OCULUM ENSAIOS
REVISTA DE ARQUITETURA E URBANISMO

DOSSIER: AGEING, TERRITORY AND ENVIRONMENT

Editors
Alejandro Perez Duarte Fernandez
e Patrícia Samora

Conflict of interest
There is no conflict of interest.

Parecer do Comitê de ética
The EpiFloripa study was approved by the Ethics Committee for Research Involving Human Subjects (CEPSH) of the Federal University of Santa Catarina under protocol no. 352/2008 and CAAE 16731313.0.0000.0121.

Received
Apr. 16, 2024

Final Version
Sep. 2,. 2024

Approved
Sep. 25, 2024

Influence of proximity to green areas on walking frequency of elderly people over 10 years – EpiFloripa Aging Cohort Study

Influência da proximidade de áreas verdes na frequência de caminhada de pessoas idosas ao longo de 10 anos: estudo de Coorte EpiFloripa Idoso

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Como citar este artigo/*How to cite this article*: Schmitt, I. G. *et al.* Influence of proximity to green areas on walking frequency of elderly people over 10 years – EpiFloripa Aging Cohort Study. *Oculum Ensaios*, v. 21, e2412347, 2024. https://doi.org/10.24220/2318-0919v21e2024a12347en.

Abstract

The practice of regular physical activity brings numerous health benefits, especially among the elderly population. One of the most commonly practiced activities by people of all ages is walking, an easily accessible physical activity. Encouraging walking, whether for commuting and/or leisure, represents a strategy to increase the level of physical activity among the elderly. The presence of green areas, tree-lined streets, parks, and squares near the place of residence is positively associated with walking. This study aimed to analyze the relationship between the perception of green areas near the residence and the walking frequency of elderly people in Florianópolis over a 10-year period (2009-2019). The database of the EpiFloripa Aging Cohort Study, a population-based and household study that monitors the health conditions of a sample of elderly people (60 years old or older), representative of the urban area of the Municipality of Florianópolis in the state of Santa Catarina, was used. A longitudinal GEE analysis was conducted to determine the effect of green area proximity on walking frequency over the waves of the EpiFloripa Aging. The analysis indicated a significant effect when there is a perceived proximity to green areas in relation to the frequency of walking for commuting, leisure, and both. The results allow us to conclude that the proximity of green areas, parks, tree-lined streets and squares contributed to a 53% increase in walking frequency for commuting and a 33% increase in walking frequency for leisure over the course of ten years.

Keywords: Green areas. Walking. Commuting. Elderly. Leisure.

Resumo

A prática de atividade física regular traz inúmeros benefícios à saúde, em especial entre a população idosa. Uma das atividades mais praticadas por pessoas de todas as idades é a caminhada, uma atividade física de fácil acesso. O incentivo à caminhada, seja ela para o deslocamento e/ou lazer, representa uma estratégia para aumentar o nível de atividade física entre

as pessoas idosas. A presença de áreas verdes, ruas arborizadas, parques e praças próximas do local de moradia estão positivamente associadas com a caminhada. Este estudo tem como objetivo analisar a relação entre a percepção de áreas verdes próximas à moradia e a frequência de caminhada de pessoas idosas de Florianópolis ao longo de 10 anos (2009-2019). Foi utilizada a base de dados do Estudo de Coorte EpiFloripa Idoso, um estudo de base populacional e domiciliar que acompanha as condições de saúde de uma amostra de pessoas idosas (60 anos ou mais), representativa da zona urbana do município de Florianópolis (SC). Foi realizada uma análise longitudinal GEE para determinar o efeito da proximidade de áreas verdes sobre a frequência de caminhada ao longo das ondas do EpiFloripa Idoso. A análise indicou um efeito significativo quando há percepção de proximidade de áreas verdes em relação a frequência de caminhada para o deslocamento, lazer e ambas. Os resultados permitem concluir que, a proximidade de áreas verdes, parques, praças e ruas arborizadas contribuiu para o aumento em 53% a frequência de caminhada para o deslocamento e em 33% a frequência de caminhada para o lazer ao longo de dez anos.

Palavras-Chave: *Áreas verdes. Caminhada. Deslocamento. Idosos. Lazer.*

Introduction

Regular physical activity brings significant health benefits, especially among the elderly population. Studies such as those by McAuley *et al*. (2006) and Rejeski and Mihalko (2001) indicate that regular physical activity is an important component for a good quality of life for the elderly, increasing their life expectancy and providing benefits in the mental, physical and social spheres.

In addition, there are also health benefits resulting from physical activity, such as the preventive effect against cardiovascular diseases (Manson *et al*., 2002) and type 2 diabetes (Folsom; Kushi; Hong, 2000). It also has an impact on life satisfaction and mental well-being of the elderly, including decreased levels of depression and anxiety (Lampinen *et al.*, 2006).

With the global elderly population growing, there is a demand for living environments that are conducive to healthy aging, such as walkable open leisure spaces. The presence of parks and green spaces near homes can lead to an increase in the level of physical activity because of the convenience of these spaces being close by (Kaczynski; Henderson, 2007). In the same way, well-connected, tree-lined streets with infrastructure encourage walking and cycling (Hong; Chen, 2014).

There is, therefore, a relationship between the presence of green spaces and higher levels of physical activity at the neighborhood level. One of the most popular activities practiced by people of all ages is walking, a physical activity that is easily accessible (Bassett Junior *et al.*, 2008). Therefore, encouraging walking, whether for commuting and/or leisure, represents a strategy to increase the level of physical activity among the elderly.

As studies show, promoting these activities can significantly reduce the number of chronic diseases, prolong years of active and independent life, in addition to improving the individual's quality of life. In this context, the literature also indicates that the presence of green areas, tree-lined streets, parks and squares near the place of residence are positively associated with walking.

Given the above, this study aimed to analyze the relationship between the perception of the proximity of green areas to the residence (parks, squares and tree-lined streets) and the frequency of walking among elderly people in the city of Florianópolis over a 10-year period (2009-2019). The hypothesis is that the frequency of walking among elderly people who perceive the proximity of green areas in their neighborhood is greater than the frequency of walking among elderly people who do not perceive the proximity of green areas in their neighborhood.

Theoretical Framework

The association between the proximity of the residence to an open leisure space, such as parks or other green spaces, and higher levels of physical activity has been mentioned in several studies (Colom *et al.,* 2018; Eronen *et al*., 2014; Gibson, 2018; La Rosa *et al.*, 2018; Mowen *et al*., 2007; Ode Sang *et al*., 2016; Petersen *et al*., 2018; Pleson *et al*., 2014; Sugiyama; Thompson, 2008; Thompson; Aspinall, 2011).

Research by Mowen *et al.* (2007) in Cleveland, Ohio, with 1515 elderly people showed that the perception of a nearby park, within walking distance, was related to physical activity and health through the frequency of the park use.

In the study by Eronen *et al.* (2014), the conclusion was that having a park or other green area within a short distance from home was the most frequently reported encourager of walking and mobility among the participating elderly participants.

A survey in Hamburg, Germany, with 272 people over 65 years of age, conducted by Petersen *et al.* (2018), showed that the weekly period of exposure to urban green spaces was significantly associated with time spent in moderate and vigorous physical activities. While urban green spaces located a long distance from the residence were pointed out as a barrier to the practice of physical activities by the interviewees.

Sugiyama and Thompson (2008), investigating green spaces near elderly people's homes in the United Kingdom, found that the pleasantness of the open space and the absence of inconveniences were associated with walking for recreation, while good paths to access open space and good infrastructure were conducive to more walking for transport. They point out that walking in and around neighborhood open spaces often involves both contact with nature and opportunities for social interaction. Thus, walking in open spaces can offer health benefits in several ways. This reinforces the importance of planning "walkable" green spaces so that they contribute to the health of older people through the quality of their neighborhood environments.

Another study, conducted by Thompson and Aspinall (2011), with people over 65 in the United Kingdom, associated proximity to parks and other green areas, and pleasant routes leading to these areas, with a higher level of physical activity.

Another cross-sectional study conducted in Great Britain, with 284 people over the age of 65 explored the association between life satisfaction and outdoor activities, such as walking (Sugiyama; Thompson; Alves, 2009). This study found that distance to open spaces in the neighborhood was significantly associated with health status, life satisfaction, and time spent walking. The results indicated that the pleasantness and safety of open spaces were relevant to life satisfaction, and that the quality of paths was associated with walking behavior. The study found that people living near good paths to open spaces were twice as likely to be "high-level walkers", that is, walking 2.5 hours per week or more. The results also indicated that having an open space within 700 m of a home was more likely to be associated with higher life satisfaction. Similarly, a cross-sectional study in two parks in Beijing examined the relationships between park path design characteristics and walking behavior among the elderly (Zhai; Baran, 2017). The correlation analysis of this study indicated that older adults prefer paths with smooth or uniform pavement, benches, flowers and lights, and are attracted to wider paths (between 3 and 3.9 meters wide) that are not connected to other activity areas in the park.

Methodological Procedures

For the analyses presented here, the EpiFloripa Aging Cohort Study database was used, a population-based and household study that monitors the living and health conditions of a sample of elderly people (60 years or older), representative of the urban area of the Municipality of Florianópolis in the state of Santa Catarina (SC).

Florianópolis is a municipality with approximately 537 thousand inhabitants in 2022, according to the *Instituto Brasileiro de Geografia e Estatística* (IBGE, Brazilian Institute of Geography and Statistics) and is located in the state of Santa Catarina. It spatially occupies the island of Santa Catarina and a small continental portion. Thus, it has a large stretch of coastline with beaches suitable for sports and recreational activities. It is also worth mentioning the role that open spaces classified in the *Sistema Nacional de Unidades de Conservação* (SNUC, National System of Conservation Units – Law No. 9.985/2000) play in the municipal context. According to Florianópolis' *Fundação Municipal do Meio Ambiente Municipal* (FLORAM, Municipal Environmental Foundation) and Municipal Government of Florianópolis 2024, the Municipality of Florianópolis has 21 Conservation Units (CUs), covering 41% of its territory. Although their central function is environmental, some of the Conservation Units existing in Florianópolis allow for leisure and recreational uses. This high percentage of territorial protection, combined with the geographical distribution of Conservation Units in a discontinuous urban area, i.e., where the urban area is permeated by hills (whose vegetation is preserved), dunes, mangroves, and bodies of water of the most diverse types, means that natural elements, especially vegetated ones, can be seen in almost the entire territory of the municipality. On the other hand, parks and squares are more concentrated in the central portion of the municipality, which is also the most densely populated area, and where the island is connected to the mainland.

In Figure 1, below, it is possible to identify the urban perimeter of Florianópolis. In this figure, it is also possible to identify the large stretch of coastline in the municipality. The conservation units mentioned above coincide, for the most part, with the green spots visible in this same figure.

The study in question began in 2009/2010 with wave 1, when 1,705 people aged 60 or over participated (n = 1,705). In 2013/2014, wave 2 occurred, with the participation of 1,197 people in this age group (n = 1,197), and in 2017/2019, wave 3, with the participation of 1,327 respondents (n = 1,327).

To ensure the sample was representative of the urban area of Florianópolis, the baseline participants (Wave 1) were selected from census tracts (IBGE, 2000) that were randomly drawn, proportionally stratified by deciles of household head income. A total of 80 out of 420 urban census tracts were selected, with the sample designed to include an estimated 20 older adults per tract (Giehl *et al.*, 2012).

In the second wave, the sample was based on the 1,705 participants from the baseline (wave 1) and at the end of the active search, 1,197 elderly people were interviewed again, as 217 deaths were detected, 129 refusals occurred and 159 losses occurred (Orsi *et al.*, 2020). The sampling plan for the third wave was constructed based on the first and second waves, and with data from the 2010 Census, in order to maintain the representativeness of the elderly population of Florianópolis (SC). Thus, of the 1,327 elderly people interviewed in wave 3, 743 came from the baseline, 105 from the EpiFloripa Aging sample who were 60 years of age or older and 487 new interviewees (Orsi *et al.*, 2020). It should be noted that the baseline people aged 60 or over, belonging to the EpiFloripa Aging census sectors of the baseline, were included to replace the sample.

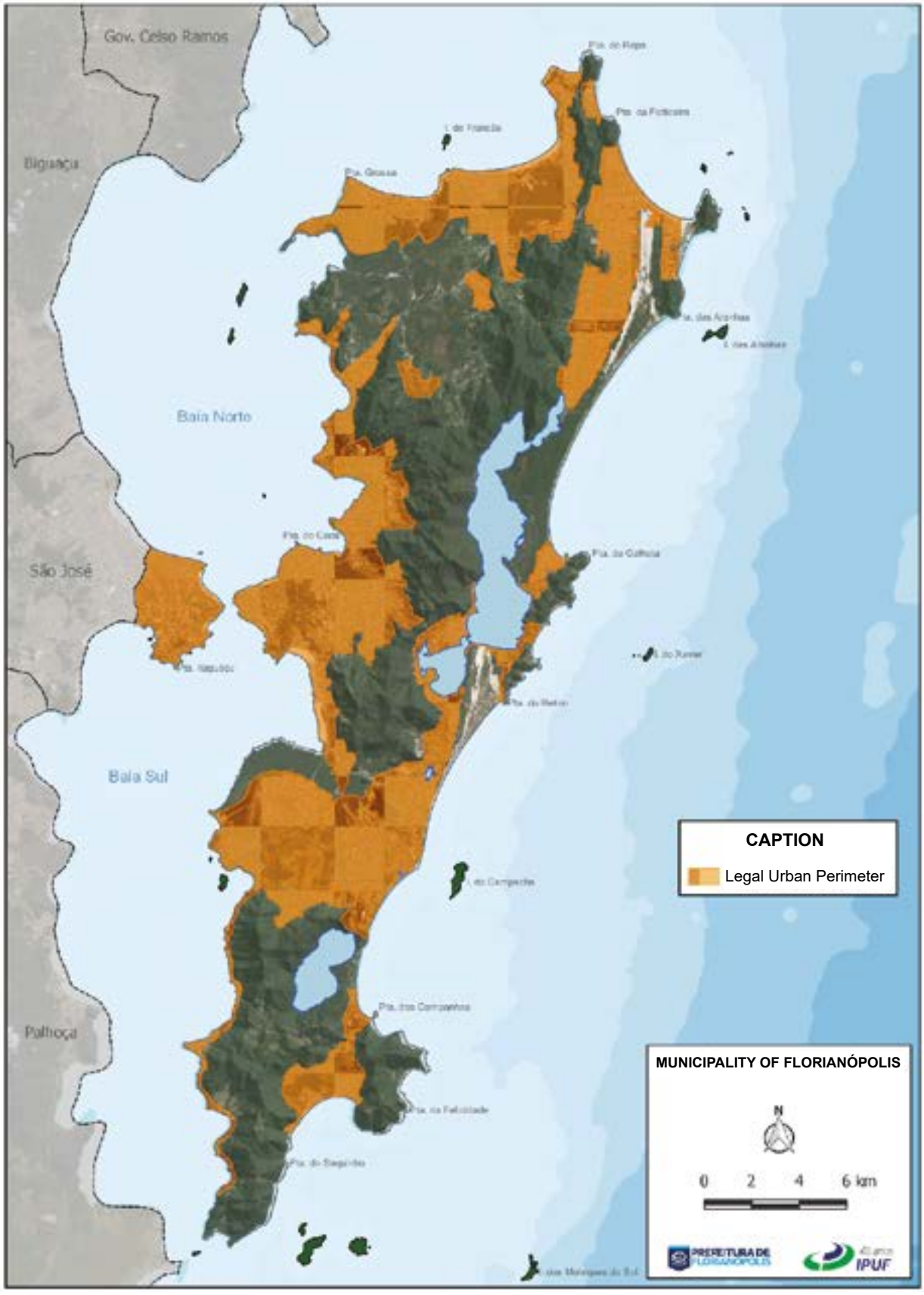

Figure 1 – Map of the legal urban perimeter of Florianópolis SC.

Source: *Instituto de Planejamento Urbano de Florianópolis* (PMF, Florianópolis Urban Planning Institute – 2022).

To recruit new elderly individuals, a partnership was established with the Municipal Government of Florianópolis, which involved the collaboration of the coordinators of the Health Centers (Orsi *et al*., 2020). They were responsible for contacting and training the Community Health Agents (CHAs) to assist in identifying elderly individuals in order to reach the minimum number of interviewees required in each census sector.

The cluster sampling design aimed to produce adequate estimates for the elderly population of the city of Florianópolis (SC).

To collect data, the research instrument adopted was a face-to-face home interview, through the application of a structured questionnaire.

The EpiFloripa Aging cohort study m*et all* ethical precepts and was approved by the *Comitê de Ética em Pesquisa Envolvendo Seres Humanos* (CEPSH, Ethics Committee for Research Involving Human Beings) of the *Universidade Federal de Santa Catarina* (UFSC, Federal University of Santa Catarina, protocol no. 352/2008 and CAAE 16731313.0.0000.0121.

Outcome and exposure variables

To achieve the research objective, the perception of proximity of green areas to the place of residence was defined as the exposure variable, and the frequency of walking by the elderly throughout the three waves of EpiFloripa Aging as the outcome variable.

For the outcome variable (dependent), three scenarios were considered: (1) frequency of walking for commuting, (2) frequency of walking for leisure, and (3) frequency of walking for commuting and leisure.

The level of physical activity in each scenario was assessed using the International Physical Activity Questionnaire (IPAQ), which was administered by EpiFloripa Aging interviewers. The IPAQ is a tool used to measure physical activity levels. Its short version assesses physical activity in the last seven days, considering the duration and weekly frequency of walking, moderate and vigorous activities. The level of physical activity is assessed in different sections. In this study, walking practices aimed at leisure and commuting were considered. In addition, the instrument used is widely recognized, standardized and validated internationally, being proposed by the World Health Organization (WHO) and the *Centro de Controle e Prevenção de Doenças* (CDC, Center for Disease Control and Prevention).

Because this is a longitudinal study, the same questionnaire was applied in the three waves of EpiFloripa Aging. For scenario 1 (walking for commuting), the following question was used: "How many days during a normal week do you walk to get from one place to another, such as going to work, the supermarket, the pharmacy, the senior social group, church, the doctor, the bank, visiting friends and relatives for at least 10 continuous minutes?". And for scenario 2 (walking for leisure), the following question was used: "Not counting any walks that you mentioned previously, on how many days during a normal week did you walk (for leisure or physical exercise) in your free time for at least 10 continuous minutes?". For scenario 3 (walking for commuting and leisure), the two questions described above were considered.

The exposure variable (independent) considers the perception of the proximity of green areas in the neighborhood of the interviewed elderly (parks, squares and tree-lined streets). In this study, some questions from the "Social Indicators" block were used, specifically the item "Perception of the environment for physical activity". In this block of questions, the elderly reported their perception of the characteristics of the neighborhood environment, defined as the places located

within a 15-minute walk from the elderly's residence. For this, two questions from the questionnaire were used, also applied in the three waves that contain information about the perception of the characteristics of the neighborhood environment: "Are there public spaces such as parks, squares, walking trails, bike paths and/or sports courts near your home?" and, "Are there green areas (such as trees) along the sidewalks and streets near your home?".

From these two questions, the exposure variable was categorized in relation to the answers "yes = 1" and "no = 0". Therefore, respondents who answered "no" to both questions were considered "not exposed" (0 + 0 = 0 ➔ not exposed). The category "exposed to one" for respondents who said "yes" to one of the questions (0 + 1 = 1 ➔ exposed to one) and "exposed to both" for respondents who answered "yes" to both questions (1 + 1 = 2 ➔ exposed to both).

Control variables

The study included control variables relating to the demographic data of the interviewees, such as age (60-69, 70-79, 80 or older) in years, sex (male or female), education (0-8, 9-11, 12 or more) in years and per capita income (up to 1, 1-2, 2 or more) in Brazilian minimum salary.

Statistical analysis

For descriptive analyses, absolute frequency (expressed in numbers) and relative frequency (expressed in percentages) were used. To estimate the effect of the perception of proximity to green areas on the frequency of walking over the 10 years of monitoring of the EpiFloripa Aging Cohort Study (2009-2019), a longitudinal analysis model with Generalized Estimating Equations (GEE) was used.

For this GEE analysis, the data were changed to long format using the "reshape" command, with "ID" as the identification variable and "wave" as the time variable. The "xtgee" command was then used for analysis and the log link function of the Gaussian family was applied. Two analysis models were performed: a crude model in which the relationship between the outcome and exposure was analyzed; and an adjusted model in which, in addition to the analysis of the outcome and exposure, control variables (sex, age, education, and income) were also included to determine whether these factors could modify the relationship between the outcome and exposure. The data were presented with their respective 95% confidence intervals and with a significance level set at $p < 0.05$. The analyses were performed using the statistical software Stata version 14.0.

Results

Table 1 presents the characteristics of the sample in the 3 waves of the EpiFloripa Aging Cohort Study. In the sample, there is a predominance of women (63.87% in wave 1, 65% in wave 2 and 61.04% in wave 3), and in relation to age, we can observe a higher frequency of the older age groups because of the aging of the cohort.

In addition, there was also an improvement in per capita income over the waves, mainly in the 1-2 and 2 or more Brazilian minimum salaries variable; regarding education in wave 3, there was an increase in the number of interviewees in the category with 12 or more years of study.

Table 1 – Characteristics of the sample in the 3 waves (2009/10, 2013/14, 2017/19) of the EpiFloripa Aging Cohort Study, Florianópolis (SC, Brazil).

Control variables						
Variable	Wave 1		Wave 2		Wave 3	
Sex	n (*)	%	n (**)	%	n (***)	%
Male	616	36.13	419	35.00	517	38.96
Female	1089	63.87	778	65.00	810	61.04
Age (years)						
60 - 69	850	49.88	412	34.42	453	34.14
70 - 79	616	36.15	509	42.52	554	41.75
80 or more	238	13.97	276	23.06	320	24.11
Education (years)						
0 - 8	1060	62.57	722	60.47	669	50.61
09 - 11	241	14.23	180	15.08	227	17.17
12 or more	393	23.20	292	24.45	426	32.22
Per capita income						
Up to 1 MS	577	34.78	233	20.32	262	20.00
1 to 2 MS	406	24.47	358	31.21	410	31.30
2 MS or more	676	40.75	556	48.47	638	48.70

Note: (*) n varies from 1705 to 1659; (**) n varies from 1197 to 1147; (***) n varies from 1327 to 1310
Source: Prepared by the authors (2024).

The exposure variable considers the perception of the proximity of green areas to the place of residence of the elderly interviewed, categorized as "Not exposed", "Exposed to one" and "Exposed to both". Figure 2 shows the proportion of interviewees in each of the categories.

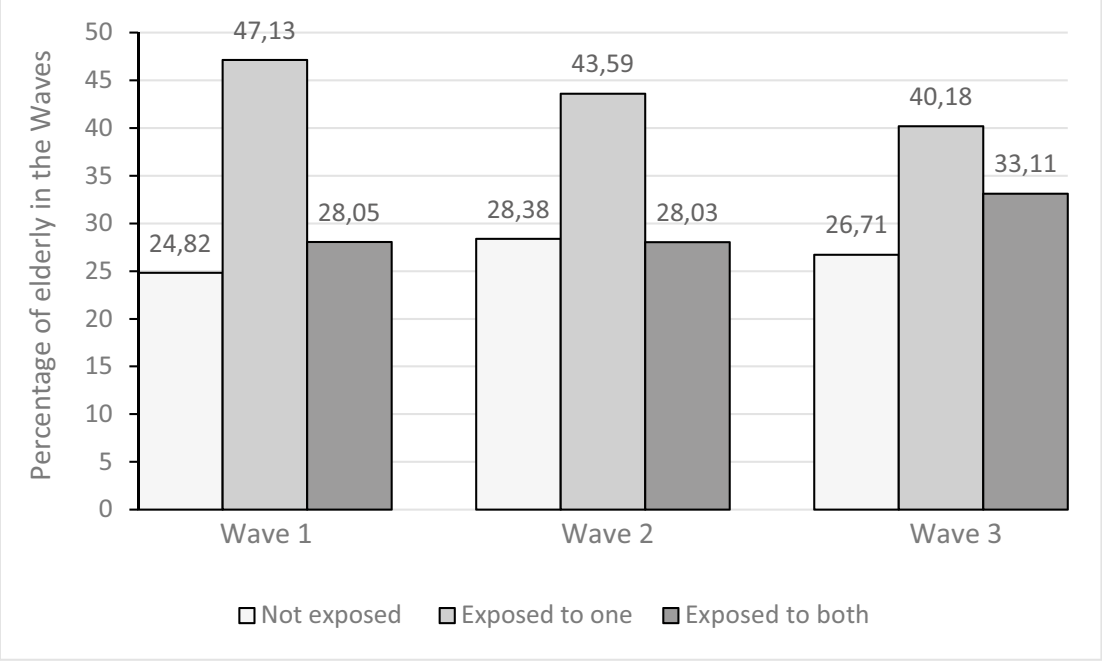

Figure 2 – Percentage of respondents in relation to proximity to parks, squares and green areas ("Not exposed", "Exposed to one", "Exposed to both").

Source: Prepared by the authors (2024).

We can observe an increase in the number of elderly people living near parks, squares and tree-lined streets in wave 3 (28.05% wave 1, 28.03% wave 2 and 33.11% wave 3).

Regarding the frequency of walking to commute (International Physical Activity Questionnaire, IPAQ-D), there is a predominance of interviewees who do not walk any day a week (39.91% wave 1, 36.60% wave 2 and 32.05% wave 3), on the other hand, a considerable portion who walk 7 days a week to commute (20.24% wave 1, 16.58% wave 2 and 23.01% wave 3). In Figure 3, it is possible to observe the distribution of the number of interviewees in relation to the frequency of walking to commute.

In the frequency of walking for leisure (IPAQ-L) there is a predominance of interviewees who do not walk for leisure on any day of the week (66.10% in wave 1, 72.19% in wave 2 and 67.05% in wave 3). Figure 4 shows the distribution of the number of interviewees in relation to the frequency of walking for leisure.

Due to the predominance of interviewees who do not walk any day for commuting or leisure, the answers were categorized as: "Does not walk" for those who responded that they do not walk any day of the week, and "Walks" for those who responded that they walk 1 to 7 days of the week. Figures 5 and 6 show the frequency of interviewees who "Does not walk" and "Walks" for commuting and leisure throughout the 3 waves, respectively.

Based on Figures 5 and 6, we can observe that there is a greater number of elderly people who walk to commute (60.09% in wave 1, 63.40% in wave 2 and 67.94% in wave 3) compared to walking for leisure (33.90% in wave 1, 27.81% in wave 2 and 32.95% in wave 3).

When considering the number of interviewees who walk to commute and/or leisure, the data were categorized into "Does not walk" which includes elderly people who do not walk for either option, "Walks" for those who walk to commute or leisure, and "Walks more" for those who walk for both activities.

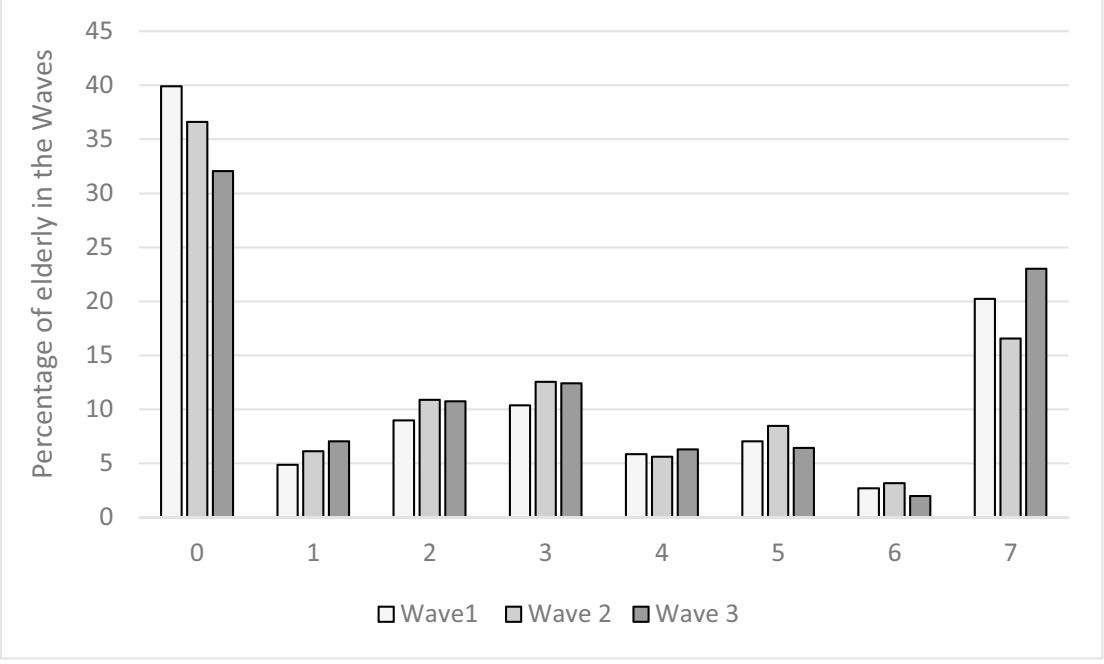

Figure 3 – Relationship between the number of interviewees and the frequency of walking to commute in days per week in the 3 waves.
Source: Prepared by the authors (2024).

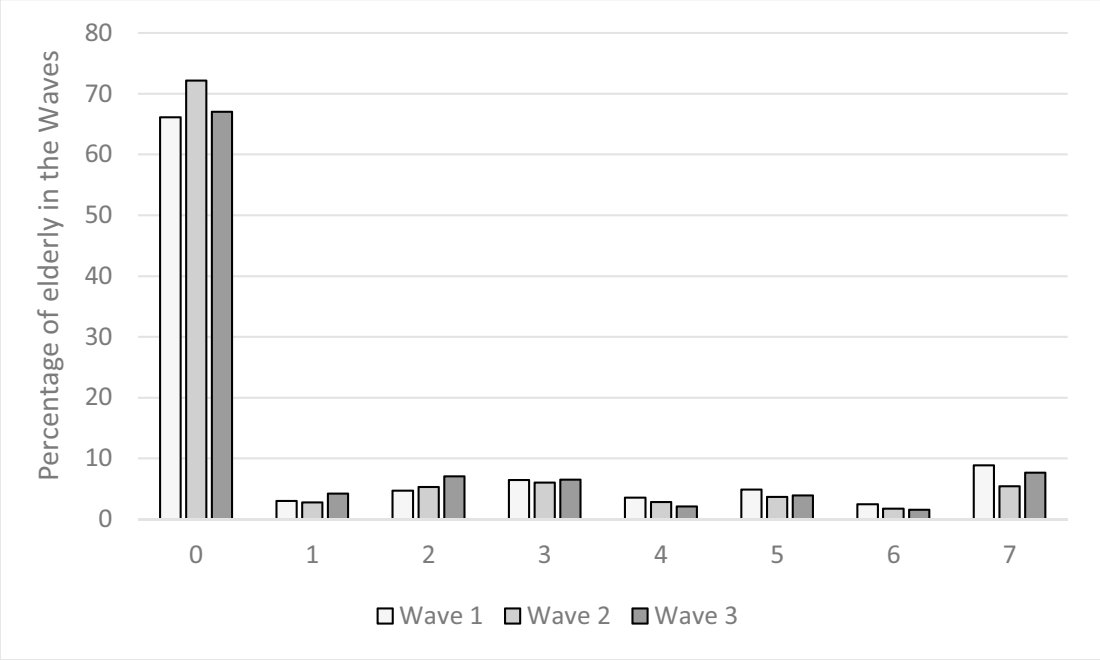

Figure 4 – Relationship between the number of interviewees and the frequency of walking for leisure in days per week in the 3 waves.
Source: Prepared by the authors (2024).

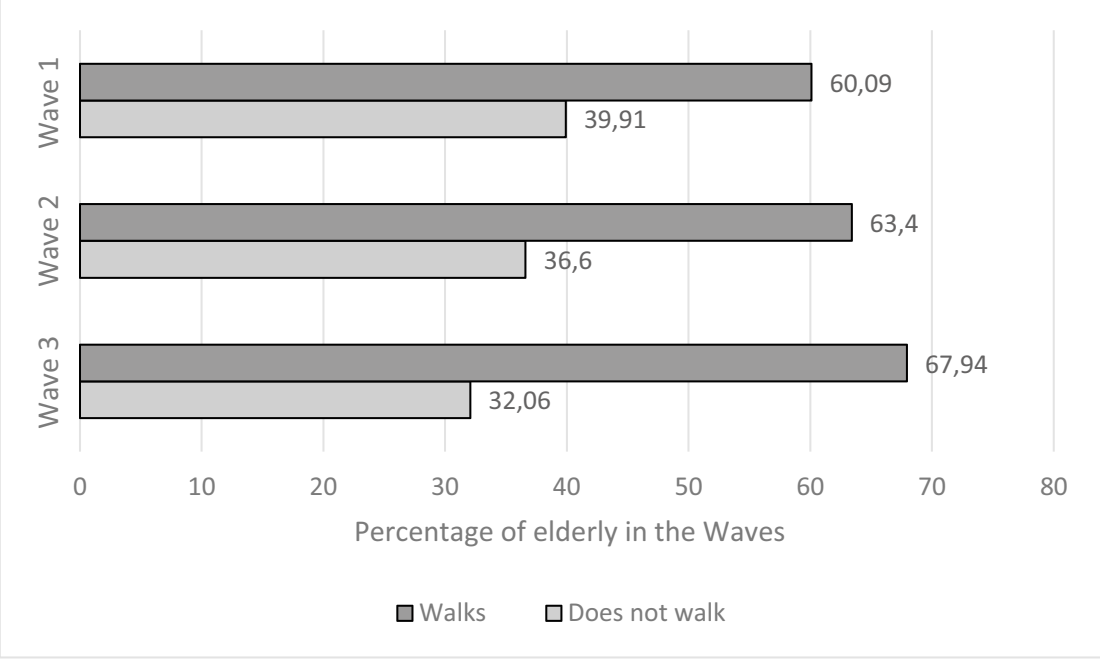

Figure 5 – Frequency of walking to commute ("Walks" and "Does not walk").
Source: Prepared by the authors (2024).

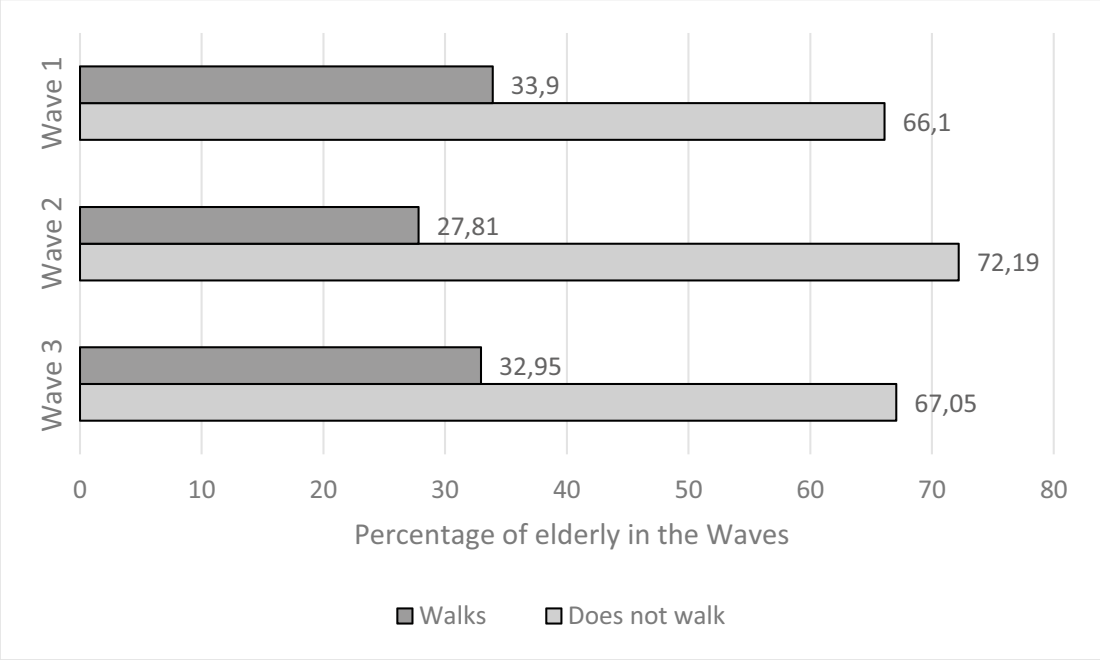

Figure 6 – Frequency of walking for leisure ("Walks" and "Does not walk").
Source: Prepared by the authors (2024).

Figure 7 shows the percentage of the sample that "Does not walk", "Walks" and "Walks more", and we can see that around half of the interviewees walk for commuting or leisure (46.59% wave 1, 51.68% wave 2 and 49.73% wave 3).

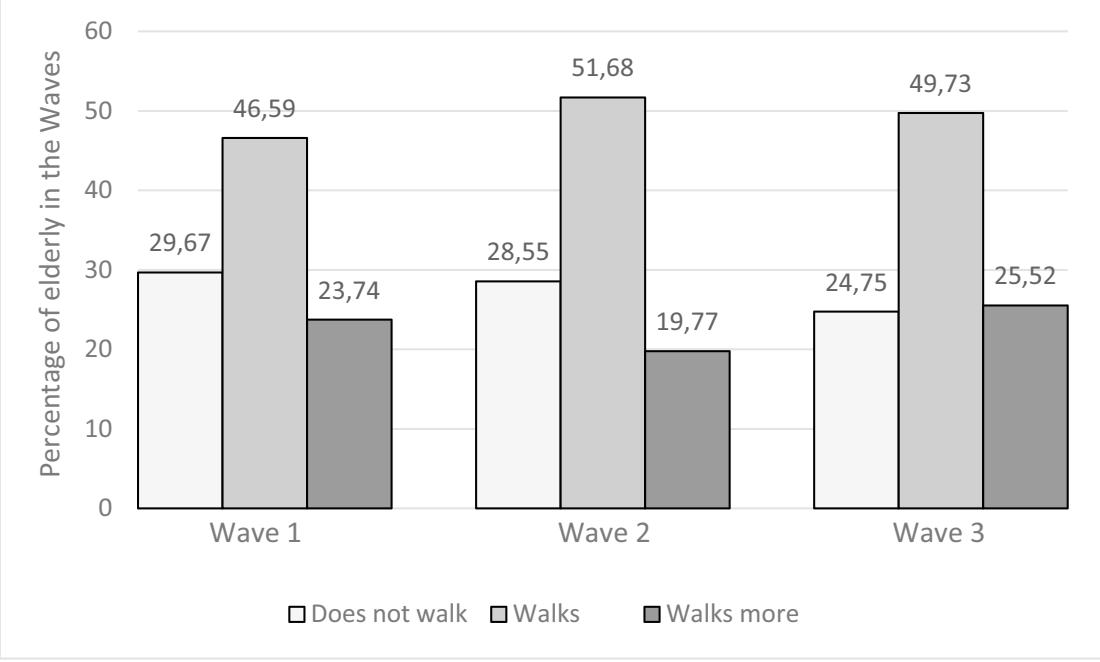

Figure 7 – Walking frequency categorized as "Does not walk", "Walks (leisure or commuting)" and "Walks more (leisure and commuting)" across the 3 waves.
Source: Prepared by the authors (2024).

Observing the frequency of walking for leisure among those "not exposed" to green areas, there is a reduction in this practice over the three waves, as shown in Figure 8 (33.66% wave 1, 19.25% wave 2, 26.38% wave 3).

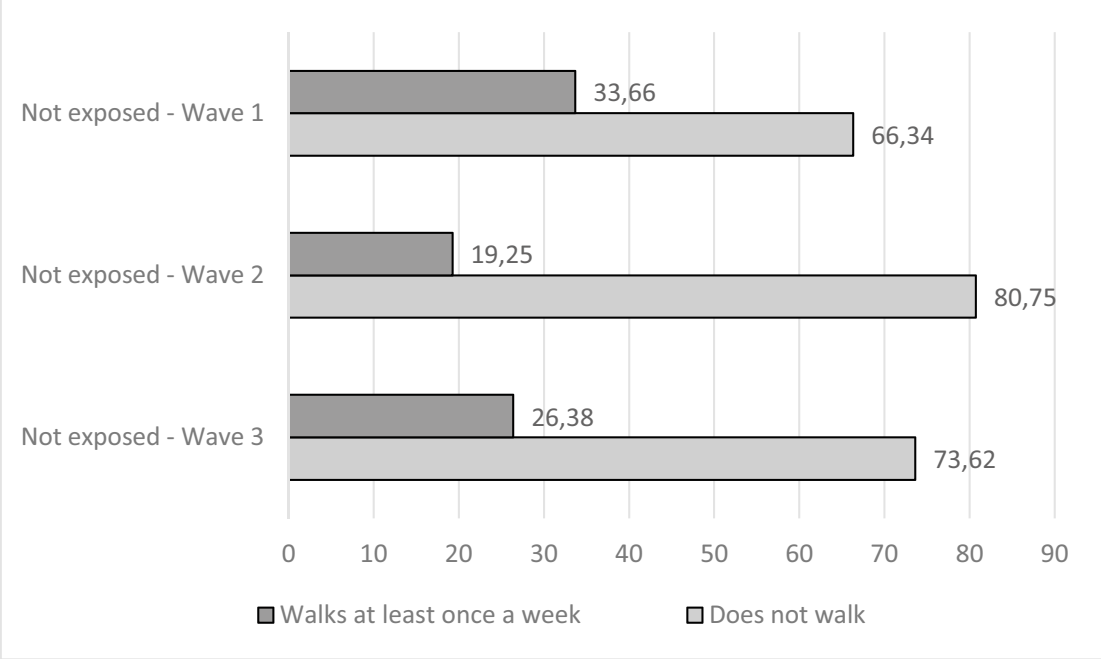

Figure 8 – Frequency of walking for leisure of those "Not exposed" to green areas categorized as "Does not walk", "Walks at least once a week" over the 3 waves.

Source: Prepared by the authors (2024).

Longitudinal analysis of walking frequency

A longitudinal GEE analysis was performed to determine the effect of the perception of proximity to green areas on the frequency of walking throughout the waves of EpiFloripa Aging. The analysis indicated a significant effect when there is a perception of proximity to green areas in relation to the frequency of walking for commuting, leisure and both.

Table 2 presents the results of the crude and adjusted analysis of the frequency of walking among elderly individuals in relation to exposure to green areas. In the adjusted analysis, the effects of control variables such as sex, age, years of education and family income were considered, with the aim of isolating the specific effect of exposure from other factors that could influence this relationship.

The analyzes were performed considering the 3 scenarios: (1) frequency of walking for commuting (IPAQ-D), (2) frequency of walking for leisure (IPAQ-L) and, (3) frequency of walking for commuting and leisure (IPAQ-D + IPAQ-L).

For each scenario, the coefficient indicating how much the walking frequency increases (or decreases) with exposure to green areas, the p-value showing the statistical significance of the results, and the 95% CI (confidence interval) are presented.

The results show that the perception of exposure to green areas is associated with a significant increase in the walking frequency, suggesting a positive and consistent relationship between exposure to green areas and walking among the elderly.

Table 2 – Crude and adjusted analysis of walking frequency (commuting, leisure and both).

Crude and adjusted analysis of walking frequency (IPAQ-D)							
Variable	Category	Crude analysis			Adjusted analysis		
		Coefficient	p value	95% CI	Coefficient	p value	95% CI
Green areas	Exposed to one	1.17	0.107	0.96 - 1.42	1.07	0.504	0.88 - 1.29
	Exposed to both	1.53	0.000	1.23 - 1.90	1.41	0.002	1.13 - 1.75
Crude and adjusted analysis of walking frequency (IPAQ-L)							
Variable	Category	Crude analysis			Adjusted analysis		
		Coefficient	p value	95% CI	Coefficient	p value	95% CI
Green areas	Exposed to one	1,19	0,041	1,00 - 1,40	1,12	0,179	0,95 - 1,32
	Exposed to both	1,33	0,003	1,10 - 1,60	1,23	0,033	1,02 - 1,48
Crude and adjusted analysis of walking frequency (IPAQ-D + IPAQ-L)							
Variable	Category	Crude analysis			Adjusted analysis		
		Coefficient	p value	95% CI	Coefficient	p value	95% CI
Green areas	Exposed to one	1.09	0.000	1.04 - 1.15	1.07	0.011	1.02 - 1.12
	Exposed to both	1.17	0.000	1.10 - 1.23	1.14	0.00	1.08 - 1.20

Source: Prepared by the authors (2024).

In the crude analysis, it is observed that exposure to green areas ("exposed to one") is associated with an increase in the score of 1.17 in the frequency of walking for commuting, 1.19 in the frequency of walking for leisure, and 1.09 in the combined frequency of walking for commuting and leisure. However, when considering greater exposure to green areas ("exposed to both"), the association between the variables intensifies, resulting in an increase in the score of 1.53 in the frequency of walking for commuting, 1.33 in the frequency of walking for leisure, and 1.17 in the combined frequency of walking for commuting and leisure.

Adjusted analyzes show that, even when controlling for factors such as sex, age, education and family income, the association between exposure and outcome remains statistically significant, although with slightly lower coefficients than in the crude analysis, which only assesses the relationship between exposure and outcome without including control variables.

In addition, the results demonstrate that a greater perception of exposure to green areas has a greater effect on the frequency of walking for commuting, compared to the frequency of walking for leisure and both.

Discussion

The main findings of this study indicate that there is a relationship between the perception of proximity of green areas to the residence and the frequency of walking among the elderly in Florianópolis (SC). Other studies corroborate the relationship between the availability of green leisure areas around the residential area and the propensity to practice physical activities, such as those by Mowen *et al.* (2007), Sugiyama and Thompson (2008), Sugiyama *et al.* (2009), Eronen *et al.* (2014) and Petersen *et al.* (2018).

For example, a cross-sectional survey with 810 older adults in Singapore investigated the interrelationships between the neighborhood's built environment, physical activity, and three

physical health outcomes (BMI, functional capacity, and presence/absence of chronic diseases) (Song *et al*., 2020). The results indicated that accessibility to parks and open spaces, as well as the safety and presence of covered paths, promote walking or cycling to these locations, as well as encourage outdoor recreational physical activity. Furthermore, the study of Song *et al.* (2020) found that higher levels of leisure-time physical activity appear to reduce the number of comorbidities, such as diabetes, hypertension, and hyperlipidemia. In contrast, participants with worse medical conditions had lower levels of recreational physical activity.

In the present study, it was found that exposure to green areas was associated with an increase in the walking frequency score for commuting (1.17), leisure (1.19) and both activities (1.09). When considering greater exposure to green areas, the association intensified, resulting in increases in scores of 1.53, 1.33 and 1.17, respectively. Furthermore, the results demonstrated that greater exposure to green areas has a more pronounced effect on the frequency of walking for commuting than for leisure or both activities. These findings are in line with previous studies (Song *et al*., 2020; Sugiyama; Thompson; Alves, 2009; Zhai; Baran, 2017), which highlight the importance of environmental characteristics (presence of green areas) in promoting physical activity among older adults.

However, an important distinction in the present study is the separate analysis of the types of walking (commuting and/or leisure) and their association with proximity to green areas, an approach less explored in previous studies. This aspect adds an additional dimension to the understanding of how green environments influence different types of physical activity among older adults.

In addition, when comparing the frequency of walking for leisure between the groups "exposed" and "not exposed" to green areas, it is observed that the perception of proximity to these areas has a positive impact, resulting in a higher frequency of walking among the "exposed" group.

Final Considerations

This study has some strengths, such as using a representative sample of elderly individuals aged 60 or over, where rigorous methods were applied by the EpiFloripa Aging Cohort Study team. In addition, the longitudinal statistical methods used in this research allow establishing the temporal relationship between exposure and outcome.

However, some limitations should be considered when interpreting the results. One example is the use of self-reported measures on the frequency of walking for commuting and leisure by the elderly, since it reflects individual perceptions of the interviewees.

On the other hand, self-reported perceptions of the proximity of green areas to the residence can contribute to the analysis of peculiar places such as Florianópolis, where the presence of green areas in the residential area is due to very diverse configurational characteristics that are sometimes difficult to map for analysis, such as trails in areas of permanent preservation. It is also important to consider the vegetated beaches that cover much of the perimeter of the coast, both on the island and on the mainland of the municipality, and which, like the coastal roads, are considered for walking. Thus, what is important in this case is the perception of urban greenery.

The results of the research allow us to conclude that the perception of the proximity of green areas to the home, such as parks, squares and tree-lined streets, contributed to a 53% increase in the frequency of walking for commuting and a 33% increase in the frequency of walking for leisure over a ten-year period. Longitudinal studies that address the relationship between proximity to green areas and physical activity are essential to monitor the positive association between these two variables, as well as to reinforce the importance of favorable living environments for healthy aging.

It can be concluded that urban planning that places greater emphasis on green spaces in its design contributes to a healthier aging population. In this sense, it is necessary to provide cities with more tree-lined streets, parks and squares distributed evenly throughout the urban areas, equipped with facilities suitable for this age group, with restrooms and rest areas. It is also important to bear in mind that not only does greenery in public areas contributes to more pleasant urban environments for commuting, but also landscaping on private lots that border the public domain, which is noticed by the population when moving along public roads.

Thus, this is yet another study that proves the importance of providing cities with green spaces, so that it can support both planners and citizens in building healthier and friendlier cities.

Future studies could explore in a representative way the configurational differences of green spaces (such as parks, squares, gardens adjacent to public spaces) and their influence on the walking practice of the elderly population, whether for commuting or leisure.

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Acknowledgements

Thanks to the EpiFloripa Aging team for their work in organizing, interviewing, and collecting data in the three waves of the study. The cohort study from wave 1 was supported by the *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq, National Council for Scientific and Technological Development), Wave 2 did not receive funding and was made possible by partnerships with the UFSC, and Wave 3 was supported by the Economic and Social Research Council. The authors would like to express their gratitude to the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

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