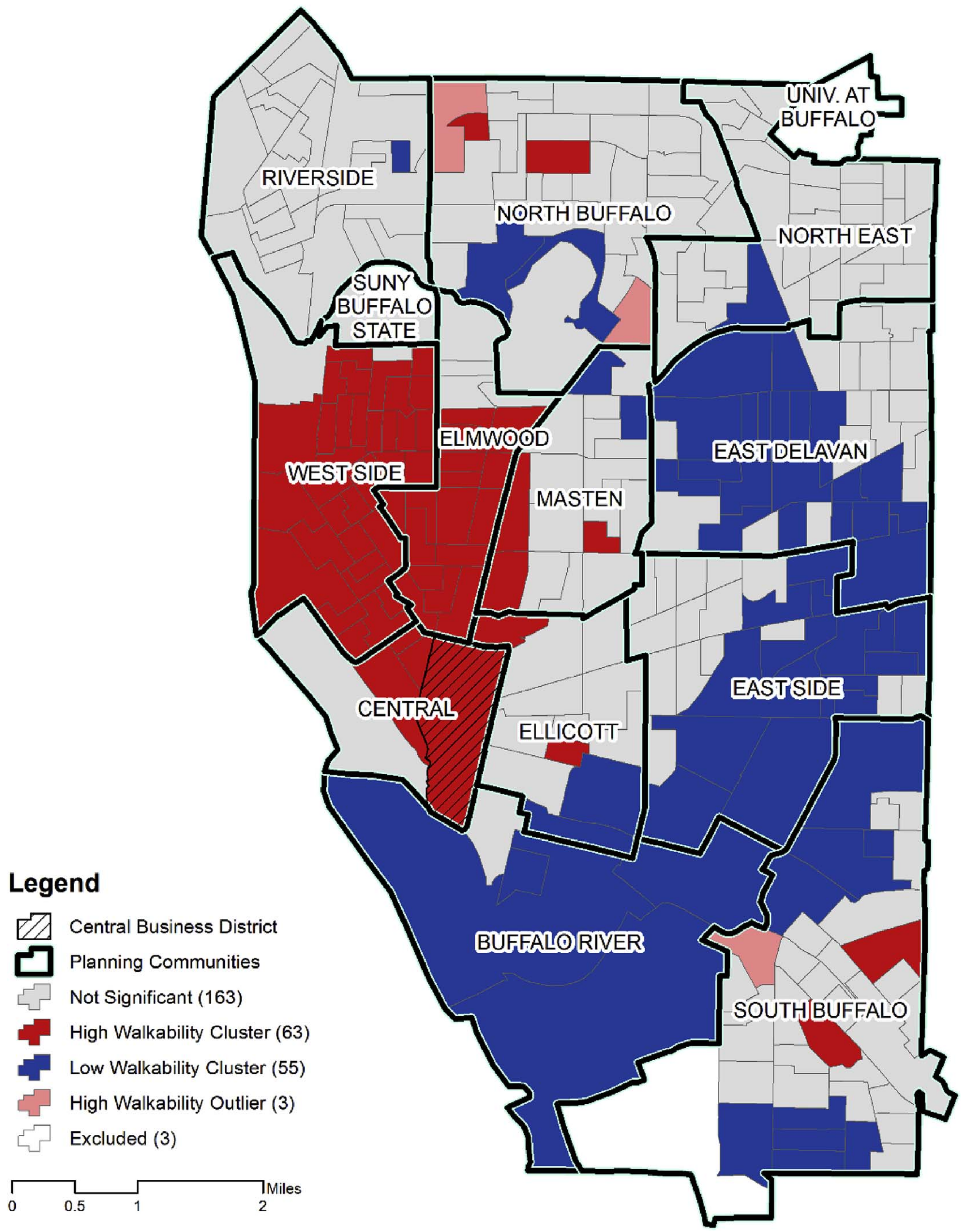

Fig. 3. Walkability clusters and spatial outliers in Buffalo, NY.

5.2. Walkable access to amenities and vehicle access

Fig. 4 shows the results of the bivariate cluster analysis, and Table 2 provides descriptive statistics for neighborhoods grouped by bivariate cluster type. With respect to research question #3, we find that 17 census block groups are parts of *clusters of limited mobility*. These block groups are located mostly in the chronically distressed East Delavan and East Side communities (e.g., Weaver & Knight, 2017), with a handful situated on either side of the East Side community's southern boundary (Fig. 4).[3] In the main, they are characterized by low vehicle ownership (LQ = 1.42), and are embedded in spatial contexts that offer low walkability. Supporting results discussed in the previous subsection, these clusters are disproportionately Black. Indeed, nearly two-thirds of the population in clusters of limited mobility are non-Hispanic Black residents (LQ = 1.68), compared to a little over one-third in the overall population. Further, and perhaps related to mobility constraints, these clusters are much more likely to contain unemployed residents than anywhere else in the City. Specifically, relative to the Citywide unemployment rate of 9.81 percent, 16.26 percent of residents in clusters of limited mobility are unemployed (LQ = 1.66). Vacancy (LQ = 1.46) and poverty (LQ = 1.28) are also highly concentrated in these block groups, while non-Hispanic White persons are considerably under-represented (LQ = 0.57). Supporting the notion that walkability comes at a premium in the residential housing market (Pivo & Fisher, 2011),

[3] It is important to note that the nine block groups in "High Vehicle Access – Low Walkability" clusters are also located in these areas—suggesting that the planning communities east of Main Street (refer to Fig. 2) all tend to have low walkability.

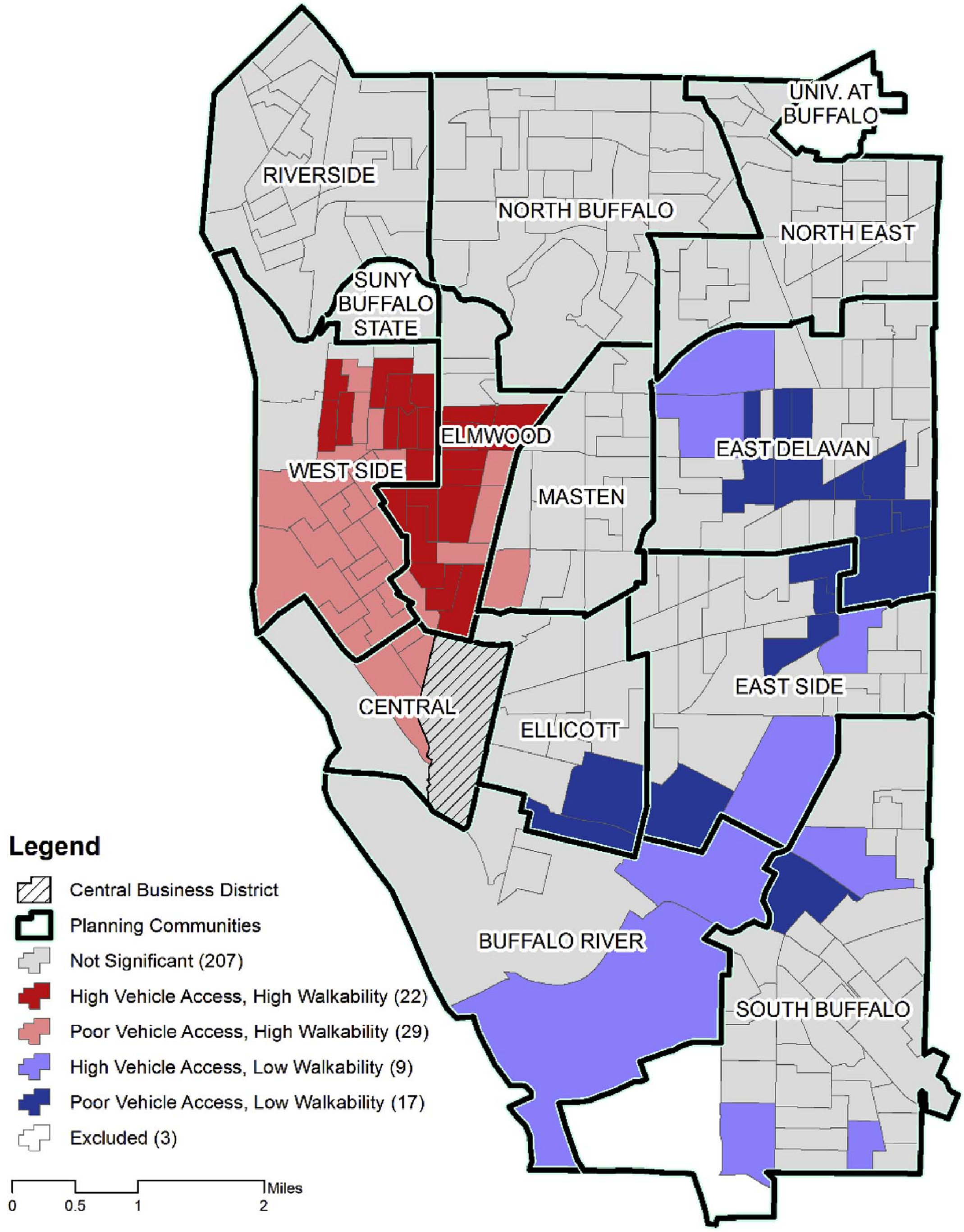

Fig. 4. Bivariate local Moran's *I* cluster results (no car ownership and walkability).

the average single-family home in clusters of limited mobility is assessed at only $31,383—more than $40,000 below the Citywide average.

On the opposite, western side of the City exists a much different story. Namely, most of the established, relatively affluent Elmwood community (refer to earlier discussion) and adjacent areas in the West Side are included in clusters where vehicle ownership and local walkability are both higher than what is expected by chance. These spaces—which might be thought of as clusters of high mobility—are disproportionately white (LQ = 1.56), with some of the lowest poverty (21.22%, LQ = 0.68) and unemployment (5.40%, LQ = 0.55) rates in the City. Consistent with findings that walkability drives up the prices and values of residential homes (Gilderbloom et al., 2015), the average single-family residential property in clusters of high mobility is valued at $161,211—more than double the Citywide average. That is, the average single-family home in clusters of high mobility is assessed at over five times the value of the average single-family home in clusters of limited mobility.

The remaining "high walkability" areas detected in the bivariate Moran's *I* test are block groups that have lower than expected [by chance] access to automobiles. As Fig. 4 illustrates, all such block groups are found in and around Elmwood, the West Side, and the Central (downtown) communities in the City (NB: the lone block group from this category in Masten is both adjacent to Elmwood, and contains the Buffalo Niagara Medical Campus mentioned earlier). Recall from above that the West Side (1) has a history of being one of Buffalo's most diverse (and economically distressed) areas (Fig. 2); but (2) due in part to its proximity to Elmwood, is experiencing recent trends toward

Table 1
Descriptive statistics for WalkScore® clusters types.

Cluster type	High Walkability Cluster		Low Walkability Cluster		High Walkability Outlier		All Others (Not Sig.)		Total
	%	LQ	%	LQ	%	LQ	%	LQ	%
Asian	7.85	1.67	1.97	0.42	0.92	0.20	4.34	0.92	4.70
Black	20.60	0.56	43.06	1.18	12.42	0.34	41.52	1.13	36.60
Hispanic	18.68	1.73	6.83	0.63	9.06	0.84	8.92	0.82	10.83
White	48.64	1.09	45.33	1.01	73.10	1.63	42.43	0.95	44.72
Below poverty level[a]	33.09	1.06	31.92	1.02	26.01	0.83	30.35	0.97	31.22
Housing units vacant	15.86	0.97	19.20	1.18	18.82	1.16	15.48	0.95	16.27
Housing units owner-occupied	30.13	0.73	49.84	1.20	50.15	1.21	43.69	1.06	41.39
No vehicle available[b]	30.11	1.05	29.47	1.03	7.47	0.26	28.24	0.98	28.73
Unemployed[c]	6.93	0.71	12.98	1.32	8.99	0.92	10.08	1.03	9.81
Mean assessed value[d]	100,499		54,721		76,295		73,304		72,595
% Change in mean assessed value[e]	+1.59		+1.37		−0.28		−0.66		+0.18
Population (% of total)	23.35		17.87		1.06		57.71		255,807
No. of block groups	63		55		3		163		284

[a] For individuals for whom poverty status is determined.
[b] For occupied housing units.
[c] For civilian labor force 16 years and over.
[d] For single-family residential properties, 2016
[e] For single-family residential properties, 2010–2016.

gentrification. On that backdrop, observe that clusters featuring poor vehicle access and high walkability have relative concentrations of Asian (LQ = 2.06) and Hispanic (LQ = 2.81) residents, and high poverty rates (45.23%, LQ = 1.45). That these spaces are defined by high WalkScores® supports recent research which suggests that shrinking cities might be capable of providing walkability to historically disadvantaged groups (e.g., Bereitschaft, 2017). The importance of this point comes into focus when we recall that walkability is linked to various social, health, and economic benefits (Jun & Hur, 2015; Doyle, Kelly-Schwartz, Schlossberg, & Stockard, 2006). Although not causal evidence that increased walkability will necessarily provide benefits to historically disadvantaged groups, such an outcome is hinted at in the finding that unemployed individuals are underrepresented in the "poor vehicle access, high walkability" cluster (8.57% unemployment rate, LQ = 0.87), but certain persons of color (namely, Hispanic individuals) are overrepresented.

If the upside of the "poor vehicle access, high walkability" cluster findings is that Buffalo—like another shrinking city in the Rust Belt, Pittsburgh, PA (Bereitschaft, 2017)—might provide high walkability to disadvantaged groups, then the downside is that high walkability is fetching ever higher prices in urban residential housing markets, even in shrinking cities (DiNatale, 2014; Epstein, 2015). For Buffalo, the walkable but still economically disadvantaged areas of the West Side and Central communities are precisely where single-family residential home values are increasing the fastest (+4.46% since 2010, compared to +0.18% Citywide; Table 2). If such trends continue, then it is possible that these spaces will become unaffordable for the less affluent (poverty LQ = 1.45) and more diverse (Hispanic persons LQ = 2.81, Asian persons LQ = 2.06, White persons LQ = 0.74) constituencies that presently occupy them. In other words, much of the "resurgence" of Buffalo's neighborhoods and the reinvestment that development actors are making into walkable neighborhoods (DiNatale, 2014; Epstein, 2014, 2015) seems to be privileging *already walkable* areas. At the same time, many locations in the City—especially the East Side and East Delavan areas, where the population is disproportionately Black—-remain comparatively unwalkable at best (Fig. 3), and clusters of highly

Table 2
Descriptive statistics for vehicle access-WalkScore® clusters types.

Cluster type	High Vehicle Access, High Walkability		Poor Vehicle Access, High Walkability		High Vehicle Access, Low Walkability		Poor Vehicle Access, Low Walkability[a]		Total[g]tbl2fnf
	%	LQ	%	LQ	%	LQ	%	LQ	%
Asian	5.80	1.23	9.71	2.06	0.21	0.05	4.14	0.88	4.70
Black	12.02	0.33	22.05	0.60	29.41	0.80	61.65	1.68	36.60
Hispanic	8.62	0.80	30.46	2.81	9.49	0.88	6.93	0.64	10.83
White	69.57	1.56	33.04	0.74	57.59	1.29	25.49	0.57	44.72
Below poverty level[b]	21.22	0.68	45.23	1.45	23.16	0.74	40.02	1.28	31.22
Housing units vacant	17.47	1.07	15.16	0.93	17.01	1.05	23.70	1.46	16.27
Housing units owner-occupied	35.77	0.86	24.64	0.60	55.63	1.34	39.75	0.96	41.39
No vehicle available[c]	16.63	0.58	42.83	1.49	17.74	0.62	40.71	1.42	28.73
Unemployed[d]tbl2fnc	5.40	0.55	8.57	0.87	11.67	1.19	16.26	1.66	9.81
Mean assessed value[e]	161,211		60,542		46,176		31,583		72,595
% Change in mean assessed value[f]	+0.65		+4.46		+0.59		+2.12		+0.18
Population (% of total)	7.69		10.07		3.29		5.12		255,807
No. of block groups	22		29		9		17		284

[a] Clusters of limited mobility.
[b] For individuals for whom poverty status is determined.
[c] For occupied housing units.
[d] For civilian labor force 16 years and over.
[e] For single-family residential properties, 2016
[f] For single-family residential properties, 2010–2016.
[g] Note: Total includes the "Not Significant" category from Fig. 4, which is omitted here for efficiency.

constrained or limited mobility at worst (Fig. 4). Thus, the notion that Buffalo *as a City* is resurgent and walkable is an exaggeration: certain groups and spaces, especially Black residents and the neighborhoods they occupy, remain outside the bounds of these phenomena; and other spaces and groups—namely the West Side and its lower income residents of color—are at risk of being swept away as waves of reinvestment bring with them rising housing values (costs) and the potential for displacement.

6. Conclusions

National and local planners and policymakers are increasingly calling for walkable neighborhoods to supplant unsustainable patterns of sprawl and related land uses that prioritize automobile travel over all other forms of mobility (Southworth, 2005). As such, it is reasonable to claim that a public-sector demand for walkability exists among urban practitioners and decision-makers. As it turns out, there is also a strong private sector demand for walkability, as homes in walkable neighborhoods consistently receive high premiums in urban housing markets (Gilderbloom et al., 2015). The coupling of these two forces has the potential to create a feedback loop, wherein [public and private] investments into walkable spaces strengthen demand for housing in those locations, thereby driving up both the costs of entry and the costs of living in walkable urban environments. The outcome of such a process is an uneven geographic distribution of walkability that tends to be biased against lower income residents and residents of color (e.g., Bereitschaft, 2017; Riggs, 2014).

That being said, like other "shrinking cities" in the U.S. Rust Belt, Buffalo, NY developed in the early 1800s as a walking city before the automobile began to reshape its development patterns. Consequently, the City is likely to feature a relatively walkable physical fabric. In that regard, Buffalo and other shrinking cities, where widespread population loss and socioeconomic decline have depressed home values (Weaver et al., 2016), have the potential to provide walkability to broader segments of their populations (e.g., Bereitschaft, 2017)—so that walkability is more than a commodity available to the affluent (e.g., Riggs, 2014).

Situated on the City of Buffalo's highly-publicized "resurgence", which is documented through rising property values, the return of businesses and amenities attracting young people, and general media boosterism (e.g., DiNatale, 2014; Epstein, 2015; Kaminer, 2016; Sommer, 2016), this study examined the uneven geographies of walkability in Buffalo and their relationships to selected aspects of with City's demographic and socioeconomic landscapes. We found that areas with low access to walkable amenities and low vehicle ownership rates are disproportionately Black and impoverished, with very low housing values and high vacancy rates; and that the neighborhoods which are currently providing low-income and non-White residents with access to walkable amenities are experiencing rapidly rising housing values.

Our finding that block groups with low vehicle ownership, high walkability, and high concentrations poverty and non-White individuals are experiencing the greatest increases in housing prices is troubling. On the face, the existence of "poor vehicle access, high walkability" clusters seems to speak to the idea that shrinking cities can in fact provide walkable neighborhoods to broad segments of the population (e.g., Bereitschaft, 2017). Below the surface, however, rapidly appreciating home values suggests that these circumstances might be temporary. Namely, the walkability benefits currently available to low income and non-White residents in these clusters are unlikely to go away—but they *are* likely to become more expensive, as homes are reassessed at higher values and ultimately bought and sold for higher prices in the real estate market. Over time, such cost of living increases may be enough to price lower income residents out of these walkable neighborhoods. Future research is needed to document in- and out-migration patterns for these block groups over time, and to better understand resident perceptions and responses to the reinvestments that are happening in their communities.

Likewise, our finding that neighborhoods with the poorest access to both walkable amenities and automobiles are disproportionately Black and impoverished—and have the highest housing vacancy rates and lowest housing values in the city—is a cause for concern and for alarm. These areas are in dire need of reinvestment; but, at present, much of the "resurgence" and reinvestment happening in Buffalo is concentrated in the walkable Central and West Side communities (DiNatale, 2014; Epstein, 2015). Thus, the challenge at present is one of unwalkable (but affordable) neighborhoods in the eastern part of the City, and walkable (but likely to be unaffordable) neighborhoods in the western part of the City. Future research and policy experimentation is needed to better understand the ways that Buffalo and other [shrinking] cities can keep their existing walkable residential environments from becoming affluent enclaves, while redirecting (re)investments to new walkability opportunities in spaces where present mobility is severely constrained (i.e., by lack of walkability *and* poor access to vehicles). In other words, our results suggest that efforts to enhance walkability in any part of the City (or elsewhere) must be more explicitly tied to social and economic justice objectives. Simply allowing the market to lead reinvestment efforts is likely to result in a pattern of high quality, walkable neighborhoods where residents have multiple transportation options and walking is a luxury; and low quality, distressed neighborhoods where walking is a primary mode of transportation, but walkable destinations do not meet residents' daily needs.

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