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Equity in Microscale Urban Design and Walkability: A Photographic Survey of Six Pittsburgh Streetscapes

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Abstract: This paper explores inequity in neighborhood walkability at the micro-scale level by qualitatively examining six streetscapes in Pittsburgh, Pennsylvania. A photographic survey is used to highlight differences in the quality and design of the built environment among pairs of streetscapes with high or low social vulnerability but approximately equal quantitative Walk Scores®. The survey revealed discernable differences in the quality and maintenance of the built environment among those in more and less disadvantaged neighborhoods. This was true of several characteristics expected to affect walkability, including enclosure, transparency, complexity, and tidiness. Streetscapes in neighborhoods with high social vulnerability exhibited less contiguous street walls, fewer windows and less transparent storefronts, less well maintained infrastructure, fewer street cafés, and overall less complexity than those in neighborhoods with low social vulnerability. Implications for planning and policy are discussed.

Keywords: walkability; walk score; equity; streetscapes; social vulnerability; environmental justice

1. Introduction

Drawing upon a walking survey of six neighborhoods in Pittsburgh, PA, this paper explores inequities that may exist in the walkability of urban environments among neighborhoods with high and low social vulnerability (SV). Of particular concern is whether disadvantaged groups, who could potentially benefit the most from compact, mixed-used urban typologies, have equal access to walkable streetscapes. Only recently has the environmental justice literature begun to address this issue. There is growing concern over the effects of inner-city gentrification and neoliberal urban revitalization policies, which, among other effects, may contribute to spatial inequities in walkability [1–3].

Equitable access to walkable urban environments may be viewed as a key element of urban sustainability, and a necessary component of fair, healthy, and livable urban communities [4–6]. There are numerous benefits to walkability. The placement of destinations and amenities in closer proximity to residences contributes to healthier, more active lifestyles [7–9] by encouraging the purposive or "active walk" [10]; i.e., walking as a means of transportation to work and other daily destinations. The quality, design, and spatial layout of the built environment plays a key role in shaping mobility patterns, including the ability and propensity of urban residents to walk or cycle rather than drive [11,12]. From a health perspective, participation in active walking is beneficial on multiple levels. Not only does walkability encourage physical activity linked to lower body mass indexes (BMI) [13], reduced cardiometabolic disease [14], and improved mental health [15]; it also reduces the emission of potentially deleterious air pollutants [13]. This includes reductions in carbon dioxide and other greenhouse gases that contribute to climate change [16,17]. Walkability is also expected to enhance social capital [18,19], improve public safety [20], and contribute economic value [21,22].

Over half a century ago, Jane Jacobs [23] attributed much of the vitality of her neighborhood of Greenwich Village in New York City to its walkability; particularly the density, short blocks,

and mutually-supportive mix of land uses that made pedestrianism attractive. She argued that a fine-grained mix of land uses was necessary to spread pedestrian activity throughout the course of the day, thereby increasing perceptions of vitality and safety. As in a positive feedback loop, this energetic milieu would then attract even more pedestrians and a greater diversity of social and economic activity. Today, however, many walkable urban neighborhoods—including Jacob's Greenwich Village—have become "victims of their own success", with gentrification and the displacement of lower income groups ultimately reducing diversity [24,25].

The process of gentrification and the associated displacement of disadvantaged groups contributes to a landscape of socio-spatial inequity, where those who could potentially benefit the most from highly walkable urban environments are systematically excluded. Disadvantaged groups are likely to include the elderly, the impoverished, minorities, and those with low education and/or low-skill occupations that have limited financial resources and are often mobility-restricted [26–28]. The inability to afford and/or operate personal automobiles may prove especially challenging for disadvantaged groups living in low walkability environments and those with poor transit accessibility [28,29].

Given the significant influence walkability can have human health, social equity, and urban sustainability more broadly, a considerable body of research has been devoted to defining and measuring this important concept. Most studies examining walkability to date have been quantitative, utilizing empirical measures of urban form at the macro-scale, such as population or housing density, land use mix, street network connectivity, and transit accessibility (e.g., [30–32]). However, with growing recognition that finer scale attributes of the urban environment, particularly at the streetscape level, may significantly affect walkability, sets of indicators have been developed to better capture and compare these complex elements of urban design and quality. Porta and Renne [33], for example, identified eight street-scale indicators: façade continuity, softness (transparency and transitional space), social width (i.e., the degree to which physical elements of the street inhibit human interaction), visual complexity, sedibility (i.e., number of seating options for pedestrians), number of buildings, and detractors (i.e., those elements that have a negative impact on the streetscape environment). More recently, Ewing and Handy [34] operationalized five succinct elements of urban design and quality expected to enhance the walkability of the streetscape: imageability, enclosure, human scale, transparency, and complexity (examined below in greater detail).

To address potential inequities in walkability, a limited number of studies have recently applied quantitative approaches to evaluating differences in urban form, design, and quality among urban neighborhoods with varying socio-demographic profiles. Much of this work has been conducted within the health and medical fields. Using Leslie et al.'s [30] walkability index based on dwelling density, connectivity, land use attributes, and net retail area, Cutts et al. [35] observed significant positive associations between percent African American and Latino residents and walkability in Phoenix, AZ, but a negative relationship between walkability and population under 18 years old. Duncan et al. [36] found no significant correlation between walkability, as assessed using the web-based algorithm Walk Score® (based on proximity to amenities, population density, and street network connectivity), and neighborhood-level socio-demographics (i.e., minority composition, poverty rate) in Boston, MA. Highlighting the potential for inter-urban variation in equity in neighborhood walkability, Koshinksy and Talen [37] found that accessibility was frequently compromised for tenants of publically-assisted affordable housing developments in the U.S., while Riggs [3] observed that black residents were more likely to live in less walkable neighborhoods in the San Francisco Bay area. Both studies assessed walkability using Walk Score®.

Even among neighborhoods with similar walkability according to macro-scale indices (e.g., Walk Score®), there may exist significant disparities due to differences in the quality of the streetscape environment. Taking a more micro-scale approach to assessing equity in walkability, Neckerman et al. [38] used walking audits to compare the commercial streetscapes of 76 "poor" and "non-poor" census tracts in New York City. They assessed walkability using five primary measures: aesthetics, safety, infrastructure for active transportation, and sidewalk amenities. Controlling for

differences in macro-scale urban form, the authors found that the "non-poor" census tracts had significantly more street trees, landmarked buildings, and sidewalk cafés, and exhibited cleaner streets and lower rates of crime and vehicular crashes than their "poor" counterparts. Although the authors assessed statistically specific experiential and sensory details such as "percent [census tracts] with excessive noise" and "percent in which police were observed", there is a need to provide a more detailed and descriptive record of the potential differences among neighborhoods in regards to walkability.

To complement and extend existing quantitative analyses, this paper utilizes a primarily qualitative, participant observation approach, applying Ewing and Handy's [34] conceptual framework for assessing elements of the meso- and micro-scale (i.e., "streetscape level") built environment expected to impact walking behavior. Rather than attempt to quantify each potential design element, a process that is limited in capturing the more nuanced, dynamic, and synergistic experience of place, a photographic survey was undertaken similar to Costa and Lopes' [39] analysis of design features and creative dynamics in Lisbon, Barcelona, and São Paulo. Characteristics of both the physical environment and the behavior of pedestrians were closely observed and recorded such that a detailed comparison could be made between sites. The goal of this endeavor was to provide a detailed observational account of differences in the quality of the walking experience and actual walking behavior between more and less disadvantaged neighborhoods, and to document and communicate these differences in an easily accessible, visual way.

2. Methods

2.1. Study Area

Three pairs of neighborhoods within the city of Pittsburgh, PA were selected for inclusion in the study (Table 1; Figures 1 and 2). Each neighborhood exhibited quantitative Walk Scores® of 70 or higher (indicating "very walkable" or better conditions); each pair of neighborhoods exhibited similar walk scores (within +/− 2) and included one neighborhood with "high" and one with "low" SV. Social vulnerability was calculated at the block group level by normalizing and summing five socio-economic and demographic variables from the United States Census Bureau: proportion of households below the poverty level, percentage of population 65 years or older, percentage non-white population, percentage with no college attainment, and percentage of workers employed in service occupations as of 2015. For a more comprehensive overview of this methodology see Bereitschaft [40]. Block groups with "high" SV were those in the top quartile, while those classified as having "low" SV were in the bottom quartile within the Pittsburgh urbanized area. Neighborhoods were defined by first selecting a commercial corridor, then including all immediately adjacent block groups. The number of block groups per neighborhood ranged from one to three.

Table 1. Descriptive statistics for three pairs of neighborhoods in Pittsburgh with similar Walk Scores and contrasting (low/high) levels of social vulnerability.

	Neighborhood					
	Squirrel Hill	**Homestead**	**Lawrenceville**	**Wilkinsburg**	**Dormont**	**Hill District**
Walk Score®	92	90	85	83	75	77
Social Vuln.	Low	High	Low	High	Low	High
# Block Groups	3	1	2	2	3	3
Main Corridor	Forbes Ave.	E 8th Ave.	Butler St.	Penn Ave.	W. Liberty Ave.	Centre Ave.
Population	3673	1212	2317	886	3429	2907
% 65+	18.8	23.5	15.0	23.1	11.2	30.3
% Poverty	9.4	40.5	17.5	31.0	9.0	40.4
% Minority	7.4	76.6	17.9	92.1	3.2	89.4
% No College	10.6	48.3	36.9	56.4	32.5	63.5
% Service Occ.	6.0	36.4	18.0	42.2	20.0	37.2
Pedestrians/minute	5.75	1.75	5.11	1.85	2.5	3.65

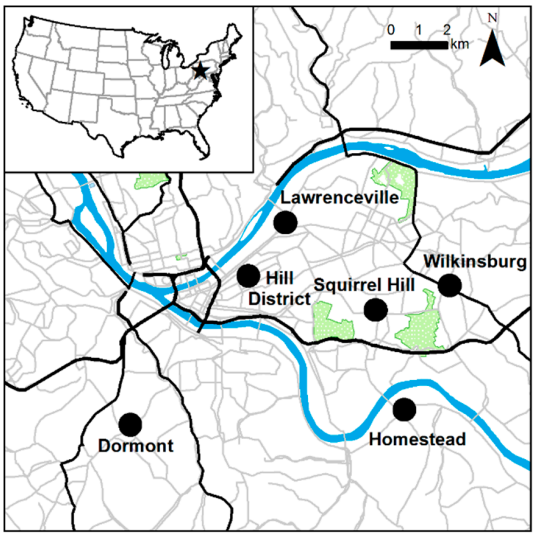

Figure 1. The study area consisted of six neighborhoods in central Pittsburgh, PA.

Figure 2. Walking route for each of the six Pittsburgh streetscapes. Soft gaps indicate parcels without buildings, but are used for other purposes; hard gaps are empty and unused lots.

2.2. Assessing Walkability

Each of the three pairs of neighborhoods exhibited similarly high Walk Scores®; the purpose of this analysis was to compare the more nuanced meso- and micro-scale attributes of the physical environment not captured by this more macro-scale, quantitative metric. Ewing et al. [41] identified several elements of the built environment expected to affect the walkability of a streetscape at these finer scales. Using a panel of ten urban design and planning experts, Ewing and Handy [34] were able to operationalize five such elements identified as "urban design qualities": imageability, enclosure, human scale, transparency, and complexity. In addition to these five design qualities, this study utilizes as a framework for analysis two additional elements: "tidiness" and "safety and sensations".

Ewing and Handy [34] quote Kevin Lynch's [42] (p. 9) definition of imageability: "It is that shape, color or arrangement of vividly identified, powerfully structured, highly useful mental images of the environment." Imageability is that which sets an urban district apart; a unique identity or "sense of place". Enclosure refers to the presence of fixed borders or a definite shape. If properly enclosed, outdoor spaces can take on the basic morphology of indoor spaces with vertical elements such as buildings and trees representing the walls, sidewalks and roadway forming the floor, and the sky the ceiling [34,43]. Human scale is related both to human size and speed of locomotion; to be human scale is to be designed and built specifically for human perception and interaction. This includes buildings generally between one and six floors [44] with limited setbacks, small signage, transparent storefronts, and the presence of street furniture, street vendors and wares, and other miscellaneous items. Transparency concerns the degree of connection between interior and exterior environments. This connection is primarily visual and most often facilitated by storefront windows, allowing those on the sidewalk to see in, while patrons inside can see out. One of Jacob's [23] most renowned assertions regarding urban design is that transparency of the first floor street wall is critical to maintaining a safe public environment. Complexity of the streetscape relates to the number of different types of elements and stimuli to which the observer is exposed [34,45]. This may include pedestrians, street signs and symbols, variations in building designs and architecture, outdoor dining, artwork, street performers, and the variety of activities occurring in adjacent buildings and spaces. Tidiness encapsulates how well the physical elements of the streetscape are cared for and maintained. Litter, graffiti, weeds and overgrown vegetation, vacant lots, and poorly maintained buildings and sidewalks can all contribute to feelings of neglect, uncertainty, and a reduced sense of security [46–48].

Finally, safety was added to account for differences in safety infrastructure such as crosswalks and signals, but also perceptions of safety related primarily to traffic density and speed. Automobiles can present significant hazards to pedestrians and are, for many, a substantial physical and psychological barrier to active transportation [49,50]. Much of the aforementioned elements are primarily assessed visually, so it was prudent to consider additional senses such as auditory and olfactory. While noxious smells and irritating noises can certainly undermine walkability, pleasant smells and sounds, such as bread baking or children playing, can enhance the walking experience.

2.3. Walking Survey

A walking survey of each neighborhood's commercial corridor was conducted by the author in May 2016. Within each neighborhood the survey was limited to one or two "main streets"; the primary hubs of social and economic activity for that community. In general, surveys were conducted by walking a distance of approximately 350 m along one side of the street, then crossing the street at a cross walk and completing the route again in the opposite direction. For each location this was done at least twice; once around mid-day and again in the late afternoon or early evening. All walking surveys were conducted within one week of each other and on a week day. Surveys typically took 40 min to one hour to complete. In addition to photographs, HD video was used to record the walking experience for further analysis. In part, this involved counting the number of pedestrians on the same side of the street and calculating the number of pedestrians observed per minute. To ensure accuracy of the pedestrian counts and account for differences in activity throughout the day, values represent

the average of mid-day and late afternoon/evening outings and were cross-checked by at least two individuals. Pedestrians were counted only when the author was in motion; the clock was paused when photographs were taken or the author was otherwise standing still. Over 3000 digital photos and nine hours of HD video were collected.

2.4. Data Interpretation

To help organize and communicate the dearth of information gathered from the walking surveys, it was useful to address particular attributes of the streetscape design and experience, and to assess broadly the quality of each sub-element by rating their condition "Good", "Moderate", or "Poor" (Table 2). These ratings reflect the author's experience and interpretation of these elements, and are meant only to highlight broad patterns in differences within and among neighborhood pairs, rather than assign any kind of absolute, quantitative value. Much of the analysis rested on the photographs and HD video collected, which allowed for a nuanced discussion of each walkability element and their variability among the six sites.

Table 2. The relative condition (good, moderate, poor) of specific attributes of the built environment across six streetscapes in Pittsburgh, PA. Major categories based on Ewing and Handy (2009).

3. Results

3.1. Urban Design

Figures 3–9 showcase select photographs representing particular walkability elements and features of the main commercial streetscape within the six neighborhoods. The observations made during the walking surveys are organized below primarily by design element, allowing a quick visual comparison to be made between specific walkability elements across multiple neighborhoods. For each element, comparisons are frequently made within, as well as between, pairs of high/low SV neighborhoods.

3.1.1. Imageability

Differences in imageability between neighborhoods with high and low SV were minor overall (Table 2). Each streetscape contained historic (i.e., pre-WWII) buildings and unique landmarks, but few or no courtyards, parks, or plazas. The most common landmarks were churches or other cultural facilities, such the North Way Christian Community Church in Dormont (Figure 3B) or the Hill House Auditorium in the Hill District (Figure 3B). Among the few pocket spaces available to pedestrians was a small plaza with limited seating in Homestead (Figure 3C) and a poorly maintained sculpture/garden space with no formal seating area in the Hill District (Figure 3D). It should be noted, however, that the low SV neighborhoods tended to have more outdoor seating overall, mainly in the form of sidewalk benches and outdoor cafes. The low SV neighborhoods Squirrel Hill and Dormont both boasted conspicuous place identifiers in the form of lamp post banners (Figure 3E,F). In addition to the "Discover Dormont" slogan, the neighborhood also showcased portraits of military veterans and service members on a separate series of banners (Figure 3G). The banners represent one of the most visible symbols of community pride and solidarity observed along the walking routes. Business signs like "Dormont Florist" and bicycle racks in the shape of a squirrel also helped reinforce the unique sense of place of these neighborhoods. While Lawrenceville (low SV) and Wilkinsburg (high SV) exhibited relatively few place identifiers, their own collection of unique historic buildings and public art helped create a well-defined sense of place. A good example is the conspicuous Karma Lounge sign in Homestead (Figure 3H).

3.1.2. Enclosure

There were clear differences in the degree of enclosure between the low and high SV neighborhood streetscapes (Table 2). As shown in Figure 2, one of the most obvious and striking differences between the two sets of neighborhoods was the continuity of the street wall. The three high SV streetscapes contained significantly more gaps between buildings, particularly in the form of "hard gaps", which are defined here as entirely unused spaces; mainly vacant lots. These spaces are differentiated from "soft gaps", which are occupied open spaces between buildings, utilized primarily as parking lots. No hard gaps were observed while walking the low SV streetscapes; however soft gaps were observed at all six locations. More striking was the abundance of poorly maintained and often unutilized hard gaps strewn among the high SV streetscapes (Figure 4A,B), leading to a sense of discontinuity and vulnerability. The sense of enclosure was further undermined by the presence of several suburban-like building setbacks (i.e., with parking lots rather than the building facing the street), particularly in the Hill District (Figure 4C) and Wilkinsburg. Street wall continuity across the three low SV streetscapes was markedly higher by comparison, with few significant gaps or building setbacks.

Figure 3. Photo collage illustrating "imageability" in Dormont (**A**,**F**,**G**), Hill District (**B**,**D**), Homestead (**C**,**H**), and Squirrel Hill (**E**), PA.

Other elements of enclosure, such as the presence of overhangs and vegetation, sight lines, and road width to building height were not as dramatically different between low and high SV streetscapes. Overall, low SV streetscapes did tend to have larger, more numerous, and better maintained vegetation, though no location featured trees along the entire route. Low SV streetscapes also tended to have more storefront overhangs, which added to the perception of the sidewalk as an "outdoor room" [51,52]. They were employed effectively in Squirrel Hill and Lawrenceville as shelter for outdoor seating areas (Figure 4D–F). Sight lines tended to vary along each of the walking routes, but in general were not overly extensive. Squirrel Hill and Wilkinsburg contained the straightest street corridors, and while sight lines were often disrupted by trees and other sidewalk and building ornamentation in Squirrel Hill, this was less the case in Wilkinsburg (Figure 4G vs. Figure 4H). Finally, although the ratio of road width to building height was variable among (as well as within) locations, there was no discernable difference among those with high and low SV. However, the Hill District, with frequent gaps in the street wall and several ample building setbacks, and along W Liberty Ave. in Dormont where a busy four lane arterial road is flanked with several one and two story buildings, the overall sense of enclosure and security was less than optimal.

Figure 4. Photo collage illustrating "enclosure" in Wilkinsburg (**A**,**H**), Hill District (**B**,**C**), Squirrel Hill (**D**,**G**), and Lawrenceville (**E**,**F**), PA.

3.1.3. Human Scale

All six streetscapes could be described as "human scale", with fine-grained elements designed primarily with human size and speed of locomotion in mind; buildings between one and four stories tall with mostly shallow setbacks, relatively small signs and symbols, and a variety of sidewalk ornamentation. There were, however, some distinguishable differences between low and high SV streetscapes not yet addressed by Imageability or Enclosure (yet may overlap with other elements not yet discussed). The three high SV streetscapes, for example, contained noticeably less street furniture than their low SV counterparts. Street cafés and sidewalk benches were a common sight in Squirrel Hill (Figure 5A), while in Homestead street cafés with tables and chairs were conspicuously absent and sidewalk benches were few and far between (Figure 5B). This pattern held for Lawrenceville vs. Wilkinsburg, and Dormont vs. the Hill District as well. The low SV streetscapes exhibited more pedestrian-oriented ornamentation and infrastructure in general, including signs (Figure 5C,D), bike racks (especially utilized bike racks) (Figure 5E), bus stop enclosures (Figure 5F), and planters (Figure 5D,G). In a few cases, retail shops showcased items for sale outside the store on the adjacent sidewalk adding to the sense of enclosure, complexity, and human-scale of the streetscape. This was

observed in Squirrel Hill (Figure 5H), Homestead (Figure 5I), and Dormont (Figure 5J). Wilkinsburg and the Hill District (the two neighborhoods with lowest walk score and highest SV of the six), by contrast, exhibited few such porous elements bridging the interior and exterior environment.

Figure 5. Photo collage illustrating "human scale" in Squirrel Hill (**A**,**E**,**F**,**H**), Homestead (**B**,**I**), Lawrenceville (**C**,**D**), and Dormont (**G**,**J**), PA.

3.1.4. Transparency

As with enclosure, there were distinct differences in the overall transparency of low and high SV streetscapes among each of the three pairs of neighborhoods. Firstly, transparency is necessarily dependent on the continuity of the street wall; without a continuous street wall there can be no "human activity beyond the street" [34,53]. Thus, due in part to the presence of such gaps in Wilkinsburg and the Hill District, the two streetscapes were rated as having relatively low transparency. The transparency of the high SV streetscapes was also undermined by fewer windows at street level (Figure 6A,B), more closed or vacant storefronts (Figure 6C,D), and, as mentioned above, fewer externalized retail activities. Store fronts in Squirrel Hill, Lawrenceville, and parts of Dormont were dominated by glass; facilitating a perception of space that extended well beyond the sidewalk and into the stores themselves (Figure 6E–G).

In addition to more continuous street walls and larger and more numerous windows, the three low SV streetscapes more effectively blended the indoor and outdoor environments with street cafés and open-air restaurants (Figure 6H,I). Such features greatly enhanced the sense of permeability, adding to the vitality and perception of security within these streetscapes.

Figure 6. Photo collage illustrating "transparency" in Wilkinsburg (**A**), Hill District (**B**), Homestead (**C**,**D**), Squirrel Hill (**E**,**I**), Lawrenceville (**F**,**H**), and Dormont (**G**), PA.

3.1.5. Complexity

All six streetscapes exhibited elements of complexity, such as a mix of building styles, designs, and signage. However, low SV streetscapes, with a more contiguous street wall and transparent storefronts, tended to showcase more overall variety and creativity in building facades, particularly at street level. This included contrasting architecture styles and eras (as in Squirrel Hill; Figure 7A), using non-linear storefront geometry (Figure 7B), incorporating varied textures and patterns (Figure 7C,D), and utilizing a variety of lighting types (Figure 7E). A greater number of businesses overall, more variety in store types, and heightened pedestrian activity (including those seated at outdoor cafés) was also observed among the low SV streetscapes. The high SV streetscapes, however, exhibited other facets of complexity such as public art displays (Figure 7F–H) and unique signs and symbols (Figure 7I,J) endemic to those locations and reflective of local history and culture. Public art of a playful or quirky nature was also observed in Lawrenceville (Figure 7K,L), contributing to the neighborhood's "edgy" personality.

Street performers were a rare sight across the six streetscapes; only one was documented in Squirrel Hill (Figure 7M). While subjective, the overall synergistic experience of complexity (that of total environmental stimulation) was highest in the two most walkable low SV streetscapes: Squirrel Hill and Lawrenceville. Here the density of pedestrian activity and variety of street level ornamentation created a pleasantly vibrant, yet not overly-stimulating, urban scene. Among high SV streetscapes, only the Hill District exhibited comparable pedestrian density; however, neither the type of pedestrian activities nor the elements of the sidewalk environment were as varied.

Figure 7. Photo collage illustrating "complexity" in Squirrel Hill (**A**–**C**,**E**,**M**), Lawrenceville (**D**,**K**,**L**), Wilkinsburg (**F**,**G**,**I**,**J**), and the Hill District (**H**), PA.

3.1.6. Tidiness

There were marked differences in the tidiness and overall maintenance of the six streetscape environments (Table 2). Among each of the three pairs of neighborhoods, the physical infrastructure of

the low SV streetscapes appeared to be better maintained. The condition of buildings and storefronts varied more so than the sidewalk, with dilapidated buildings observed in Homestead (Figure 8A), Wilkinsburg (Figure 8B), and the Hill District (Figure 8C). The condition of the sidewalk generally varied more so within, rather than between, streetscapes, but overall was found to be in fair to good condition. Perhaps the most obvious sign of neglect were the empty lots (i.e., "hard gaps") and discontinuous street wall common to each of the three high SV streetscapes. A mix of litter and vegetation often dominated these interstitial spaces (Figure 8D,E). Litter in general was more prominent among the high SV streetscapes, as was weedy and unmaintained vegetation (Figure 8F–H). Vegetation throughout the low SV streetscapes tended to be well-manicured by comparison, often consisting of flowers (Figure 8I) and other ornamental varieties. Very little graffiti, however, were observed in either the low or high SV streetscapes, with more prominent examples on buildings only observed in Lawrenceville (Figure 8J) and Wilkinsburg. It was also noted that the type and condition of parking meters varied between streetscapes, with older (and often rusting) coin-based meters located in each the high SV streetscapes (Figure 8K), while the more modern electronic meters were only found in Squirrel Hill and Lawrenceville (Figure 8L). Taken together, low SV streetscapes exhibited a greater degree of overall maintenance and tidiness that implies "that there are natural guardians who may intervene and strongly discourage potential criminals", thus contributing to the perception of security and safety [47].

Figure 8. Photo collage illustrating "tidiness" in Homestead (**A**,**D**,**F**), Wilkinsburg (**B**,**E**,**K**,**G**), Hill District (**C**,**H**), Dormont (**I**), and Lawrenceville (**J**,**L**), PA.

3.1.7. Safety and Sensations

To augment the visual details of each streetscape, detailed notes were taken describing sounds and smells, and other elements of the environment that may enhance or detract from the pedestrian experience. Importantly, sensations like sound and smell can have high temporal variability; thus, what is reported here may be quite different on other days or times. The most common smells were that of cooking food at nearby cafés and restaurants and (unfortunately) automotive exhaust. The smell of cooking food was most prominent in the low SV streetscapes of Squirrel Hill, Lawrenceville, and Dormont; not surprising given the greater number and variety of restaurants in these neighborhoods. The smell of automotive exhaust was particularly noticeable and corresponded with heavy traffic (especially truck traffic) in Homestead, Lawrenceville, and parts of the Dormont route. There were no distinct smells in either Wilkinsburg or the Hill District. The soundscapes were generally dominated by automotive traffic, including car stereos, sirens, and honking. With a greater density of pedestrian traffic and activity, the road noise was often offset in Squirrel Hill by people talking and laughing along much of the walking route. The density and variety of pedestrians clearly enjoying themselves, with a street musician performing in the background at times, contributed to an overall sense of security and well-being in Squirrel Hill that was unmatched elsewhere. By contrast, the noise, vibrations, and turbulence from large trucks traveling at relatively high speed, coupled with fairly quiet and vacuous sidewalks, was unsettling in Homestead (Figure 9A) and along W. Liberty Ave. in Dormont (Figure 9B) in particular, though also to a lesser extent in Wilkinsburg (Figure 9C).

Figure 9. Photo collage illustrating "safety and sensations" in Homestead (**A**,**F**,**J**), Dormont (**B**,**H**), Wilkinsburg (**C**,**I**), Squirrel Hill (**D**), Hill District (**E**), and Lawrenceville (**G**), PA.

A more tangible aspect of pedestrian safety, crosswalk features and mechanisms, also showed some variability across streetscapes. Squirrel Hill appeared to have the most comprehensive and legible crosswalk infrastructure that included well-maintained white crosswalk stripes and signage, pedestrian traffic signals, buttons to trigger stop lights, audio signals for the hearing impaired, and intra-block crosswalks illuminated with overhead signs and flashing lights (Figure 9D). Several of these features were found elsewhere, such as the intra-block crosswalk and display found in the Hill District (Figure 9E), and other electronic buttons and signs assisting pedestrians in Homestead (Figure 9F), Lawrenceville (Figure 9G), and Dormont (Figure 9H). Wilkinsburg, and, to a lesser extent, the Hill District, generally had fewer and less well maintained crosswalk amenities. While there were several pedestrian traffic signals, pedestrian push buttons (to trigger stop lights) were uncommon and crosswalk stripes and lines on the roadway were often absent or faded (Figure 9C). Interestingly, new research suggests that higher pedestrian volumes are associated with fewer injuries at intersections, while marked crosswalks and pedestrian signals may have the opposite effect [54]. Lastly, although each of the six streetscapes were visited around early to mid-afternoon, several stores were closed in each of the high SV neighborhoods, with storefronts often protected with metal security gates (Figure 9I,J).

3.2. Pedestrian Activity

Actual walking behavior varied widely among the six locations, each deemed "very walkable" by WalkScore®. Pedestrian activity was highest in Squirrel Hill, where 5.75 pedestrians/min were observed, and Lawrenceville with 5.11 pedestrians/min (Table 1). Both neighborhoods exhibited relatively low SV. The Homestead and Wilkinsburg neighborhoods, each with higher SV, were relatively quiet, with just 1.75 and 1.85 pedestrians/min, respectively. Dormont and the Hill District reverse the trend observed for the previous two pairs, with the highest pedestrian count (3.65 pedestrians/min) observed in the Hill District, the more socially vulnerable of the two neighborhoods.

4. Discussion and Conclusions

This field survey of six streetscapes in Pittsburgh, PA revealed marked differences in the quality and maintenance of the built environment, as well as the level of pedestrian activity, among those in more and less disadvantaged neighborhoods. Micro-scale differences in enclosure, transparency, complexity, and tidiness were particularly discernable despite controlling for macro-scale variations in walkability according to the widely-used Walk Score® metric. Such differences highlight the limitations of macro-scale measures of walkability, which may fail to uncover significant inequities across demographic and socio-economic groups. Neckerman et al. [38] came to a similar conclusion, having found statistically significant disparities in streetscape-scale aesthetics, safety, and pedestrian conveniences between poor and non-poor neighborhoods in New York City.

The observational and photographic evidence presented here supports the notion that disparities in micro-scale walkability may be a feature common to large U.S. cities, and that these differences may have a significant impact on actual walking behavior. In two of the three neighborhood pairings, the low SV neighborhoods exhibited nearly three times as many pedestrians per minute than their high SV counterparts. The Dormont/Hill District match-up presented an interesting exception, however, with the more socially vulnerable Hill District exhibiting more pedestrian activity. In the Hill District, pedestrian activity was concentrated primarily around the corridor's several bus stops, while in Dormont pedestrians appeared to avoid W. Liberty Ave. with its busy four-lane road and narrow sidewalks. With few gaps in the street wall, and a large variety of shops and other destinations, Squirrel Hill and Lawrenceville are more likely to attract pedestrians for utilitarian and recreational purposes; walking as a *mode of choice*. In the Hill District there are fewer in situ destinations and amenities, and more pedestrians associated with transit stops, suggesting that walking here is more utilitarian and transit-focused; a *mode of last resort* for primarily low-income residents. This is a critical distinction in regard to equity given the clear differences in the micro-scale quality of the built environment observed

in this study. Even those socially vulnerable neighborhoods deemed highly accessible according to WalkScore®, and exhibit similar levels (or more) of pedestrian activity relative to their less socially vulnerable counterparts, may not necessarily provide as suitable an environment for walking [3].

The photo collages and detailed observational accounts of the six streetscapes presented in this paper not only provide additional evidence for inequities in neighborhood walkability among more and less advantaged neighborhoods, they capture and communicate details of difference not previously explored in the literature. Most notably, the detailed descriptions of imageability, enclosure, transparency, and non-visual sensations at the micro-scale level contribute to our expanding knowledge of inequities in walkability. There were clear differences in enclosure, for example, with few gaps in the street wall among neighborhoods with low SV, but a large number of gaps, particularly "hard gaps" in the form of vacant lots, among neighborhoods with high SV. There were also fewer windows and less transparent storefronts in high SV streetscapes. Combined with fewer positive sensations and more negative stimuli, such as heavier and higher-velocity automotive traffic, the overall ambient experience and practical use of space in high SV streetscapes was often less conducive to walking.

There is opportunity to further apply Ewing and Handy's [34] rich conceptual framework (with potential additions as seen in this paper) for assessing walkability at the streetscape level by examining additional streetscapes in more cities, and perhaps cities situated at other levels of the urban hierarchy. Though this investigation was limited to the qualitative account of a single observer, it has demonstrated the utility of this framework as a means of organizing and discussing a wide variety of disparate features, which may be used as the basis for additional research with potentially greater temporal and spatial scope. Investigations that utilize statistics to compare micro-scale attributes of the built environment could also benefit from exploring these and other additional features in different cities and at different times. With that said, there is a need to better understand precisely how each of these elements impacts the walking experience, how these impacts might vary among groups and individuals, and what elements are most crucial to different types of walking (e.g., recreational vs. utilitarian).

For planners and policy makers looking to advance equity in neighborhood walkability, the results of this investigation suggest that disparities exist at the micro-scale, and that such disparities should be considered alongside the macro-scale elements density, connectivity, transit accessibility, and land use mix. Encouraging infill development along older commercial corridors would not only reduce "hard gaps" in the street wall, but also potentially contribute to greater density and mix of land uses. Sidewalk or streetscape improvement programs can encourage businesses to utilize more fully adjacent outdoor environments suitable for street cafés and other activities. Business improvement districts (BIDs), within which an additional tax is levied on property owners, have become a popular means for local business owners to collectively address security concerns, promote their commercial interests, and provide for maintenance and capital improvements [55]. In Pittsburgh, BIDs have been established in the "Golden Triangle" area of Downtown and in Lawrenceville. On a more basic level, the identification of design deficiencies, as explored in this analysis, may help local planners and community groups most effectively apply finite financial resources to support walking behavior and enhance the walking experience [56].

Encouraging walking behavior through design is perhaps one of the most effective and holistic ways to promote urban sustainability as it contributes to each of the three "pillars" of sustainability: environmental, social, and economic. Moving away from automotive and toward active transportation is expected to improve public health, reduce waste and environmental degradation, increase community cohesion, and encourage economic development [57–59]. The central role of walkability in advancing sustainability objectives has been recognized by the U.S. Green Building Council (USGBC), whose Leadership in Energy and Environmental Design for Neighborhood Development (LEED-ND) considers such features as "walkable streets", "tree-lined and shaded streetscapes", "compact development", and "housing affordability," alongside the standard building-scale LEED considerations such as energy efficiency and water use reduction [60]. As comprehensive as the

LEED-ND rating system is, it may benefit from a more nuanced examination of the quality of the built environment as explored in this paper.

While infill development, BIDs, and other revitalization strategies may encourage neighborhood walkability and advance sustainability objectives, they may also encourage gentrification, leading to the displacement of disadvantaged groups [2,61]. Such measures may therefore reduce, rather than improve, equity in neighborhood walkability. Inclusive housing requirements, community-engaged planning, and the preservation of older, affordable commercial spaces can help mitigate displacement in gentrifying neighborhoods [62,63]. Over five decades ago, Jacobs [23] recognized the need to mix old and new buildings, and to pace new development as to not eliminate affordable space for smaller, less profitable enterprises. This advice is particularly salient given the current rise in large-scale mixed-use infill developments in the U.S. [64]. Achieving greater equity in neighborhood walkability—at all scales—thus demands a fine balancing act in which diversity and inclusivity are preserved amid advances in the quality and condition of the shared urban environment.

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