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Review

Systematic Review: Landscape Characteristics Correlated with Physical Activity of the Elderly People

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Abstract: (1) Background: Green and open spaces are conducive to physical activity for the elderly. However, it is unclear how different landscape characteristics relate to the physical activity of the elderly. (2) Methods: following the PRISMA method, this study reviewed the existing literature on the landscape characteristics correlated with the elderly's physical activity (PA) from Web of Science, Scopus, and PubMed. We conducted a systematic full-text review of 25 eligible reports and studies related to the linkage between the characteristics of green and open spaces and the elderly's physical activity (PA); (3) Results: Nature/greenery, safety, road/path conditions, aesthetics, PA facilities, accessibility, amenity, water, and elderly accessibility facilities were found to be positively associated with elderly's PA. Pavement conditions (gravel), the presence of water, poor maintenance, neighborhood aesthetics, and GVI are negatively correlated with the elderly's PA; (4) Conclusions: We close the paper by making a few recommendations for future policy-making, practice, and research. It is suggested that the landscape characteristics be applied in evidence-based policy-making and design, and in tackling health inequality. Future research should be more specific about the impact of site-scale factors, include landscape characteristics specifically needed by the elderly to conduct PA, and involve a wider scope of green and open space on top of neighborhood green and open space and parks. Additionally, these studies should take into consideration different cultural settings and geographical scales to reveal the different effects of various aspects of green and open space.

Keywords: green and open space; landscape characteristics; elderly people; physical activity; health and well-being

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1. Introduction

The ageing of the population is one of the greatest challenges of the 21st century. Physical activity is an important health promotion approach for elderly individuals [1–4]. However, there is a relatively low prevalence of physical activity among adults of advanced age. The national surveys of the United States, NHANES, NHIS, and BRFSS, showed that 27.3%, 35.8%, and 44.3% of older adults meet the physical activity recommendation of 150 min per week of moderate-to-vigorous physical activity (MVPA), respectively [5]. In the 2008 national survey of New Zealand, 34.2% of the elderly (aged 65 and older) met the physical activity requirement of 30 min of MVPA on five or more days per week [6]. In England, only 47% of older adults (65–74 years old) met the recommended level of physical activity according to a 2012 national survey [7]. A systematic review revealed that the proportion of elderly people who met the recommended level of physical activity ranged from 9.8% to 82.6% in urban China and from 52.7% to 60% in rural China [8].

It has been demonstrated that elderly adults can reap additional benefits from engaging in physical activity when it takes place in a green environment. An empirical investigation found that individuals report higher levels of happiness, as well as lower levels of anger

and despair, after going on walks in natural settings [9]. People who live in areas that are physically closer to formal parks are more likely to meet the recommendation for daily physical activity [10]. Living in an area with greater green space has also been connected to a larger proportion of people meeting the recommended amount of physical activity (30 min of moderate to vigorous physical exercise at least five days per week) [11]. These benefits of engaging in physical exercise while being exposed to green space are probably attributable to the fact that green space provides a setting that is open, clean, and inviting [12]. The biophilia hypothesis suggests that humans have an innate tendency to love natural elements [13]; evolutionary psychology theories suggest that landscape preference is influenced by the past need for survival [14]; the attention restoration theory suggests that exposure to nature can improve mental fatigue and concentration. All of these theories suggest that green space offers a variety of psychological benefits [15,16]. Additionally, there is a correlation between larger amounts of green space and increased levels of social interaction among the elderly [17].

The connection between physical activity and green and open space[1] has been the subject of a substantial body of research, which includes a number of review articles. However, the vast majority of the earlier review articles concentrated their attention on people of all ages and frequently relied on composite measurements of green and open space (such as a composite score derived from a number of separate measurements or an accumulation of a number of different hypothesized components) [18]. For example, the review of numerous outcomes of green space including type-2 diabetes, obesity, and physical activity, however, assessed the exposure and access to green space exclusively [19]. Lachowycz & Jones conducted a review that primarily focused on the question of whether or not the presence of green space is positively correlated with PA [20]. In addition, they provided a summary of several specific landscape characteristics that are correlated with PA, including the following: the distance to coastal environments; access to attractive and large green spaces; park amenities such as shading; the number of green spaces; and the size of green spaces. The review on green space intervention also identified aggregated green space initiatives such as restorations to a skate park and senior center, a set of park enhancements, the installation of urban greenway routes, and the complete greening actions of vacant lots [21] (p. 251). On the other hand, the review by Kaczynski & Henderson [18] focused on the individual landscape variables rather than a compromised measure. They summarized the positive correlates, which included living near a coast/lake/beach and having access to "trails/paths, parks, recreation centers, exercise/fitness facilities, sports fields, golf courses, and swimming pools" (p. 339). Whereas, to the best of the author's knowledge, there has not been a comprehensive review conducted on the topic of how landscape design elements are connected to the PA of elderly persons. Levy-Storms and colleagues reviewed the park characteristics related to elderly people's PA, pointing out specific items that are preferred by elderly people, including contrastive colors on pavements and seatings, benches that are easier for wheelchair accessibility, graphics on signs, and other such items [22]. However, in order to better facilitate the physical activity of the elderly, there is a pressing need for research on a broader range of green and open space types in addition to parks.

The purpose of this study is to revisit the publications that investigated the connection between green and open space and the physical activity of senior people and to discover landscape aspects that are connected with elderly people's PA. The systematic review begins with a search and selection of the relevant literature. The results section begins by describing the characteristics of the selected studies and then organizes the findings into objectively measured and perceived landscape characteristics that are correlated with the elderly's PA. Following is the discussion of the results from four aspects, including the facilitators of elderly PA, the special needs of the elderly in an urban setting, the mixed findings, and limitations and suggestions for policymaking, practice, and future research. The conclusion is then drawn regarding the positive and negative correlations of the elderly's PA, as well as the implications of the review.

This work makes a contribution to the existing body of knowledge in the following ways: first, the study provided a summary of the characteristics of the studies with regard to the countries and types of green and open space covered, depicting the big picture of green and open space studies on the relation with elderly PA; second, the study examined the correlation between objectively measured and perceived aspects of the terrain and the level of physical activity that elderly people achieved; third, the study's implications include inspiring specific directions that need more investigation.

2. Methods

2.1. Search Strategy

One of the authors (D. Li) conducted a systematic search of the literature according to the PRISMA method (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) [23]. The PRISMA method was developed in 2009 to transparently report the quality of randomized controlled trials based on a checklist of 27 descriptive items. The method has been widely applied to assessing the quality of research [24–29]. Following the PRISMA statement, the literature search was conducted for studies on the relationship between urban green and open space and the physical activity of the elderly in April 2019 and April 2022. We chose three extensively used online databases on health (PubMed), and inter-disciplinary (Scopus and Web of Science) studies widely used in the disciplines of landscape architecture and urban planning [28,30]. The timeframe of the articles was from 2000 up to April 2022, since the 21st century has seen an increasing number of studies in this field. The same keywords searching within titles and abstracts were applied to each database for the following aspects: "green and open space" AND "landscape characteristics" AND "elderly people" AND "physical activity".

2.2. Study Selection Criteria

The identified studies were eligible if they met all the following criteria:

- Type of articles: English peer-reviewed publications.
- Study designs: empirical, observational studies (e.g., cross-sectional, or longitudinal studies), or experimental studies; quantitative, or mixed-method studies that included quantitative analysis.
- Individual variables: all kinds of green and open space (e.g., parks, plazas, open green fields), measures of landscape characteristics (e.g., vegetation areas, forms of plantings, size of the activity space).
- Outcomes: odds or intensity of leisure-time physical activity of the elderly.
- Measures of outcomes: subjective and/or objective physical activity measure.
- Research questions should include studying the relationships between the characteristics of green and open spaces and the physical activity of elderly people.

Studies that met one of the following criteria were excluded from the review:

- Studies that provided only descriptive results.
- Studies that used only qualitative methodologies in data collection and analysis.
- Articles not written in English.
- Studies that focused on only children or young adults.
- Studies that focused on the built environment without discussing the characteristics of green and open spaces.
- Studies that focused on tourism instead of daily visits to the green and open spaces.

2.3. Data Extraction Process

Based on PRISMA statements, the researcher built a standardized data extraction table to collect variables about methodology and outcome. The aspects of methodology and outcome of the research were: author(s), year (of publication), city & country, study design, geographical coverage, sample size, age, response rate, gender (the proportion of female respondents), green and open space measure, physical activity, adjustment variables,

statistical model, and the relationship found between the characteristics of the green and open space and the PA of elderly people [23,31]. The findings of the included studies are summarized narratively.

2.4. Study Selection

Figure 1 represents the process of study selection. 690 articles were identified, among which 555 were unique. The articles were searched through keywords, titles, and abstracts, including 239 from PubMed, 229 from Scopus, and 222 from Web of Science. 503 articles were excluded by title and abstract screening according to the selection criteria. The remaining 52 articles were read in full. 27 articles were excluded because two articles did not differentiate leisure-time PA from other types of PA, 16 articles did not specify landscape characteristics, two articles used PA as a mediating factor, one article had no access, three articles did not include leisure-time PA, and another three articles did not examine the relationship between PA and landscape characteristics. Hence, 25 articles met the selection criteria and were included.

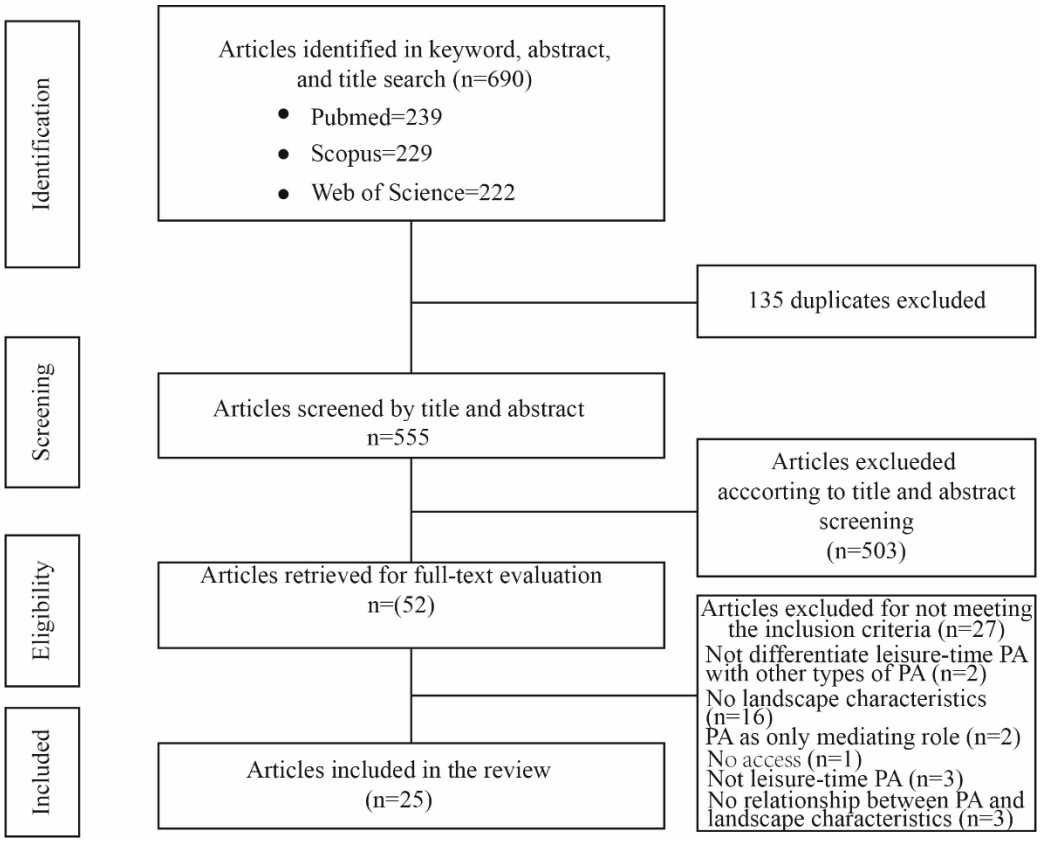

Figure 1. The flowchart of the study selection process.

3. Results

3.1. Characteristics of Selected Studies

Our final sample thus included 25 case studies from seven countries across the world. Details of each case are presented in Table 1. We found that the majority of the cases (40%) were carried out in China (n = 10), followed by the UK (n = 6). We reviewed the 25 cases and recorded their primary information, including participants' age group and methodology (type of green and open space data and type of physical activity data) among these cases. For the stakeholder group, we found some research targeted multiple age groups, with age ranges of 18–75 (n = 1), and 45–69 (n = 1). Other studies targeted the elderly only, with age ranges of 50 years and over (n = 1), 55–65 (n = 1), 60 and over (n = 10), 65 and over (n = 3), 65–94 (n = 1), 69–92 (n = 1), 75–90 (n = 4), and another two studies did not

specify the ages of the elderly. In terms of the types of data, 13 articles assessed the green and open space characteristics by participants (52%), 9 articles measured the green and open space characteristics objectively (36%), and three articles adopted the mixed method approach involving both subjective and objective measures of the green and open space (12%). The physical activity data were assessed by participants in 16 articles (64%), by GPS or other wearable devices in seven articles (n = 28%), by general observation, and by the SOPARC (System for Observing Play and Recreation in Communities) method in one article, respectively. Most of the studies investigated neighborhood green and open space (12 articles), parks (seven articles), streetscape green space (two articles), urban green space (one article), and university settings (one article) (Figure 2).

Table 1. Study characteristics of the included articles (n = 25).

Characteristics of studies	References	*n* (%)
Sample Characteristics		
Country		
China	[1–4,6–8,13–15]	10 (40%)
UK	[5,10,21–23,25]	6 (24%)
Finland	[17–20]	4 (16%)
US	[16,24]	2 (8%)
Austria	[9]	1 (4%)
Portugal	[11]	1 (4%)
Spain	[12]	1 (4%)
Age		
18–75	[11]	1 (4%)
45–69	[22]	1 (4%)
50 years and over	[6]	1 (4%)
55–65	[9]	1 (4%)
60 and over	[1–4,7,8,13–15,23]	10 (40%)
65 and over	[5,10,24]	3 (12%)
65–94	[16]	1 (4%)
69–92	[21]	1 (4%)
75–90	[17–20]	4 (16%)
Elderlies age not specified	[12,25]	2 (8%)
Methodology		
Type of green and open space data		
Assessment by study participant	[2,3,5,7–11,13,14,17,19,21]	13 (52%)
Objective	[1,4,6,12,18,20,22,23,25]	9 (36%)
Both	[15,16,24]	3 (12%)
Type of physical activity data		
Assessment by study participant	[1,3,6–10,13–19,22,23]	16 (64%)
GPS or other wearable devices	[4,5,11,12,20,21,24]	7 (28%)
Observation	[25]	1 (4%)
SOPARC (System for Observing Play and Recreation in Communities)	[2]	1 (4%)

3.2. Objectively Measured Landscape Characteristics Correlated with Elderly's PA

This section is aimed at synthesizing the findings of the association between leisure-time PA and objectively measured landscape characteristics. Nine articles investigated the relationship between leisure-time PA and objectively measured landscape characteristics. In general, 19 landscape characteristics were assessed in association with leisure-time PA in nine independent studies. The 19 objectively assessed landscape characteristics were classified into 7 categories. Table 2 shows the categories and significance of 19 landscape characteristics. Following the PRISMA statement, Table 3 (in supplementary material) provides a summary of the geographical coverage, age, gender, greenspace measure, physical activity measure, statistical model, and connection discovered in the eligible papers.

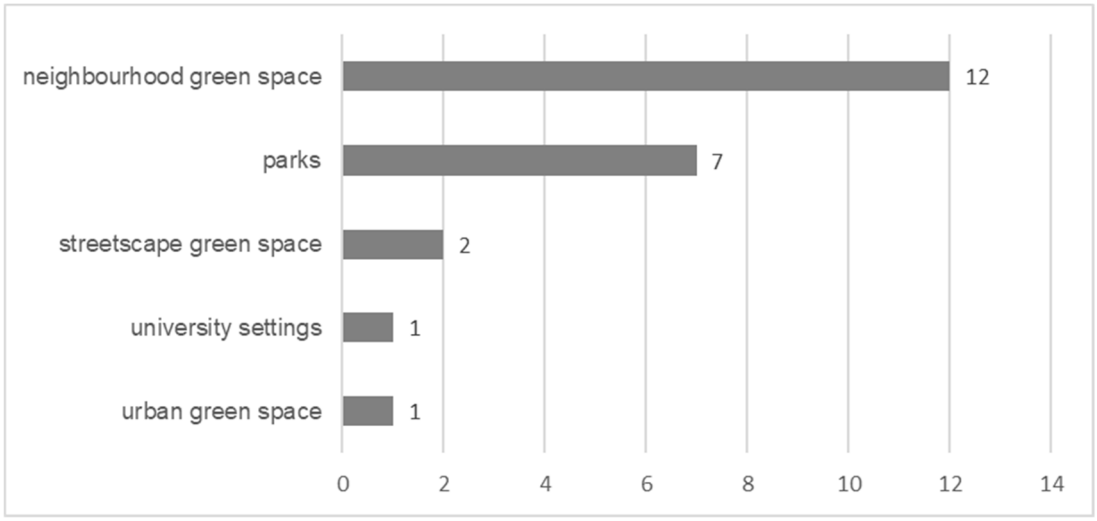

Figure 2. Type of studied green space.

Except for the normalized difference vegetation index (NDVI), green space area, habitat diversity, and the presence of water, each objective landscape characteristic measure was assessed once in a study. NDVI was investigated by 4 studies, with inconsistent results such that half of the four studies found a positive significant relationship between leisure-time PA and the objectively measured landscape characteristics [32,33], and half found no significant relationship [34,35]. The two articles measuring green space area also came up with inconsistent results, one indicating a positive relationship with leisure time PA [36], and the other indicating a non-significant relationship [37]. When it comes to the presence of water, ref. [38] proved higher PA in areas with the presence of water, yet [39] found seniors in parks without water spent more energy. Other indicators about nature/greenery, such as habitat diversity in natural and green areas [32,38], total park area [39], presence of outdoor fitness equipment [39], trail length [39], and natural area [39] were found positively related to leisure time PA.

Table 2. Summary of the significance of objective measures of landscape characteristics.

Number	Category	Objective Measure	References	Key Findings
1	Nature/greenery	Normalized Difference Vegetation Index (NDVI)	[1,22]	(+)
			[6,12]	(×)
		Green space area	[16,23]	(+)
			[16]	(×)
		Habitat diversity in natural and green areas	[18,22]	(+)
		Green View Index (GVI)	[6]	(−)
		Total park area	[4]	(+)
		Natural area	[4]	(+)
		Number of parks	[24]	(×)
		Area of shrubland and grassland	[12]	(×)
		The intervention of trees, flowers, artificial tree decorations	[25]	(×)
2	Pavement conditions	Area of gravels	[12]	(−)
		Area of pavement	[12]	(×)
		Area of mixed features	[12]	(×)
3	Water	Presence of water	[18]	(+)
			[4]	(−)
		Area of water	[12]	(×)

Table 2. *Cont.*

Number	Category	Objective Measure	References	Key Findings
4	Accessibility	Proximity from home	[12,15]	(+)
			[6]	(×)
5	Activity area	Paved activity area	[4]	(×)
		Presence of a sports court	[4]	(×)
6	Fitness equipment	Presence of outdoor fitness equipment	[4]	(+)
7	Road/path conditions	Trail length	[4]	(×)

Association between leisure-time PA and objectively measured landscape characteristics: (+) = significantly positive; (−) = significantly negative; (×) = not significant.

Eight of the 19 objectively-measured landscape variables were found to have no significant association with leisure time PA. The number of parks, area of shrubland and grassland, the intervention of trees, flowers, and artificial tree decorations were variables about green and open space that were found to have no significant relationship with leisure time PA. Two variables about pavement conditions (area of pavement and area of mixed features) were also proved to have no significant relationship with leisure time PA. In addition, variables about activity area (paved activity area and presence of sports courts) and area of water were also found to have no significance with leisure time PA. Only two objective landscape measures were found to be negatively correlated with leisure time PA, which were the area of gravel and GVI. The study of [34] found that the gravel pavement was negatively associated with time spent on active activities (defined as counts per minute >216 vector magnitude (VM) detected accelerometers). The view of streets greenery was found negatively correlated with the elderly's active activities, indicating that elderly people in Shanghai do not wish to do active activities on the streets with green views [35].

Table 3. Overview of the Included Studies based on PRISMA statements.

Study ID	Author (Year)	City, Country	Geographical Coverage	Age	Gender (Female, %)	Greenspace Measure	Physical Activity Measure	Statistical Model	Relationship
1	[33]	Guangzhou, China	19 streets of neighbourhood streetscape greenery	60 and over	56.9	NDVI (Normalized Difference Vegetation Index)	Questionnaire about the average time spent on physical exercises	SEM (Structural Equation Modeling)	Neighbourhood streetscape greenery was positively related to older adultsaverage time spent on physical activity
2	[40]	Hong Kong, China and Leipzig, Germany	6 parks from each city	60 or above	46.7% (Hong Kong) 58.5% (Leipzig)	Perceived park environments: park safety, attractiveness, PA facilities, and amenities	System for Observation Play and Recreation in Communities (SOPARC): PA types and intensity levels in activity areas.	Hierarchical regression	Park attractiveness, distance, and PA facilities and amenities were significantly associated with park-based PA among older adults in Leipzig but not in Hong Kong.
3	[41]	Hong Kong, China and Leipzig, Germany	6 parks from each city	60 or above	52.7	Perceived park environments: park accessibility, safety, attractiveness of parks, physical activity areas, and PA facilities and amenities.	Self-reported park-based PA: PA type, amount of their PA (frequency and duration per week) and intensity levels of their PA in parks.	Multiple linear regressions	Perception of park safety, park attractiveness and park features had a positive association with energy expenditure of PBPA.
4	[39]	Shanghai, China	15 neighbourhood parks	60 and over	43.6	Seven park design characteristics: Park area, trail length, paved activity zone area, natural area, presence of water, outdoor fitness equipment, and court.	Pedometer	One-way ANOVA & linear regression	Seniors in parks with larger surface areas, longer trails, larger natural areas, and outdoor fitness equipment had taken more steps. Seniors in parks without water expended more energy. Seniors' energy expenditure was positively associated with the presence of outdoor fitness equipment.
5	[42]	Birmingham, UK	8 deprived wards	65 and over	62.5	Neighbourhood Environment Walkability Scale (NEWS): perceived neighbourhood safety, pedestrian infrastructure, and aesthetics.	GPS tracking unit	Hierarchical linear regression	Participants perceiving their neighbourhoods to be safer, quieter, or more aesthetically pleasing are more likely to take longer outdoor walks.

Table 3. *Cont.*

Study ID	Author (Year)	City, Country	Geographical Coverage	Age	Gender (Female, %)	Greenspace Measure	Physical Activity Measure	Statistical Model	Relationship
6	[35]	Shanghai, China	23 communities	50 years and over	55.04	Normalized Difference Vegetation Index (NDVI), park size, proximity, and Green View Index (GVI)	WHO Global Physical Activity Questionnaire (GPAQ)	Multilevel two-part model	Only GVI improves the likelihood of total physical activity and active transportation. However, GVI is negatively related to recreational physical activity.
7	[43]	Nanjing, China	16 residential communities	60 and over	50.78	Accessibility (slip-resistant facilities), physical environment (noise, air quality, lighting), supporting facilities (greenery, handrail, security, cleaning, fitness equipment, seating)	Questionnaire: leisure activities (Tai Chi, walking, shopping, vigorous activities).	Correlation analysis	Leisure activities were significantly correlated with road accessibility and slip-resistance measures.
8	[44]	Yiwu, China	8 communities	60 and over	52.4	Chinese version of NEWS: walking and cycling facilities, aesthetics, crime safety, safety from traffic.	International Physical Activity Questionnaire-Short version (IPAQ-S).	Multivariate linear regression	Better aesthetic environment would motivate older people to engage more in recreational physical activity.
9	[45]	Victoria, Australia	84 suburbs	55- to 65-year-olds	52.9	Perceived park proximity, and satisfaction with park quality.	Long version of International Physical Activity Questionnaire (IPAQ-L)	Zero-inflated negative binomial (ZINB)	Among those who walked for recreation, higher park quality was related to more weekly minutes of recreational walking. No relationship between park quality and other types of PA were found.
10	[46]	UK	9 streets	65 and over	53.3	Neighbourhood open space (NOS): pleasant local open space; barriers/nuisance; bad footways/paths; easy to get out and about; good paths and cycleways.	Frequency of outdoor visits, time spent on utilitarian and recreational walking, gardening, outdoor sports, and other outdoor activities.	Hierarchical blocked linear regressions	Summer outdoor activity and time outdoors are predicted by having a clean and nuisance-free local park and attractive routes to it, as well as other natural environments nearby.
11	[47]	Vila Real, Portugal	University settings	18–75	64.84	Connectedness (emotionally) to Nature Scale (CNS)	Triaxial accelerometer wGT3X-BT	Correlation and stepwise regression	Connection to nature did not explain variation in physical activity.
12	[34]	Barcelona, Spain	122 urban green spaces		44.4	Polygons of green space extracted from GIS: pavement, gravel mix surfaces, shrubland and grassland, and water. Distance from home.	Qstarz Q-1000XT GPS loggers and ActiGraph GT3X. Total time spent in green space, time spent sedentary, in active behaviour.	Mixed-effect multilevel regression	A higher proportion of gravel was associated with registering less active time by senior participants. A shorter distance was associated with more time spent on active activities.
13	[48]	Dalian, China	Urban area	60 or older	48.1	Questionnaire: footpath conditions, neighbourhood aesthetics, and safety from traffic.	Interviewer-administered questionnaire involving a 7-day recall: time, origin, destination, travel mode, route names or bus number, tripduration of the habitual activities.	Multinomial logit (MNL) model	Satisfaction with footpath conditions is associated with more participation in leisure-time walking in a park; satisfaction with neighbourhood aesthetics negatively associated with leisure-time walking in a park.
14	[49]	Dalian, China	Urban area	60 or over	52.3	Same with above	Same with above	Same with above	Accessibility, footpath conditions, neighbourhood aesthetics, and traffic safety were found to have no significant relationship with older adults' outdoor activity participation patterns. Crime safety was associated with high-frequency leisure-time physical activity.
15	[50]	Dalian, China	Diverse neighbourhoods	60 or over	49.7	Objectively measured distance to the park. Residential satisfaction with footpath conditions and neighbourhood aesthetics.	Same with above	Same with above	Individuals who are satisfied with footpath conditions are more likely to participate in any type of outdoor physical activity. The coefficients of neighbourhood aesthetics indicate that individuals who are satisfied with neighbourhood aesthetics are more likely to participate in short-duration walking, exercise, and medium-duration exercise.

Table 3. *Cont.*

Study ID	Author (Year)	City, Country	Geographical Coverage	Age	Gender (Female, %)	Greenspace Measure	Physical Activity Measure	Statistical Model	Relationship
16	[37]	Portland, US	56 neighbourhoods	65 to 94 years old	64	GIS measure of the total green and open spaces for recreation. Self-reported proximity to any number of local recreational facilities, safety for walking and from traffic.	Neighbourhood walking (walking, strolling, or other physical activities) in the respondents' neighbourhood.	Regressed on GIS	Perceived number of nearby recreational facilities was positively related to high levels of walking activity.
17	[51]	Jyväskylä and Muurame, Finland	Residential areas by low hills, several lakes	75–90 years old	62	Perceived barriers and facilitators in the outdoor environment (PENFOM; 16 items): parks, walking routes, nature, appealing landscape, familiar surroundings, good lighting, own yard, other people outdoors motivate, services or shops near, even sidewalks, walkways without steep hills, resting places by the walking route, peaceful and good-quality pedestrian routes, no car traffic, no cyclists on walkways, and safe crossings.	Self-reported physical activity was assessed using a seven-point scale combining frequency and the intensity of common physical activities	Logistic regression	Perceived high number of environmental facilitators were associated with higher odds of at least moderate PA among the elderly.
18	[38]	Jyväskylä and Muurame, Finland	Two Finnish neighbouring municipalities	75–90 years old	62	The presence and diversity of natural areas (presence of water, patch density, number of land types, diversity of land use, and habitat diversity.	Self-reported by participants using the question "Thinking of the past half year, which of the following best describes your physical activity?"	Logistic regression	Higher habitat diversity within natural areas correlates with higher PA among older people without walking difficulties and the presence of water correlates with higher PA among those with walking difficulties.
19	[52]	Jyväskylä and Muurame, Finland	Two Finnish 2 neighbouring municipalities	75–90 years old	62	PENFOM	Self-reported question "Thinking of the past half year, which of the following best describes your physical activity?"	Kruskal-Wallis test or Pearson's Chi-Square test	1. In city centres and dense areas outside centres, nature and lakeside, and walking and skiing trails were associated with higher odds for PA. Higher PA was found for walkways without steep hills, good lighting in city centres, and safe crossings in dense areas. 2. In dispersed areas, parks and nature-based facilitators were associated with higher odds for PA, and peaceful walkways, good lighting, and even sidewalks, also correlated with higher PA. 3. High number of infrastructure-based facilitators correlated with higher PA only among city centre residents.
20	[53]	Jyväskyläand Muurame in Central Finland	Two Finnish 2 neighbouring municipalities	75–90 years	62	Habitat diversity in natural and green areas	Accelerometer	Linear regression	More diversity in natural and green areas was associated with more MVPA minutes.
21	[54]	20 towns in the UK	N/A	69–92 years old	44.52	Older People's Environments and CVD Risk (OPECR) tool, with 100 indicators including 'quality of pavement', 'lowered curbs', 'barriers on pavement', 'pavement width', etc.	GT3x accelerometer, Time in MVPA (min/day).	Multilevel linear regression	There was no evidence that any of the physical environment domains captured by the audit tool were associated with time spent in MVPA.
22	[32]	Caerphilly county borough, Wales, UK	N/A	45–69	0	Normalized Difference Vegetation Index (NDVI).	The frequency of their participation in each of the 22 activities	Logistic regression	Increasing the percentage of green space within a 400-metre radius buffer around the home was significantly associated with more participation in physical activity.

Table 3. *Cont.*

Study ID	Author (Year)	City, Country	Geographical Coverage	Age	Gender (Female, %)	Greenspace Measure	Physical Activity Measure	Statistical Model	Relationship
23	[36]	East Anglia, UK	N/A	60 and over	N/A	Each participant's neighbourhood exposure (overlaying the mapped green space with the participant's neighbourhood boundary in the GIS software)	Physical Activity Questionnaire (EPAQ2)	Multi-variable regression models	People living in greener neighbourhoods experienced less of a decline in physical activity than those living in less green areas.
24	[55]	Baltimore, Maryland-Washington, DC and Seattle-King County, Washington regions, US	neighbourhood environment	65 and over	53.1	Objective measures: sum of z-scores of measures of residential density, retail floor area ratio, intersection density, land use mix, and number of parks. Perceived measures: perceived aesthetics and walking facilities.	ActiGraph accelerometers	Mixed effects regression models	High aesthetics accounted for more MVPA than low aesthetics.
25	[56]	Greater Manchester, UK	neighbourhood environment	older adults not specified	N/A	Interventions: tree and flower planting, and artificial tree decorations such as strings of small electric lights and tree socks.	Three levels of physical activity (Sedentary, Walking, Vigorous) by observation	Logic model	There was no evidence that the intervention increased observable wellbeing behaviours or use of these spaces.

To sum up, five of the objectively measured landscape variables were found to have a significantly positive relationship with leisure time PA, eight found no relationship, two were found to have negative significance, and four were found to have inconsistent results.

3.3. Perceived Landscape Characteristics Correlated with Elerly's PA

In total, 26 perceived landscape characteristics were measured in the 14 articles (Table 4). These perceived measures can be classified into nine categories. Half of the 14 articles used measurement scales invented or validated elsewhere, including the Neighborhood Environment Walkability scale (NEWS) [42,44], Neighborhood Open Space scale [46], Connected to Nature scale (CNS) [47], Perceived barriers and facilitators in the outdoor environment (PENFOM) [38,51], and Older People's Environments and CVD Risk (OPECR) tool [54]. The other seven articles came up with their own inventories of measurement.

Half of the tested relationships proved to be positive relationships (n = 31), while only one relationship was negative. Yet 31 tested relationships were demonstrated to be non-significant. Seven out of the 26 variables were found to be only positively correlated with leisure-time PA, which included slip-resistant facilities [54], park attractiveness [40,41], presence of walking and skiing trails [53], nature and lakeside [53], number of recreational facilities (senior centers, gym/fitness centers, public parks, trails) [37], hills in the nearby environment [51,53], and satisfaction with park quality [45].

One variable was found to be only negatively related to leisure time PA, which was barrier/nuisance [46].

Eight variables were demonstrated to have no significant relationships with leisure time PA, such as the number of parks within 500 m distance from home [55], handrails [43], cleaning [43], emotional connection to nature [47], pleasant local space [46], (the presence of) greenery [43], seating [43], and amenity (public toilets, post boxes, public bins, etc.) [54].

However, there were ten variables showing an inconsistent relationship with leisure time PA, manifesting positive significance in some articles while having no significant relationship in other articles. Inconsistent results existed in accessibility, safety, safety from traffic, lighting, neighborhood aesthetics, quality of roads/cycleways, neighborhood pedestrian infrastructure, benches, PA facilities, and the quietness of the environment. Regarding accessibility, more articles found non-significant relationships [41,45,46,52,54] than positive significance with leisure time PA [43,51]. For safety, non-significant relation-

ships [37,40,43,44,49] were proven more than positive significant relationships [41,42].There were more articles proving positive relationships between safety from traffic [48,51,53] than articles proving non-significant relationships. Likewise, for the quality of roads/cycleways, more articles illustrated positive relationships [46,48,50–52] than non-significant relationships [49,54]. More complex cases were illustrated for neighborhood aesthetics, which was found to have positive significance [42,44,50], non-significant relationships [49,54], and negative associations [48] with leisure time PA. Lighting was found by two articles to have a positive association with leisure time PA, and a non-significant relationship between the two articles. PA facilities were found positively related with leisure time PA by two articles [40,41] but not significantly related by one article [43]. Benches and quietness of the environment were demonstrated by one article to be positively correlated with leisure time PA and one article to have no significant relationship.

Table 4. Summary of the significance of perceived measures of landscape characteristics.

Number	Category	Perceived Measure	References	Key Findings
1	Safety	Safety	[3,5]	(+)
			[2,7,8,14,16]	(×)
		Safety from traffic.	[13,17,19]	(+)
			[8,14,16]	(×)
		Lighting	[17,19]	(+)
			[7,21]	(×)
2	Road/path conditions	Quality of roads/cycleways	[10,13,15,17,19]	(+)
			[14,21]	(×)
		Presence of walking and skiing trails	[19]	(+)
		Neighbourhood pedestrian infrastructure (i.e., presence of amenities)	[5]	(+)
			[8]	(×)
3	Accessibility	Accessibility	[7,17]	(+)
			[3,9,10,16,19,21]	(×)
		Number of parks within 500 m of home	[24]	(×)
4	Aesthetics	Park attractiveness	[2,3]	(+)
		Neighbourhood aesthetics	[5,8,15]	(+)
			[13]	(−)
			[14,21]	(×)
5	Nature/greenery	Nature and lakeside	[19]	(+)
		Hills in the nearby environment	[17,19]	(+)
		Satisfaction with park quality	[9]	(+)
		Greenery	[7]	(×)
		Emotional connection to nature	[11]	(×)
		Pleasant local space	[10]	(×)
6	Amenity	Benches	[17]	(+)
			[19]	(×)
		Amenity	[21]	(×)
		Seating	[7]	(×)
		Quietness	[17]	(+)
			[7]	(×)
7	PA facilities	PA facilities	[2,3]	(+)
			[7]	(×)
		Number of recreational facilities (senior centres, gym/fitness centres, public parks, trails)	[16]	(+)
8	Maintenance	Cleaning,	[7]	(×)
		Barriers/nuisance	[10]	(−)
9	Elderly accessibility facilities	Slip-resistant facilities	[7]	(+)
		Handrail	[7]	(×)

Association between leisure-time PA and objectively measured landscape characteristics: (+) = significantly positive; (−) = significantly negative; (×) = not significant.

4. Discussion

4.1. Facilitators of Elderly's PA

As a result of a synthesis of the objectively measured and perceived landscape characteristics correlated with elderly people's PA, there are nine categories that have been grouped from the twenty-five different landscape elements (Table 5). According to the higher order ranking, the nine categories of positive correlations are as follows: nature/greenery, safety, road and path conditions, aesthetics, PA facilities, accessibility, amenity, water, and elderly accessibility facilities. It is clear that people are most interested in the aspects of the park that pertain to the natural environment and greenery, particularly the amount of vegetation (as measured by the Normalized Difference Vegetation Index, the area of green space, the habitat diversity in natural and green areas, the Green View Index (GVI), the total park area, and the natural area). However, the ergonomic elements that are tailored specifically to the requirements of older people have received the least amount of research and have only been the subject of one study. According to the findings of the study conducted by S. Yu and colleagues [43], the performance of the slip-resistance measure of the road, steps, and ramps is positively correlated with elderly PA.

Table 5. The comparison of landscape characteristics positively correlated with the elderly's PA and all age groups.

Landscape Characteristics Positively Correlated with Elderly's PA	Reference	Landscape Characteristics Positively Correlated with PA of All Age Groups	Reference
Nature/greenery (size, presence of hills, etc.)	e.g., [33,55,56]	Nature/greenery (size, number)	[20]
Road/path conditions	e.g., [34,50,52]	Trails and paths	[18]
Aesthetics	e.g., [37,40,41]	Aesthetics	[20]
PA facilities (number of recreational facilities, Paved activity area, Presence of sports court and outdoor fitness equipment)	e.g., [39–41]	PA facilities (exercise/fitness facilities, sports fields, golf courses, swimming pools)	[18]
Accessibility	e.g., [34,43,51]	Accessibility	[18,20]
Amenity (benches, quietness of the environment)	[51]	Amenities (such as shading)	[20]
Safety (safety from crime, safety from traffic, lighting)	e.g., [41,42,48]		
Water	[38]		
Elderly accessibility facilities	[43]		

On the other hand, it has been discovered that five aspects of the landscape are connected negatively with senior people's PA. These aspects are as follows: pavement conditions (gravel), the presence of water, poor maintenance, neighborhood aesthetics, and GVI. It is ironic that the presence of water, the aesthetics of the neighborhood, and GVI, which are negative correlates of older adults' PA in some studies, have been shown to be positive correlations in other research. The diverse research environments likely are to blame for the varying outcomes about water. The positive association is evident in Finland, where older people consider water to be a familiar aspect [38]. A negative correlation was found in China [39], where elderly people spent more energy in parks without water. With respect to aesthetics, in the study conducted by [50], satisfaction with neighborhood aesthetics was found to be a negative correlate of leisure-time walking in parks. This is likely due to the fact that if people were satisfied with the aesthetics of their neighborhood, they might choose to walk around their own neighborhood rather than going to parks to do so. While the view of greenery on the streets is negatively connected with energetic activities, it is positively correlated with walking and cycling, which indicates that different types of green spaces are good for different kinds of activities [35].

4.2. Elderly's PA Needs in Urban Landscape as Compared with the Young Adults

Elderly individuals are more likely to suffer from a decline in their biological functions, such as "a drop in muscle strength, higher levels of weariness, reductions in agility, coordination, equilibrium, flexibility, and joint mobility," and increased rigidity in the tendons [22] (p. 689). As a consequence of this, it is recommended that the environmental design takes into account the ergonomic aspects in order to make PA easier for senior people [57]. Their qualitative research identified ergonomic design aspects for the elderly's PA. These include the use of contrasting colors for the ground and the seating, the use of graphic images on the signs, seats that are accessible for wheelchair users, shorter paths, flat plots, safe use of the area, amenities such as drinking fountains and garbage bins, and immediate lighting that is low in intensity.

On the other hand, the evidence-based literature that currently exists does not contain a substantial amount of examination on the impact of the ergonomic elements of green and open spaces. The discrepancies between the landscape characteristics positively correlated with elderly people's PA and those of people of all ages are compared in Table 5 There are several characteristics that are shared between senior people and people of all ages, such as nature and greenery (in terms of size and number), trails and walks, aesthetics, public access facilities, accessibility, and amenities. Yet the research conducted on senior citizens' PA covered additional aspects than those conducted on other age groups, such as safety, water feature, and elderly accessible feature (slip-resistance of the road, steps, and ramps). Despite this, the attention to age-specific considerations is insufficient since only one study involved the ergonomic environmental aspect [43]. The age-specific environmental needs of the elderly's PA require more academic attention in future studies in order to inspire a more elderly-inclusive design that benefits healthy ageing.

4.3. Mixed Findings of the Landscape Characteristics Correlated with Elderly's PA

There is a degree of inconsistency in the conclusions of various research concerning the same aspects of the environment. Inconsistent relationships were found between elderly people's PA and four objectively measured landscape characteristics (NDVI, green space area, presence of water, and proximity from home) and ten perceived landscape characteristics (accessibility, safety, safety from traffic, lighting, neighborhood aesthetics, quality of roads/cycleways, neighborhood pedestrian infrastructure, benches, PA facilities, and quietness of the environment). The mismatch can be attributed to a variety of factors, some of which include differences in the scale of space, the cultural context, and the types of measurement used. For instance, Ref. [36] analyzed the data from a survey conducted on 15,672 older persons in the county of Norfolk in the United Kingdom. They found that a greener locale was associated with increased levels of physical activity during leisure time PA. However, research conducted in Oregon, United States [37], found that the area of green and open space in the residential level (within a half-mile radius of the resident's home address) was negatively correlated with neighborhood walking. However, the area of green and open spaces at the neighborhood level is positively correlated with walking in the neighborhood, while. This dual result suggests that green areas of different green spatial scales also function differently in terms of their influence on physical activity. In the case of the peacefulness of the environment, the longitude Finland study of [51] demonstrated that in the follow-up interview, more peaceful and high-quality pedestrian routes are correlated with higher odds of engaging in at least moderate physical activity among individuals who had a low level of physical activity at the beginning of the study. In contrast, the results of questionnaire research conducted on 258 senior individuals in Nanjing indicated no correlation between noise and physical activity [43]. As a result of these inconsistencies, it may be deduced that not all landscape characteristics correlated with senior people's physical activity have the same outcomes across geographical locations and spatial scales. The complex issue of how landscape characteristics affect elderly's PA requires careful consideration for research settings and assessment methods.

4.4. Limitations and Recommendations for Further Practice and Research

Given the overview of 25 suitable pieces, there is still not a clear enough grasp of the specific aspects of the environment that attract greater leisure time physical activity for elderly people. There is a paucity of site-scale research to inform design methods, the variety and scope of green and open space explored are limited, and there is little focus on elderly-people-specific landscape characteristics. The following are suggestions for future policy-making, practice, and research.

Future studies should further explore how landscape characteristics impacted elderly people's PA in a specific green area. In the existing studies, more emphasis was devoted to landscape characteristics on a neighborhood and larger scales. Only two articles looked at site-scale characteristics. [39] looked at the length of trails, the area of paved activity zones, the presence of courts, and other things. [34] looked at the area of pavement, the area of shrubland and grassland, the area of gravel, and the area of mixed surfaces. In addition, the focus of these two publications is on the objective measurement of landscape characteristics. There is currently a lack of clear information regarding how the elderly's sensory experiences impacted whether or not they engaged in physical activity in a specific green area on the site scale.

Expanding the scope of green and open space to include a wider variety of settings is yet another important direction of future research. Not only different types of green space, such as formal green and open spaces, and informal ones, such as all kinds of leftover spaces and shared spaces, can be considered, but also different geographic scales. In addition, a wider range of factors, such as ecosystem concepts, stormwater concepts, climate, community ownership, etc., can be addressed. The majority of previous research focused on investigating neighborhood green and open spaces (12 publications) and parks (seven articles). In order to maximize the possibilities for elderly individuals' PA, additional research could be carried out on all types of green and open space, such as urban squares, riverfront green space, streetscape green space, riverside green space, urban squares, and leftover spaces.

In addition, the existing body of research has not given an adequate amount of attention to the green and open space parameters that are unique to the physical activity requirements of the elderly, as was mentioned previously. Because of the wear and tear that occurs in older people's bodily functions as part of the "natural" ageing process, it is vital to consider ergonomic factors while designing landscapes [57]. In future research and clinical practice, the distinct characteristics of the aged population should receive more attention and consideration. Last but not least, because the influence of landscape characteristics on the physical activity of senior people is a complex subject with a large number of conflicting results, researchers conducting subsequent studies had to use appropriate methods and take into account the particular cultural context. In this way, inconsistent correlations regarding the same landscape characteristics (including NDVI, green space area, presence of water, proximity from home, safety, and neighborhood aesthetics, among others) can be comprehended and used to more specific regional and cultural situations, without the need to apply standard findings everywhere from an overly united perspective.

With respect to future policy-making, the identified facilitators and barriers to the elderly's PA can be implemented in green and open space strategies and planning and design codes of green and open space intended for healthy ageing, age-friendly environments, and encouraging elderly people's physical activity. In such strategies and codes, facilitators such as nature and vegetation-related factors, the condition of roads and pathways, aesthetics, PA facilities, amenity, and accessibility facilities should be emphasized, while barriers such as poor pavement conditions and poor maintenance should be avoided. Moreover, the correlations can aid in addressing health disparities. Knowing the correlations between landscape characteristics and the elderly's PA can help identify environmental factors that contribute to the health disparity and make elderly people in disadvantaged areas less likely to engage in PA. Then, policies can be formulated to target interventions for these communities in order to improve the environment and encourage the elderly to engage in

more PA. To sum up, the correlations between landscape characteristics and the elderly's PA can help policymakers to make evidence-based policy decisions in creating environments that support healthy aging.

The review's findings can also be applied to the practice of urban planning and design. On the one hand, planners and designers are benefited from the design of all types of green and open spaces by the knowledge of landscape characteristics positively and negatively correlated with elderly PA. In urban renewal, on the other hand, the findings can assist planners and designers in identifying important aspects for intervention. For example, depending on different situations, providing a sufficient amount of green space and nature, introducing play courts for a variety of activities, enhancing the quality of the pathways, providing shade and benches, etc. Overall, findings on the correlations between landscape characteristics and elderly physical activity can inform planners and designers on how to promote physical activity and improve health outcomes for the elderly population through the planning and design process.

However, the limits of this review must also be acknowledged. First, the bulk of the reviewed research used a cross-sectional study method, which cannot be used to draw any causal conclusions. The longitude research approach was only employed in a single study. Second, the breadth of the literature search is to some extent restricted. There are databases that are unavailable to the author, as well as articles that are not included in the papers that have been peer-reviewed, such as book chapters and reports. Consequently, more studies based on continuous dynamic observation on the relationship between landscape and physical activity of elderly people and broader case collection must be examined in further research.

5. Conclusions

This study is a review of the previous research on the landscape characteristics correlated with geriatric physical activity. Both objectively and subjectively measured landscape characteristics were examined, and the results revealed certain aspects that the policymaking, planning, design practices, and future research must take into account. Findings regarding the correlations between landscape characteristics and elderly PA can be utilized in evidence-based policymaking to create green and open space strategies that are more friendly to the elderly and combat health disparities. The findings are also instructive for planners and designers, who can learn significant landscape characteristics that can encourage physical activity among the elderly. Finally, studies in the future should be more specific about the impact of site-scale factors, include landscape characteristics that are specifically needed by the elderly to conduct PA, and involve a wider scope of green and open space on top of neighborhood green and open space and parks, such as all kinds of leftover spaces and shared spaces. Additionally, these studies should take into consideration different cultural settings and geographical scales to reveal the different effects of various aspects of green and open space.

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Note

[1] Green and open space refers to both green space (meaning "land that is partly or completely covered with grass, trees, shrubs, or other vegetation") and open space (meaning "any open piece of land that is undeveloped (has no buildings or other built structures) and is accessible to the public"). Cited from US EPA, 'What is Open Space/Green Space? | Urban Environmental Program in New England', 2017. https://www3.epa.gov/region1/eco/uep/openspace.html (accessed on 6 May 2019).

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