

Article

Planning Walkable Neighborhoods for “Aging in Place”: Lessons from Five Aging-Friendly Districts in Singapore

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Abstract: Today, “walkability” is considered a critical component of an aging-friendly neighborhood. This study examined the relationships between the neighborhood physical environment, walkability, and physical activity levels of older residents in Singapore. Five neighborhoods notable for their “aging in place” strategies were selected for a site survey. A questionnaire focusing on the evaluation of neighborhood walkability was administered to older adults in these neighborhoods. The questionnaire included three sections: neighborhood satisfaction, walkability, and the daily physical activity of older adults. The results indicated that adequate physical facilities and connectivity to the city were critical to older adults’ satisfaction with their neighborhoods. The mean walking time significantly dropped as the number of nearby facilities increased, and the number of facilities was negatively correlated with the daily activity levels of older adults. Thus, planners should attempt to calibrate the provision of neighborhood facilities to maintain the physical activity levels of older adults.

Keywords: aging society; neighborhood; walkability; activity levels; elderly people



Citation: Tao, Y.; Zhang, W.; Gou, Z.; Jiang, B.; Qi, Y. Planning Walkable Neighborhoods for “Aging in Place”: Lessons from Five Aging-Friendly Districts in Singapore. *Sustainability* **2021**, *13*, 1742. <https://doi.org/10.3390/su13041742>

Academic Editor:

Carmela Cucuzzella

Received: 2 December 2020

Accepted: 28 January 2021

Published: 5 February 2021

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1. Introduction

1.1. Aging in Place: A Walkable Environment

With rapid population aging around the world, both policy makers and the elderly themselves are promoting the concept of “aging in place”, which allows older adults to remain in a familiar environment for as long as possible [1,2]. Research has shown that late life residential environments represent a critical context for aging [3]. Neighborhoods, in which older adults spend most of their time, are an important target of research on ways of ensuring aging-friendly environments [4–6].

One of the most critical tasks in creating aging-friendly neighborhoods for older residents is to ensure walkability, because walking, a moderate form of physical activity, is regarded as having the potential to maintain the health of older adults [4,7,8]. The connections between walkability, the built environment, and the well-being of older adults have begun to attract considerable interest from scholars [9–11]. Studies have revealed that promoting walking in neighborhoods is an important way to ensure the continued health of older adults, especially their mental health [8,12–15], because they spend more time than youngsters in the local environment [16]. Other research has indicated that the perceived pedestrian infrastructure, street connectivity, land-use mix access, and safety are all associated with the physical activity levels of residents. They have highlighted that the accessibility of areas for social interaction and stores are associated with the walking time of older adults [15,17,18]. Based on these findings, scholars have made recommendations for healthy neighborhood planning, such as the idea of a “15-min walkable neighborhood” [19].

Recently, thousands of healthcare workers have been infected by coronavirus disease 2019 (COVID-19) in hospitals and aged care facilities. Studies have shown that coronavirus droplets can travel farther than two meters [20,21], making it especially important to create a healthy outdoor environment. Moreover, it has been highlighted that older adults are at high risk of contracting COVID-19 due to their relatively weak immune systems [22]. Aging in place could reduce the number of seniors and thus the workload of health workers in aged care facilities, while increasing the opportunities available for older adults to engage in outdoor exercise and breathe fresh air, as a healthy outdoor lifestyle is an efficient method of avoiding cross-infection in these indoor facilities.

1.2. Neighborhoods Promoting Aging in Place in Singapore

Singapore is situated in Southeast Asia. It has a population of 5.7 million and a population density of 7766/km² [23]. Based on the latest 2019 Population Trend Report of Singapore, the percentage of the elderly population has increased from 6.0% to 13.7% over the last 30 years, and the proportion of the resident population aged 65 years and over was as high as 14.4% in 2019 (Figure 1).

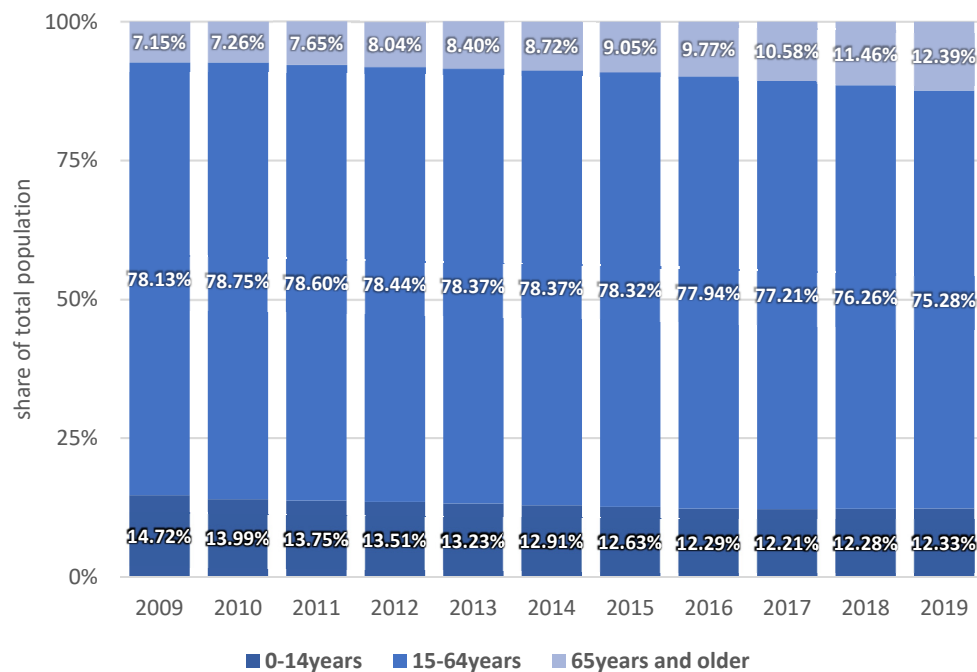


Figure 1. Singapore: Age structure from 2009 to 2019 (<https://www.statista.com/statistics/378566/age-structure-in-singapore/>).

Singapore's government places significant emphasis on urban greening in its approach to development, based on the assumption that extensive and high-quality urban greenery and green infrastructure can support human health and create livable cities [24,25]. In Singapore, as a "Garden City", many strategies to promote daily outdoor activities among citizens have been implemented by the government, such as street planting and the creation of parks and open spaces, courtyards, sky terraces, and roof sky decks on public housing estates and in public buildings [24,26].

In addition to urban greenery, the Singaporean government has introduced an action plan for successful aging [27], which includes many ways of fostering aging-friendly neighborhoods. Among them are initiatives specifically targeting the enhancement of the physical environment for senior-friendly communities in Singapore. The government also offers social and health services and programs for the elderly in communities. It has developed three initiatives encouraging community participation to provide bottom-up

and mutual help for the elderly. These initiatives cover 21 aging-friendly community programs conducted in Singapore (see Table A1).

All of these programs relating to the physical environment and social health services have been effectively designed to promote aging-friendly neighborhoods. However, the utilization of the relevant facilities and demand from residents have not yet been examined. Therefore, the authors of this paper sought to examine the relationships between the top-down strategies implemented by the Singaporean government and the real needs of older residents, especially in terms of walkability-related infrastructure construction.

1.3. Research Objective

To date, few studies have focused on how the environment may influence the walking and other activity levels of older adults in urban areas [13]. In addition, Singapore's aging friendly neighborhoods have rarely been evaluated. Therefore, this study aimed to explore the relationships between the physical environment, neighborhood walkability, and the daily physical levels of elderly people in Singapore.

2. Methods

2.1. Site Selection

To ensure that the cases were representative enough to allow the conclusions to be generalized to a larger population, three main criteria were used for site selection: initiatives promoting senior-friendly communities in Singapore, town planning models, and demographic aging rate. First, the cases covered 21 aging-friendly community programs conducted in Singapore (see Table A1). Second, the cases included neighborhoods with all kinds of spatial planning models. Reflecting on the spatial planning models, the Housing Development Board (HDB) [28] divides 23 towns and three estates into three categories: mature towns/estates that were developed before the 1980s, middle-aged towns/estates that were built in the 1980s or early 1990s, and young towns that were developed in the 1990s and afterwards (see Table A2). Considering towns' structural models and residential areas, Hee and Heng [29] classified the development of new towns into five stages. Third, the cases covered a full spectrum of demographic aging rates. According to the United Nations, societies can be classified by aging rate as non-aging, aging, aged, or super-aged, based on whether their proportion of residents aged 65 or over is below 7%, between 7% and 14%, between 14% and 21%, or over 21%, respectively. Consequently, five neighborhoods defined by administrative boundaries were selected: Henderson Hill, Marine Parade, Yuhua East, Woodlands East, and Waterway East (Figure 2).

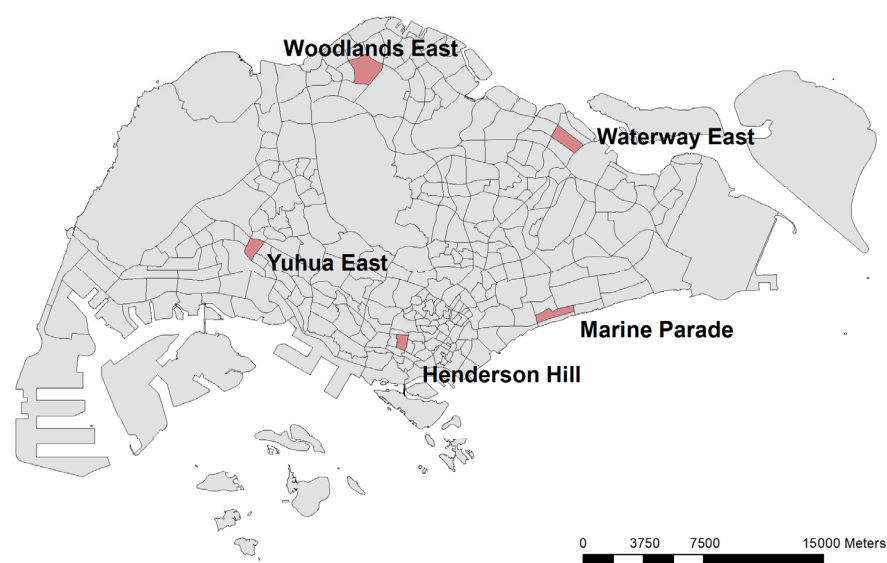


Figure 2. Five selected aging neighborhoods in Singapore.

2.1.1. Henderson Hill

Henderson Hill (Figure 3) is a subzone of Bukit Merah, which was constructed during the first stage of new town development (see [29] for details of new town typologies). It is located in the center of Singapore. The size of this area is 59.54 ha. It has 11,870 residents, and 22.83% of the population are aged 65 or over. A community garden and a therapeutic garden are located in the east of this area. Henderson Hill is a hilly area with a large number of rental flats. Residents' low economic status encourages them to use the local services and facilities, especially as they lack the money to travel frequently beyond their local area to enjoy public spaces and services.

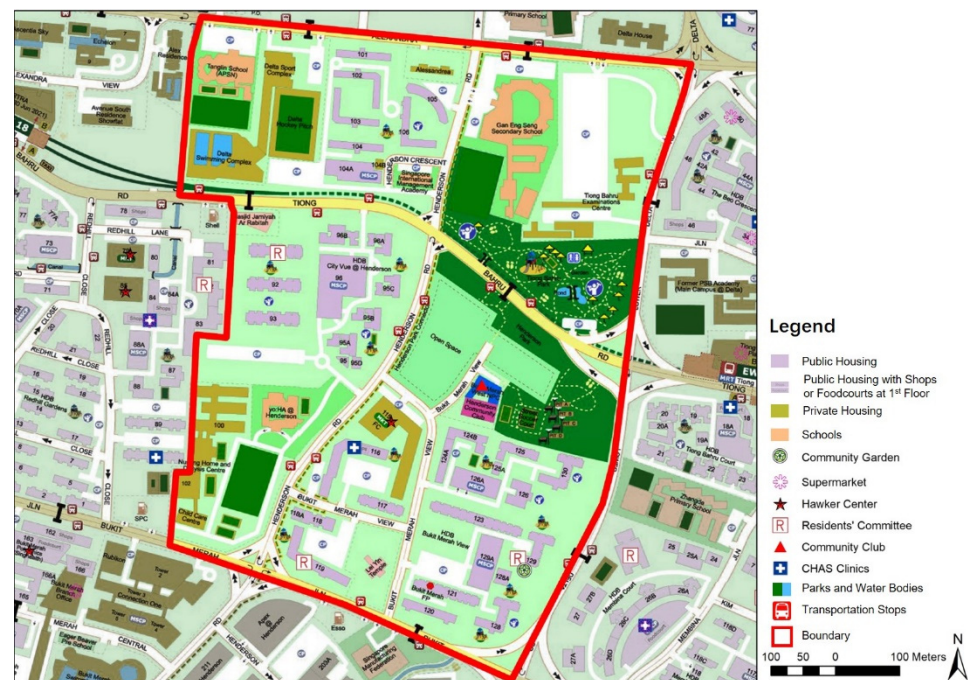


Figure 3. Henderson Hill.

2.1.2. Marine Parade

Marine Parade (Figure 4) is a mature estate located in the central region of Singapore. Its construction commenced in 1972, and most of its buildings had been leased by 1975. The area is characterized by flexible building arrangements, evenly distributed open spaces, and hierarchical commercial centers. Car parks represent the largest proportion of the open spaces. As its neighborhoods were established at roughly the same time and have a similar layout, Marine Parade represents the second stage of the new town typology, which is based on a town center–neighborhood center–subcenter prototype [30]. The residential population of Marine Parade is aging, with 19.58% of its population over 65 years old. The most important reason for selecting Marine Parade is that it was the first pilot case in City for All Ages (CFAA), which is a ground-up initiative run by grassroots leaders and residents in Singapore with cooperation by the government, communities, and the wider public [31]. This first CFAA pilot case featured more elderly-friendly fitness corners, larger block numbering, leveled void decks, and a longer “green man time” for traffic light crossings. The initiative also identified seniors living alone, launched a new senior activity center, and built a Befriending Network of 40 volunteers—the youngest being 53 years old and the oldest being 84 years old [31].



Figure 4. Marine Parade.

2.1.3. Yuhua East

Yuhua East (Figure 5), located in the town of Jurong East, represents the third stage in the new town development typology. It is characterized by the precinct concept and the commercial use of the first level of public housing flats. Yuhua East is found in western Singapore. Its construction began in 1979. From this stage, the planning of new towns in Singapore began to follow a town center–neighborhood center–precinct structural model [29]. A precinct is “a cluster of 4 hectares, or sometimes half the size, serving 400–800 families housed in four to eight apartment buildings” [29]. The use of precincts encourages social interactions via the communal use of space [29]. Yuhua East is an aging neighborhood, with 15.07% of its population over 65 years old. Although Yuhua East is not part of the CFAA initiative, it hosts the smart HDB (“HDB” refers to public housing estates in Singapore). The Home @ Yuhua project is the first pilot case of smart homes in Singapore. This project equipped homes with elderly monitoring [32], tele-rehab, and tele-video consultation [33] systems.

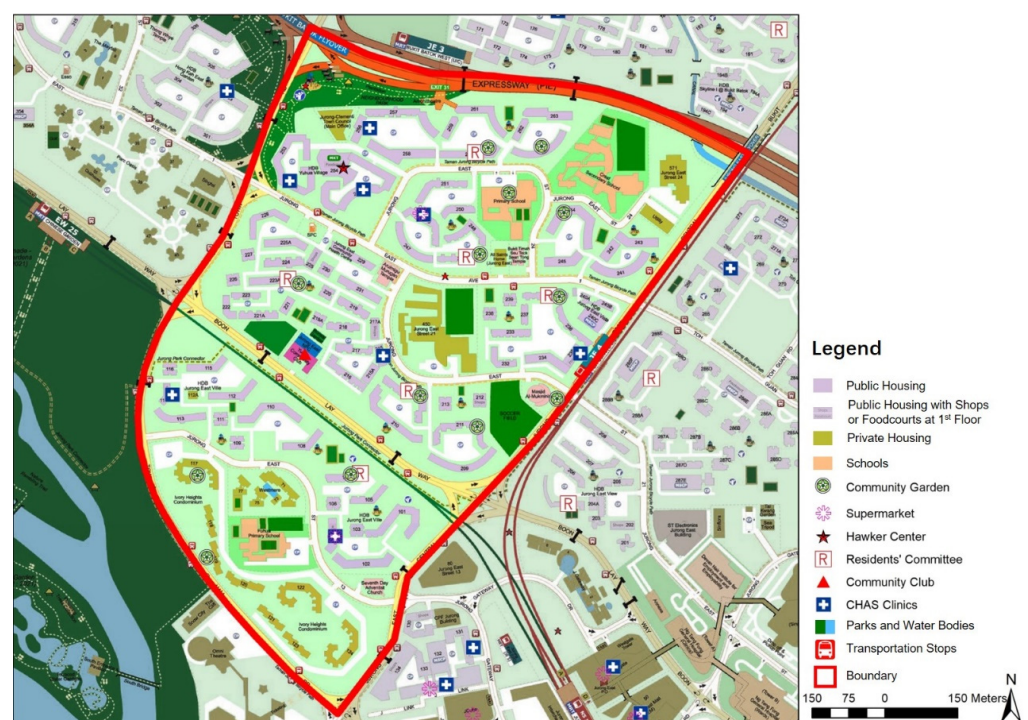


Figure 5. Yuhua East.

2.1.4. Woodlands East

Woodlands East (Figure 6) is located in Woodlands, in the north of Singapore. It belongs to the middle-aged town demographic and the fourth stage of the new town development typology, featuring a semi-public space enclosed by buildings and an integrated multi-story carpark [29]. It is now close to being classified as an aging neighborhood, with 6.05% of its population over 65 years old. This site includes Kampung Admiralty, the first one-stop integrated elderly care complex. It integrates housing for the elderly with a wide range of social, healthcare, communal, commercial, and retail facilities, which are distinct from the scattered care facilities in other cases.

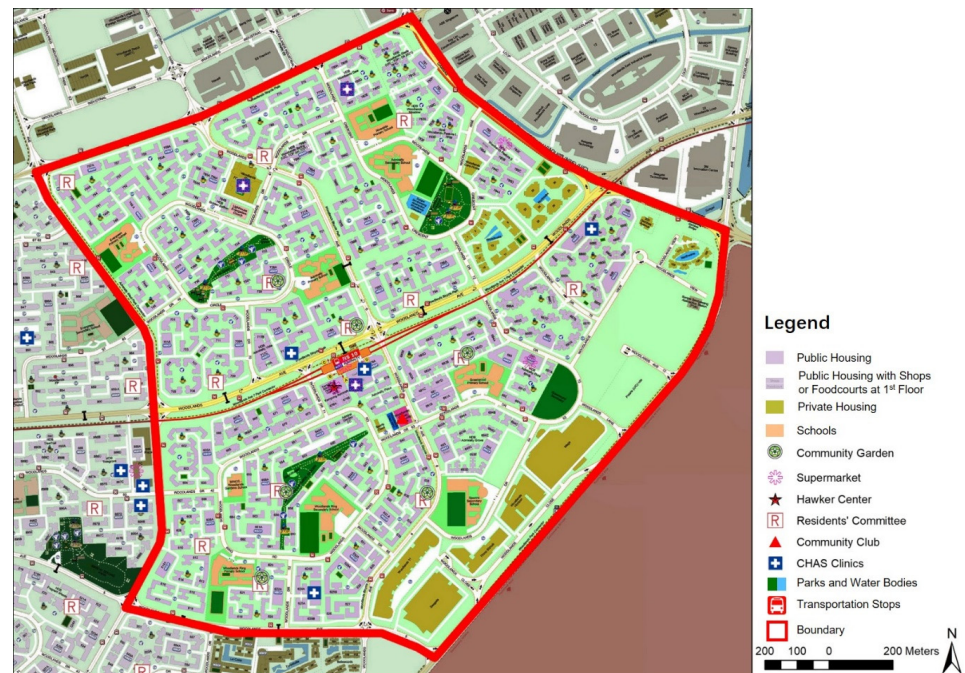


Figure 6. Woodlands East.

2.1.5. Waterway East

Waterway East (Figure 7) is located in Punggol in northeastern Singapore, which represents the fifth stage in the new town development typology. It has a grid-like system complemented by mass rapid transit (MRT) and light-rail transit (LRT) systems [29]. At this stage, the previous town center is represented by a large-scale shopping mall, which was integrated with MRT or LRT. Oasis Terraces, a new generation of the neighborhood center, has also been unveiled in Waterway East to provide an integrated “live–work–play–learn” environment with a new design concept [34]. The precinct has been moved from the road level to the top of the multi-story carpark [34]. Waterway East has a young population, with only 5.83% of its population over 65 years old. It is not part of the CFAA initiative.

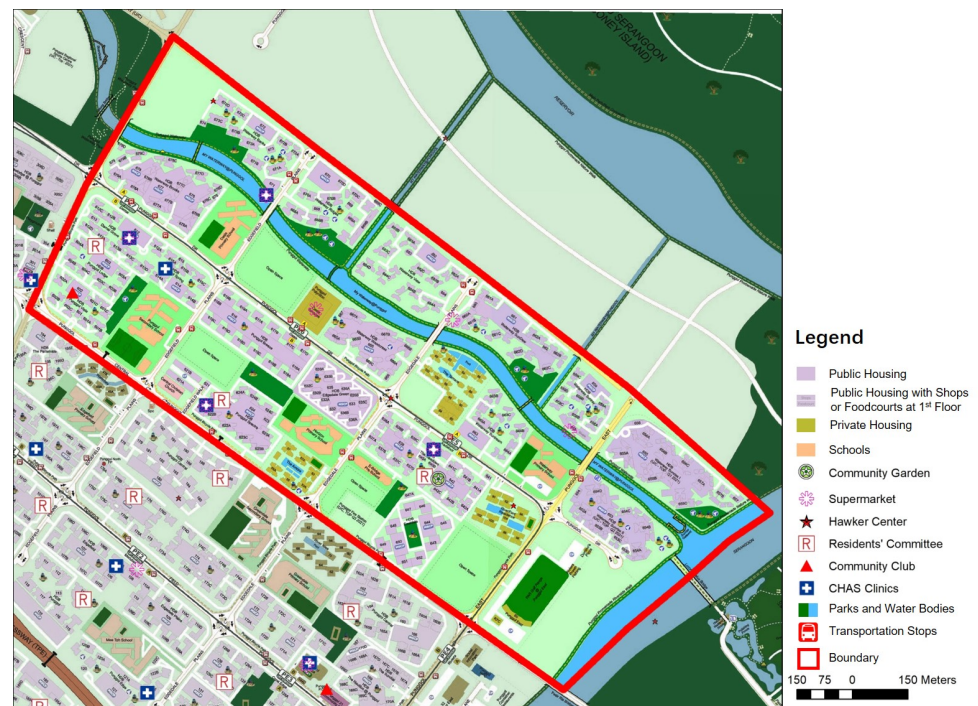


Figure 7. Waterway East.

Basic information on the neighborhood facilities in the five selected aging districts is provided in Table 1.

Table 1. Basic information of five selected neighborhoods in Singapore.

	Henderson Hill	Marine Parade	Yuhua East	Woodlands East	Waterway East
Area (ha)	59.54	116	92.48	255.35	148.92
Population	11,510	27,550	25,460	97,090	47,550
Proportion of people aged above 65	22.83%	19.58%	15.07%	6.05%	5.83%
Number of parks and water bodies	1	1	4	6	9
Size of water parks and water bodies (m ²)	29,614	14,844	33,130	105,415	222,663
Number of transportation stops	14	19	17	46	23
Number of supermarkets	1	7	2	8	6
Number of hawker centers	1	2	1	1	0
Number of residential buildings with commercial at 1st floor	19	31	49	94	50
Number of residents' committees	2	7	6	13	4
Number of community clubs	0	1	1	1	1
Number of community gardens	1	6	13	6	1
Number of elder care facilities	7	5	5	4	2
Number of CHAS clinics	1	6	8	7	5
Number of Silver Zones	1	2	0	0	0

Data source: Population Trends (2016); Singapore Residents by Subzone and Type of Dwelling, June 2016 (data.gov.sg); number of residential buildings with first-floor commercial use, counted by the author, Zhang Wei; number of Silver Zones obtained from the Land Transport Authority (2016); numbers of other facilities obtained from Onemap, 2018 (www.onemap.sg/main/v2/themes).

The participants in this study were all volunteers aged 55 or over, with 25 recruited from each selected neighborhood.

2.2. Questionnaire

The background part of the questionnaire covered basic socio-demographic and situational variables, such as gender, age, ethnicity, number of adults sharing one's home, years of living in the neighborhood, and number of blocks. The main part of the questionnaire comprised three sections: neighborhood satisfaction, perceived walkability, and physical activity of elderly people. Both English and Chinese versions of the questionnaire were provided to meet the respondents' different demands. The survey was conducted by 7 investigators, whose mother language was Chinese. One investigator's undergraduate degree was completed in English, and two of the investigators had International English Language Testing System (IELTS) scores of 6.5 and 7, respectively. In the first section, the questionnaire used a 5-point satisfaction scale (from -2 to 2) to measure the respondents' satisfaction with the number of different neighborhood facilities, such as parks, stops, hawker centers, and clinics. Hawker centers are typically located in public housing estates; they house many stalls that sell a variety of Singaporean and other Asian cuisines. The mean walking time from home to each facility was also indicated by the participants. Respondents who used a walking stick were excluded from the research. In addition, the number of blocks between home and each facility was recorded to double check the reported walking time to each facility [35]. In the second section, questions related to walkability were selected from the Neighborhood Environment Walkability Scale—Abbreviated (NEWS-A). Categories including service, street, place, surroundings, and environment were evaluated. Questions were selected from NEWS-A to provide a succinct measure of various aspects of the built environment that related to walking. The validity of this set of questionnaire items had already been confirmed [36]. The third section of the questionnaire was adapted from the International Physical Activity Questionnaire—Elderly (IPAQ-E), using four questions to evaluate the daily activities of the participating older adults. This questionnaire is one of the most popularly used to assess the physical activity levels of the elderly, and the IPAQ-E has been shown to have acceptable validity with an elderly sample [37]. The full questionnaire was approved by the National University of Singapore Institutional Review Board, with reference code S-18-312E. Each questionnaire took approximately 15 min to complete, and incentives such as paper fans were handed out to the respondents at the end of the survey.

2.3. Data Analysis

Correlation analysis and regression analysis were applied to determine the relationships between each neighborhood's attributes and the occupants' satisfaction with its walkability. The data were analyzed using SPSS version 20.0 (IBM).

3. Findings and Results

3.1. Basic Information on Participants

A total of 125 older adults were surveyed, with 25 recruited from each selected aging zone. After the interviews, 123 valid questionnaires were selected for analysis. Basic information on the surveyed participants is provided in Table 2. The survey sample comprised 83 males and 41 females, all of whom were aged 55 or above. Those aged 55 to 65, 65 to 74, and 75 and above made up 34%, 37%, and 29% of the sample, respectively. The majority of the participants were Chinese, and most lived with one (35%) or two (22%) family members. The majority of the respondents had lived in their neighborhoods for more than 10 years (70%), and 35% of them had lived there for more than 30 years. As a result, they were generally very familiar with their residential districts.

Table 2. Sample characteristics.

Characteristic	Category	Number of People	Percentage
Gender	male	83	67%
	female	41	33%
Age group	55–64	42	34%
	65–74	46	37%
	>75	35	29%
Race	Chinese	118	95%
	Indian	1	1%
	Others	5	4%
Number of adults live with	0	22	17%
	1	43	35%
	2	27	22%
	3	21	17%
	≥4	11	9%
Years of living in the neighborhood	1–9	37	30%
	10–19	18	15%
	20–29	25	20%
	>30	44	35%

3.2. Neighborhood Satisfaction

Details of neighborhood satisfaction and the mean walking time from home to each facility are listed in Table 3. Overall neighborhood satisfaction was positive, receiving a score of 1.0. This indicated that the respondents were satisfied with the neighborhood facilities. Transportation received the highest score, 1.4, which was followed by supermarkets and hawker centers, each of which received a satisfaction score of 1.0. The satisfaction votes for parks, ground floor commercial use, clinics, and residents' committees ranged from 0.5 to 0.8, and the satisfaction score for elderly care facilities was 0.2.

Table 3. Neighborhood satisfaction and walking time.

Facilities	Mean (−2 to 2)	Walking Time (Minutes)
Parks and water bodies (quantity)	0.8	10
Parks and water bodies (size)	0.7	
Transportation stops	1.4	5
Supermarkets	1.0	9
Hawker centers (food)	1.0	8
Residential buildings with commercial at 1/F	0.6	6
Residents' committees	0.5	9
Community gardens	−0.4	10
Elderly care facilities	0.2	8
CHAS clinics	0.6	13
Overall neighborhood satisfaction	1.0	N/A

To evaluate the relationship between the mean walking time and satisfaction, walking time from home was also recorded in the questionnaire. The results showed that transportation stops had the shortest walking times, with a mean value of five minutes. The walking time to ground floor commercial buildings, hawker centers, elderly facilities, supermarkets, and residents' committees was within ten minutes. The walking time to parks and community gardens was around ten minutes, and the longest walking time was that between home and clinics, at thirteen minutes.

The correlations between the physical environment, satisfaction votes, and average walking time were examined (Table 4). The results showed that the number and size of parks and water bodies, the number of community gardens, and the number of elderly care facilities were positively correlated with satisfaction. The respondents seemed quite

satisfied with the provision of nature scenery in the neighborhood. The mean walking time significantly dropped with an increase in the number of nearby parks and water bodies, supermarkets, residents' committees, community gardens, and clinics. The result indicated that the provision of appropriate physical facilities could increase the satisfaction vote and decrease the mean walking time of the elderly people.

Table 4. Correlation between environment attributes, satisfaction votes, and walking time.

Facilities	Environment Satisfaction		Walking Time	
	Sig.	<i>p</i> Value	Sig.	<i>p</i> Value
Parks and water bodies (quantity)	0.294 **	0.001	−0.316 **	0.001
Parks and water bodies (size)	0.293 **	0.001	−0.175	0.072
Transportation stops	−0.016	0.862	0.220 *	0.017
Supermarkets	−0.036	0.692	−0.323 **	0.001
Hawker centers (food)	−0.106	0.253	−0.087	0.373
Residential buildings with commercial at 1/F	0.035	0.702	−0.198	0.051
Residents' committees	0.091	0.315	−0.206 *	0.048
Community gardens	0.244 **	0.006	−0.636 **	0.000
Elderly care facilities	0.217 *	0.016	−0.031	0.799
CHAS clinics	0.037	0.420	−0.452 **	0.000

*. Correlation is significant at the 0.05 level. **. Correlation is significant at the 0.01 level.

3.3. Neighborhood Walkability

The respondents' satisfaction with five categories of neighborhood environment, namely services, street conditions, place, surroundings, and environment, was evaluated on a 4-point scale: disagree (1), slightly disagree (2), slightly agree (3), and agree (4). The first four categories were selected from NEWS, and the last category was developed based on Singapore's climate characteristics, such as its hot temperature and rainy season.

Regarding service provision (Table 5), the respondents agreed that many services were within walking distance, such as stores and transit stops. They also reported that it was easy to park in local shopping areas. Moreover, the street conditions (in terms of even surfaces and a lack of obstacles) in the neighborhoods were rated positively. Three main aspects of the street were evaluated to assess walkability, namely dead-end roads, distance between intersections, and alternative routes. The majority of the participants agreed that the streets showed good connectivity, and intersections and alternative routes even received mean votes of 3 and above, which is rather positive. As for the sidewalks, the selected neighborhoods were adequate for pedestrian use and had enough greenery. All of the respondents except those from Yuhua East reported that their neighborhoods offered attractive natural views and buildings. The questions relating to environment focused on sunshade and rainfall in the tropics. Most of the respondents agreed that their neighborhoods provided enough shelter and canopy cover, which influenced their willingness to engage in outdoor activities.

3.4. Neighborhood Environment and Physical Activity Levels of Older Adults

This study revealed that the neighborhoods' weather environment influenced the physical activity of the older adults. In IPAQ-E, weekly physical activity level is calculated as "low", "moderate", or "high". The results also indicated that a negative correlation existed between the number of hawker centers (providing food) and the daily activity levels of the elderly adults (sig. = −0.229, *p* = 0.05). No other correlation existed between neighborhood environment attributes and the physical activity levels of the elderly people.

Table 5. Neighborhood environment walkability vote.

Selected Items from NEWS	Henderson Hill	Marine Parade	Yuhua East	Woodlands East	Waterway East
1.Service					
1.1 Stores are within easy walking distance of my home.	3.24	3.52	3.4	3.28	3.63
1.2 Parking is difficult in local shopping areas.	2.36	2.76	2.16	2	2.00
1.3 There are many places to go within easy walking distance of my home.	3.16	3.56	3.48	3.32	3.58
1.4 It is easy to walk to a transit stop (bus, train) from my home.	3.48	3.72	3.72	3.4	3.63
1.5 The streets in my neighborhood are hilly, making my neighborhood difficult to walk in.	2.08	1.48	1.6	1.6	1.25
1.6 There are major barriers to walking in my local area that make it hard to get from place to place (for example, freeways, railway lines, rivers).	1.52	1.52	1.6	1.52	1.46
2.Street					
2.1 The streets in my neighborhood do not have many cul-de-sacs (dead-end streets).	3	3.44	2.36	2.92	3.13
2.2 The distance between intersections in my neighborhood is usually short (100 yards or less; the length of a football field or less).	3.12	3.6	3.44	3.56	3.50
2.3 There are many alternative routes for getting from place to place in my neighborhood (I don't have to go the same way every time).	3.16	3.28	3.52	3.56	3.42
3.Place-sidewalks					
3.1 There are sidewalks on most of the streets in my neighborhood.	3.36	3.6	3.52	3.6	3.79
3.2 Sidewalks are separated from the road/traffic in my neighborhood by parked cars.	2.92	2.6	2.48	2.92	3.21
3.3 There is a grass/dirt strip that separates the streets from the sidewalks in my neighborhood.	3.16	3.52	3.56	3.2	3.58
4.Surrounding					
4.1 There are trees along the streets in my neighborhood.	3.36	3.56	3.4	3.36	3.83
4.2 There are many interesting things to look at while walking in my neighborhood.	2.28	2.52	1.76	2.28	3.00
4.3 There are many attractive natural sights in my neighborhood (such as landscaping, views).	2.24	2.52	1.84	2.36	3.04
4.4 There are attractive buildings/homes in my neighborhood.	2.16	2.48	1.76	2.12	2.83

Table 5. Cont.

Selected Items from NEWS	Henderson Hill	Marine Parade	Yuhua East	Woodlands East	Waterway East
5.Environment					
5.1 Hot temperatures decrease my outdoor activities.	2.72	2.48	2.12	2.28	2.75
5.2 Rainy days decrease my outdoor activities.	3.04	2.52	2.6	2.56	3.13
5.3 Shelter and trees give shade for the sidewalks in my neighborhood.	2.88	3.48	3.24	3.12	3.13
5.4 Shelter protects rainfall for the sidewalks in my neighborhood.	2.64	3.44	3.2	3.08	3.00

4. Discussion

Many studies have reported that key neighborhood characteristics (street connectivity, density, etc.) are significantly associated with the life satisfaction [38–40], social interaction [41], and health status of residents [42]. In this study, of all neighborhood facilities, transportation received the highest overall satisfaction vote and had the smallest mean walking time. This indicates that connectivity to the city is a critical determinant of residents' satisfaction with their neighborhood. Adequate physical facilities also had a positive correlation with the neighborhood satisfaction vote and a negative correlation with walking time. The mean walking time significantly dropped with an increase in the number of nearby parks and water bodies, supermarkets, residents' committees, community gardens, and clinics. These results suggest that the provision of appropriate physical facilities is a critical factor in neighborhood design, as it can enhance both the satisfaction and the daily life walking patterns of older adults.

Previous studies have found that perceived walkability is associated with both participation in and duration of physical activity [17], especially among older adults [38]. At the surveyed five sites, the respondents were satisfied with most of the neighborhood conditions regarding walkability. Site 5 received a low score for attractive surroundings, because the neighborhood was constructed in 1970s, and its design and facilities seemed old-fashioned. In the future, to develop aging-friendly neighborhoods, modern design elements could be included to enhance the vitality and satisfaction of their older residents.

The outdoor environment has a large impact on the behavior of residents. Research has pointed out that poor neighborhood conditions are associated with lower levels of physical activity among older adults [43]. One study examined the effect of food retail on the physical activity of adolescents and found that the availability of food stores within walking distance increased their physical activity levels [44]. In contrast, the current study found a negative correlation between the number of hawker centers and older adults' physical activity. The availability of hawker centers does not appear to increase older adults' physical activity. A possible explanation is that compared with youngsters, older adults are much more reliant on the convenience of neighborhood facilities and less willing to walk far for shopping and dining. In short, the convenience of neighborhood facilities reduces physical activity levels among elderly people. Similar findings have been reported by other researchers [18]. Based on this interesting finding, the authors believe that the density of the neighborhood facilities should be properly designed, such as by reducing the number of hawker centers, to encourage older adults to maintain suitable levels of daily physical activity.

5. Conclusions

This study identified connectivity to a city as a critical factor determining the satisfaction of older residents with their neighborhoods. In addition, the presence of adequate physical facilities was positively correlated with neighborhood satisfaction scores and

negatively correlated with walking time. Moreover, the convenience of neighborhood facilities was found to reduce the physical activity levels of elderly people.

Indeed, neighborhood environments are important contexts for aging. The government should provide appropriate facilities, improve accessibility, and increase walkability to enhance the satisfaction of older adults with their local environments. Planners, architects, and landscape designers should create more attractive surroundings to enhance the vitality and satisfaction of older residents. The density of the facilities should also be carefully evaluated, as this factor directly influences the daily activity levels of older adults. The number of neighborhood facilities and the physical activity levels of elderly people must be carefully balanced. Better insights into the role of walkability in creating aging-friendly neighborhoods will be beneficial to governments, architects, and urban planners.

It should be pointed out that the proportions of the participants surveyed in this study were inconsistent with the demographic breakdown of Singapore's population, which comprises approximately 70% Chinese, 15% Malay, and 10% Indian. This inconsistency may have prevented the data in this study from fully reflecting the behavioral habits of average elderly people in Singapore. The ethnic proportions obtained in this study are related to two main factors. First, some of the older participants were illiterate and only understood their mother tongues; therefore, the investigators needed to ask the questions verbally in the participants' mother tongues. Second, the investigators in this study were Chinese–English bilingual. In the future, researchers should also recruit Malay- and Tamil-speaking investigators. In addition, environmental elements such as air temperature, humidity, and air velocity should be evaluated to determine the correlation between levels of outdoor comfort and neighborhood walkability in the tropical context. The data collected from the selected cases have been aggregated for the analysis, while future studies will focus on individual case to have more in-depth understanding of the specific facilities and built environment features. This paper would like to testify to the correlation between the provision of neighborhood facilities and the physical activity level of the respondents. Since the correlation did not show statistical significance, the result of this part was not elaborated. With more detailed data, hopefully, there will be significant correlation coming out.

Author Contributions: Conceptualization, Y.T. and W.Z.; methodology, Y.T. and W.Z.; software, Y.T.; validation, Y.T. and W.Z.; formal analysis, Y.T.; investigation, Y.T. and W.Z.; data curation, Y.T. and W.Z.; writing—original draft preparation, Y.T. and W.Z.; writing—review and editing, Y.T., W.Z., Z.G., B.J. and Y.Q.; visualization, W.Z.; project administration, W.Z. All authors have read and agreed to the published version of the manuscript.

Funding: National Science Foundation of Shenzhen University (Grant No. 85304-00000261; Grant No. 860-000002110338); National Natural Science Foundation of China (Grant No. 51708282).

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of National University of Singapore (protocol code S-18-312E and date of approval 8 March 2019).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to the agreement between the authors and the Institutional Review Board of National University of Singapore.

Acknowledgments: The authors gratefully acknowledge the help with the data collection provided by Han Wei, Mao Jingshang, and Zhang Chengjun, which made this research possible. We are also grateful to Yu Pei for helping to input the survey data. We would like to extend our thanks to our colleagues Heng Chye Kiang, Cho Im Sik, Tan Beng Kiang, and Lau Stephen Siu Yu from the National University of Singapore for providing valuable insights into the selection of cases. Last but not least, this paper is dedicated to the many participants who provided the data.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Programs for promoting aging-friendly neighborhoods in Singapore.

Category	No.	Programs	Introduction	Agencies in Charge	Reference
Physical Environment	1	Silver Zone	Silver Zones enhance the road safety for the elderly through gateway treatment, pinch point, mountable center dividers, bus-friendly hump, etc.	Land Transport Authority	LTA [45]
	2	Therapeutic Horticulture Programs	The Therapeutic Horticulture Program uses plants and nature-related activities for elderly groups, persons with dementia, and other special needs in the therapeutic gardens to: Promote low intensity exercise and improve motor skills; Stimulate memory; Encourage positive social interactions and connection with nature; and Promote mindfulness.	National Parks	NParks [46]
	3	Active Aging Hubs (AAHs)	AAHs are one-stop day centers for seniors that can serve a range of needs—from active aging services for ambulant and healthy seniors, to day care and day rehab services for seniors in need of care, as well as volunteer activities.	Ministry of Health (MOH); Housing & Development Board (HDB)	Gan [47], KWSH [48], NTUCHealth [49]
	4	Smart Home	The smart HDB @ Yuhua project equips homes with an elderly monitoring system (EMS) that allows caregivers to monitor their care recipients through sensors placed in the flat, and it alerts caregivers via text messages.	HDB	HDB [33]
	5	2-Room Flexi Flats	Under the 2-room Flexi Scheme, elderly citizens have the flexibility of choosing the length of lease on their 2-room flat, based on their age, needs, and preferences. The 2-room Flexi flats come in 2 sizes: 36sqm and 45sqm, and they are available either on a 99-year lease or short-lease. Grab bars will be installed, and other senior-friendly fittings are optional.	HDB	HDB [50]
	6	Rental flats	Flats under the Public Rental Scheme are heavily subsidized to cater to Singapore Citizen (SC) households who have no other housing options, for instance, low-income seniors.	HDB	HDB [51]
	7	Enhancement for Active Seniors (EASE)	The Enhancement for Active Seniors (EASE) scheme allows homeowners to improve the comfort and enhance the mobility of elderly residents living in HDB flats. EASE offers three types of improvement items regarding elder-friendly fittings, including grab bars within the flats, slip-resistant treatment to floor tiles of two bathrooms, and ramps.	HDB	HDB [52]
	8	CFAA	Town Audits are useful for identifying physical defects and hazards in the neighborhood that might be unsafe for seniors. By walking along routes commonly taken by residents, the volunteers take note of the areas that could be improved to make the environment safer and easier for the seniors' day-to-day activities.	MOH	MOH [53]

Table A1. Cont.

Category	No.	Programs	Introduction	Agencies in Charge	Reference
Physical Environment	9	Elevated retirement community	Kampung Admiralty is a one-stop integrated complex that integrates seniors' housing, health care, care facilities, hawker centers, and shops amid lush greenery in a bid to be an elevated "modern kampung".	HDB	Heng and Chua [54]
	10	Town and Community Plazas	Town and community plazas around Singapore enable residents to gather, enjoy activities with friends and neighbors, and foster community ties in their towns.	HDB	HDB [55]
	11	Participatory renewal programs	The involvement of communities started through a series of upgrading programs, such as the Neighborhood Renewal Program (NRP), Building Our Neighborhoods' Dream (BOND) Program, and most recently, the Remaking Our Heartlands Program	HDB	Cho and Križnik [56]
Social and Health Services and Programs	12	CFAA	Health screenings and functional screenings; health and wellness programs	MOH	MOH [53]
	13	Eldercare facilities	Senior Cluster Network (SCN); Senior Activity Centers; Day Care centers; Befriending Service; Gero-Counseling Service; Sheltered Homes (SHs)	MOH; Ministry of Social and Family Development (MSF)	MOF, MOH [57]
	14	Community Health Assist Scheme (CHAS) clinics	Lower- to middle-income families (\$1800 monthly income per person in one household) can qualify for the CHAS, which provides them with subsidies at participating General Practitioners (GPs) and dental clinics in the community.	MOH CHAS	MOH [58], CHAS [59]
	15	National Silver Academy	National Silver Academy (NSA) enables seniors to stay cognitively active through learning.	NSA	NSA [60]
	16	Senior Citizens' Executive Committees (SCEC)	SCEC plans and organizes a wide array of activities and courses to enrich the life experiences of senior citizens. There are sports and dance activities that are specially designed to help participants stay fit and healthy. There are also courses that fulfill the pursuit of lifelong learning by offering skills to pick up a new language, improve one's cooking, and even explore the possibilities of computer technology. It aims to engage and empower seniors to lead active, healthy, and meaningful lives in the community.	People's Association (PA); Community Club (CC)	PA [61]
	17	PA Wellness Program	The PA Wellness Program offers those aged 50 and above opportunities to take part in activities to help them remain mentally, physically, and socially active.	PA, CC, Residents' Committee (RC) and Neighborhood Committee (NC)	PA [61]
	18	Tele-health	Elderly Monitoring Systems, Vital Signs Monitoring, Tele-rehabilitation and Video Consultation, Smart Health Video Consultation (VC) for Healthcare, Smart Health TeleRehab	Smart Nation and Digital Government Office (SNDGO)	SNDGO [62]

Table A1. Cont.

Category	No.	Programs	Introduction	Agencies in Charge	Reference
Empowerment of Bottom-Up Caregivers	19	Community Networks for Seniors (CNS)	By combining the strengths and resources of Voluntary Welfare Organization (VWO), grassroots and community groups, as well as government agencies, CNS connect the seniors to different combinations to social and health care services.	Agency for Integrated Care (AIC)	AIC [63]
	20	CFAA	Social support networks are prompted through various programs. Angel Ambassadors program, ComSA Program, Cooking for A Cause, etc.	MOH	[53]
	21	Community Participation, i.e., Community Gardens	Community gardens are common spaces where people of different demographics come together to create, develop, and sustain a gardening space in their locality. Through community gardening, the gardening culture and a greater sense of civic ownership is manifested amongst the public and private estates, schools, and organizations.	National Parks Board (Nparks)	NParks [64]

Table A2. Towns and estates by category.

Mature Towns/Estates	Middle-Aged Towns/Estate	Young Towns
Queenstown	Bukit Batok	
Bukit Merah	Bukit Panjang	
Toa Payoh	Choa Chu Kang	
Ang Mo Kio	Jurong East	
Bedok	Jurong West	
Clementi	Bishan	Punggol
Kallang/Whampoa	Hougang	Sengkang
Geylang	Serangoon	Sembawang
Marine Parade	Tampines	
Central Area	Pasir Ris	
	Woodlands	
	Yishun	
	Bukit Timah	

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