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Built environment and physical activity in elderly: a systematic review of South America

Ambiente construído e atividade física para idosos: uma revisão sistemática da América do Sul

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ABSTRACT

A systematic review was conducted to evaluate studies on the association between the characteristics of a built environment and levels of physical activity (LPA) of elderly people in South America. The searches were conducted on the Bireme, SciElo, Web Of Science and Scopus databases in 2017. Empirical quantitative studies published in Portuguese, English and Spanish, starting in 1990, were included to provide information on the relationship between a built environment and physical activity (PA) for elderly in South America. After the exclusion of repeated titles, 9,592 studies were found, only nine of which were selected, all with a cross-sectional design and samples composed of both sexes, and 77.8% carried out in Brazil. Most of the studies (66.7%) used the abbreviated version of the Neighborhood Environment Walkability Scale (NEWS-A Brazil) to evaluate the built environment and 88.9% used the International Physical Activity Questionnaire to evaluate LPA. Total walking distance (leisure and active transport) was investigated in 22.2% of the studies, leisure PA in 55.5% and displacement PA in 44.4%. The presence of PA facilities and services was associated with LPA, as well as connectivity, street incline and perceived safety. It was concluded that the installation of PA facilities, as well as improved safety, can increase the LPA of the elderly. In addition, satellite image information and audits should be considered when evaluating the built environment.

Keywords: Motor activity; Built environment; Elderly.

RESUMO

Foi realizada uma revisão sistemática com o objetivo de avaliar estudos sobre características do ambiente construído relacionadas aos níveis de atividade física (NAF) de idosos da América do Sul. As buscas foram realizadas nas bases eletrônicas Bireme, SciElo, Web Of Science e Scopus durante o ano de 2017. Foram incluídos estudos empíricos, quantitativos, a partir do ano de 1990, que apresentassem informações sobre a relação entre ambiente construído e atividade física (AF) para idosos da América do Sul, publicados em português, inglês ou espanhol. Após a exclusão dos títulos repetidos, restaram 9.592 artigos, desses, apenas nove foram selecionados, todos com delineamento transversal e amostras compostas por ambos os sexos, sendo 77,8% realizados no Brasil. A maioria dos artigos (66,7%) empregou a Escala de Mobilidade no Ambiente Comunitário Abreviada – A-NEWS Brasil para avaliar o ambiente construído e 88,9% utilizou o Questionário Internacional de Atividade Física para avaliar NAF. A caminhada total (lazer e deslocamento) foi investigada em 22,2% dos estudos, a AF de lazer em 55,5% e a AF de deslocamento em 44,4%. A presença de estruturas para prática de AF e de serviços foram associados ao NAF, assim como a conectividade e inclinação das ruas e a percepção de segurança. Concluiu-se que a instalação de estruturas para prática de AF, bem como a melhoria da segurança, podem aumentar o NAF em idosos. Além disso, o emprego de informações obtidas por satélite e auditagem deve ser considerada para avaliação do ambiente construído.

Palavras-chave: *Atividade motora; Ambiente construído; Idosos.*

Introduction

Scientific advances have significantly increased life expectancy over the years, resulting in a growing elderly population[1]. However, aging is also accompanied by a decline in functional capacity and a rise in the risk of disease[2]. To mitigate the natural decline in functionalities, healthy habits must be adopted, including good nutrition and regular physical activity (PA)[3]. In this respect, a favorable environment, with adequate sidewalks, pedestrian safety and diverse nearby settings [4] may result in PA becoming a habit[5].

The ecological model of correlates and determinants of PA[5] suggests that individual, interpersonal, and environmental aspects, in addition to national, re-

gional and global policies contribute to adherence to active behavior[5]. As such, given that PA is performed in specific areas[6], environmental aspects have attracted considerable attention in recent decades[7]. Studies conducted in Latin America[8], North America[9], Europe[10], Asia[11] and Oceania[12] have sought to find associations between built environment and PA in older adults, in both leisure and active transport[13,14].

These investigations showed correlations between environment and LPA in the elderly and, in turn, health and well-being[2,15,16]. However, information on the characteristics of an environment that may lead seniors to maximize both leisure and transport-related LPA may also change according to the region. Given that most studies that investigated the relation between the built environment and PA were conducted in high-income countries[17], with social and environmental characteristics very different from those of low-income nations, it is important that the literature to data on the relation between the built environment and LPA in developing countries such as Brazil, since this information can be used in policies, programs and initiatives to promote PA. The Statute of the Elderly stipulates that the state must guarantee public policies that promote healthy aging[18].

This systematic review was conducted to assess the association between the characteristics of a built environment and the physical activity levels of older adults in South America.

Methods

The systematic review, which followed the methodological procedures described in the literature[19], was conducted in peer-reviewed journals and indexed in Bireme, SciElo, Web Of Science and Scopus databases. First, an exploratory search was carried out to identify keywords related to built environment and PA. Next, a search was conducted to identify the terms standardized by Health Sciences Descriptors (DeCS), in Portuguese and Spanish, which were used in Bireme and SciELO databases as well as their English counterparts, standardized by the Medical Subject Headings (MeSH), used on the Web of Science and Scopus databases. The descriptors and keywords were combined with the Boolean operators "AND" and "OR". Descriptors, keywords and the initial syntax used on the databases are presented in Box 1. The search was carried out independently by peers in January 2018, and in the event of disagreement, a third researcher was consulted, in line with PRISMA methodology[19].

Box 1 – Initial syntax with descriptors and keywords used.

Português:
(meio ambiente construído OR ambiente construído OR ambiente urbano OR ambiente) AND (atividade motora OR caminhada OR exercício OR atividades de lazer OR recreação OR atividade física OR estilo de vida sedentário OR tempo sedentário OR comportamento sedentário OR inatividade física OR sedentarismo) AND (idosos OR envelhecimento OR adultos idosos OR pessoas mais velhas OR aposentado)

Inglês:
(controlled environment OR built environment OR urban environment OR environment) AND (motor activity OR walking OR exercise OR leisure activities OR recreation OR physical activity OR sedentary lifestyle OR sedentary time OR sedentary behavior OR physical inactivity OR sedentary) AND (aged OR aging OR older adults OR ageing OR older people OR senior OR retired)

Espanhol:
(medio ambiente controlado OR entorno construído OR ambiente urbano OR ambiente) AND (actividad motora OR caminata OR ejercicio OR actividades recreativas OR Recreación OR actividad física OR estilo de vida sedentário OR tiempo sedentário OR comportamiento sedentário OR inactividad física OR sedentário) AND (anciano OR envejecimiento OR adultos mayores OR envejecimiento OR personas mayores OR más antiguo)

Quantitative empirical studies from 1990 onwards that explored the relation between the built environment and PA in the elderly were included, according to the following criteria: original articles published in English, Spanish and Portuguese, conducted with seniors residing in Latin American cities. Studies that did not separately assess the urban and rural areas and adults and seniors or did not test the relation between built environment and PA were excluded. Review and opinion articles, letters to the editor, books, book chapters, research reports, dissertations and theses were also excluded from analysis.

The first step of the review consisted of searching for articles on the databases, where 16,688 studies were identified. After the exclusion of 7,176 repeated studies, 9,512 remained for the title reading stage. In this step, 9,148 articles were excluded for not exhibiting a relation with the study objective. The next step involved reading the 364 remaining abstracts, keeping the studies that showed a relation between the built environment and PA in older adults. Of these, 335 articles were excluded, for reasons described in Figure 1. Twenty-nine studies were read in their entirety, 20 of which were excluded for not being conducted in Latin America. Finally, the nine articles that met the inclusion criteria were submitted to the systematic review. The article selection process flow is shown in Figure 1.

After the nine studies were read, information was

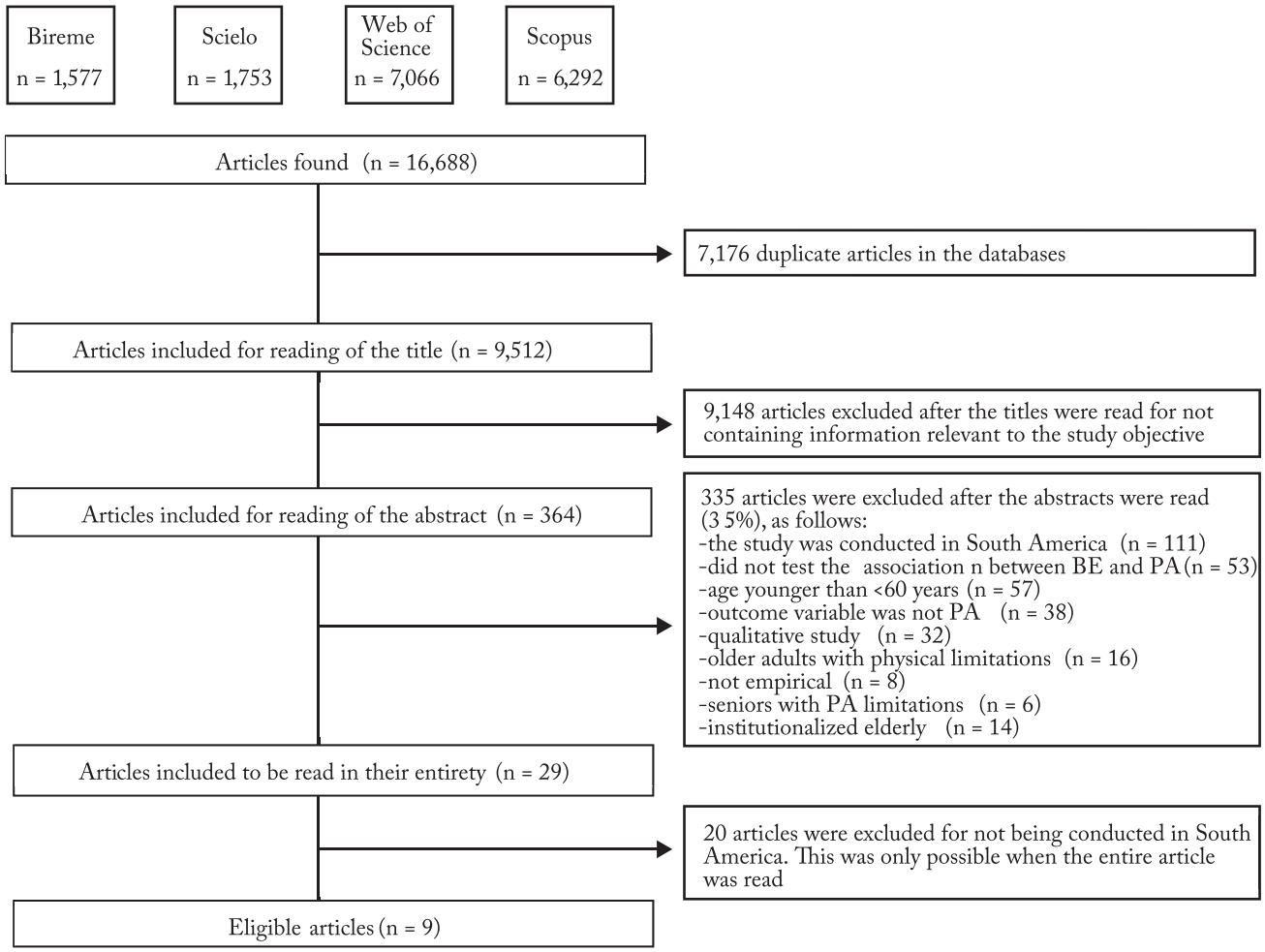

Figure 1 – Flowchart of the selection and exclusion of studies on the built environment and physical activity level in South American seniors, 2017.

extracted regarding the author, year of publication, country, sample size, sex, age, PA domain, PA cutoff point, and frequency of active seniors according to PA domain, instruments used to measure the built environment and PA as well as the quality of the studies.

The articles selected were assessed and rated for their quality, using observational study guidelines[20]. Only 16 of the 27 original items were used in the analysis, since they are related to observational (cross-sectional) studies. The following items were evaluated: quality of the description of hypotheses/objectives; quality of the description of the outcome under study; sample characterization; quality of the description of the variables of interest; discussion of the primary confounding factors; quality of the description of the main study outcomes; random variability estimates of the principal findings.

Different PA-related outcomes were reported in the studies. As such, to better describe the results, these findings were divided into three categories: walking, leisure-time PA and active transport. The walking variables are those in the original study where the authors did not differentiate between walking for leisure and transport. In the leisure-time PA category, variables that quantified the time spent on leisure-time activities, without specifying which activities were performed, were included. For active transport, those whose outcomes were related to cycling and walking for transport were considered. Finally, the result obtained in each study was described, including unadjusted and adjusted statistical analyses.

Results

Nine articles met the eligibility criteria in terms of the characteristics of the built environment with respect to the LPA of Latin American seniors.

The articles were published between 2009 and 2017, and all exhibited a cross-sectional design, most (77.8%) conducted in Brazil. The sample varied from 385 to 1,705 subjects, all composed of men and women. Most of the studies (66.7%) used the abbreviated

version of the Neighborhood Environment Walkability Scale (NEWS Brazil)[21] to assess the built environment, a self-assessment tool of the environment. The International Physical Activity Questionnaire[22] was used to assess PA in 88.9% of the studies. Leisure-time PA was investigated in 55.5% of the studies, active transport in 44.4% and walking (leisure and for transport) in 22.2%. All the included studies received a score of 82.3 in terms of quality[20]. With respect to adjustment variables, all of the studies included schooling and sex, and age was considered in 88.9% of the investigations (Table 1).

As previously mentioned, several PA-related outcomes were reported in the studies. As such, in order to better describe the results, the findings were divided into three categories: walking, leisure-time PA and active transport.

With respect to walking, ≥ 60 minutes per week showed an association with the incline of the terrain (OR = 0.61; 95%CI: 0.38-0.97) and park density (OR = 1.42; 95%CI: 1.02-1.98). When adjusted for sex, the walking time of men to a soccer field (OR = 3.43; 95%CI: 1.46-8.10) and the presence of soccer fields (OR = 4.12; 95%CI: 1.41-12.02) were associated with walking. For women, walking time to a Basic Health Unit (OR = 3.71; 95%CI: 1.19-11.54) and the presence of town squares (OR = 4.70; 95%CI: 1.43-15.43) were associated with walking (Table 2).

In regard to leisure-time PA for men, the studies showed an association with the presence of town

Table 1 – Studies that associated the built environment and physical activity level in South American seniors (n = 9).

Author	Year published	Country	n	sex	age	PA domain	PA cutoff point	Active (according to PA domain)	PA instrument	BE instrument	Study quality[a]	%[b]
Salvador et al.[23]	2009	Brazil	385	152 men/ 233 women	Average = 60 to 74 years	AT	≥ 150 min/ without WT	72 (45%) men / 62 (27.9%) women	IPAQ_long form	NEWS	16	94.1
Salvador et al.[24]	2009	Brazil	385	152 men/ 233 women	Average = 60 to 74 years	LTPA	≥ 150 min/ without LTPA	29 (19.1%) men / 27 (12.5%) women	IPAQ_long form	NEWS	16	94.1
Gómez et al.[25]	2010	Colombia	1,886	737 men/ 1229 women	60 to 98 years	Walking	≥ 150 min/ without and ≥ 60 min/without total walking	1,176 (62.4%)	IPAQ_short form	GIS	14	82.3
Parra et al.[8]	2010	Colombia	1,966	737 men/ 1,229 women	60 to 98 years	LTPA	Active use of the park	187 (27.5%)	Fuzhong 2005[26]	GIS	14	82.3
Salvador et al.[27]	2010	Brazil	385	152 men/ 233 women	Average = 60 to 74 years	Walking	≥ 150 min/without total walking	86 (56.9%) men / 77 (34.1%) women	IPAQ_	NEWS	16	94.1
Corseuil et al.[28]	2011	Brazil	1,652	598 men/ 1,058 women	≥ 60 years	AT	≥ 150 min/ without active transport (cycling and walking)	27.5% (455)	IPAQ_long form	NEWS	15	88.2
Giehl et al. [29]	2012	Brazil	1,656	598 men/ 1,058 women	≥ 60 years	LTPA	≥ 150 min/ without LTPA	590 (35.6%) men / 436 (26.3%) women	IPAQ_long form	NEWS	15	88.2
Giehl et al.[3]	2016	Brazil	1,705	602 men/ 1,065 women	≥ 60 years	LTPA / AT	≥ 10 min/without WL; ≥ 10 min/ without WT	WL 589 (34.5%) / WT 1.046 (61.4%)	IPAQ_short form	GIS	16	94.1
Giehl et al.[30]	2017	Brazil	1,637	591 men/ 1,046 women	≥ 60 years	LTPA/ AT	≥ 10 min/without and ≥ 150 min/ without WL; ≥ 10 min/without and ≥ 150 min/with WT	-	IPAQ_long form	NEWS	16	94.1

BE = built environment; PA = physical activity; AT = active transport; LTPA = leisure-time physical activity; WT = walking for transport; WL = walking for leisure; a = number of items on the quality scale (n) discussed by the article; b = number of items on the quality scale (%) discussed by the article.

Table 2 – Built environment variables associated with levels of physical activity (n = 9).

Author	PA domain	Adjustment variables	Main Results
Salvador et al.[23]	AT	Age and schooling	Men = presence of soccer fields (OR = 2.56; 95%CI: 1.01-6.48); perceived safety at night (OR = 4.36; 95%CI: 1.04-18.33). Women = public lighting (OR = 3.10; 95%CI: 1.26-7.61).
Salvador et al.[24]	LTPA	Schooling	Men = presence of courts (OR = 2.95; 95%CI: 1.23-7.09); time to walk to a bank (OR = 3.82; 95%CI: 1.26-11.62); time to walk to a health unit (OR = 3.60; 95%CI: 1.50-8.61); perceived safety (OR = 4.51; 95%CI: 1.29-13.79). Women = time to walk to a church or religious temple (OR = 3.63; 95%CI: 1.33-9.88); presence of town squares (OR = 3.63; 95%CI: 1.33-9.88); presence of gyms (OR = 2.49; 95%CI: 1.10-5.62).
Gómez et al.[25]	Walking	Sex, age, schooling, socioeconomic level and physical activity limitations	≥ 60 minutes of walking per week = terrain incline ≥ 5% (OR = 0.61; 95%CI: 0.38-0.97); park density (OR = 1.42; 95%CI: 1.02-1.98).
Parra et al.[8]	LTPA	Age, sex and schooling	Active use of parks = terrain incline ≥ 5% (OR = 0.53; 95%CI: 0.30-0.93); average (OR = 2.78; 95%CI: 1.72-4.48) and high (OR = 2.98; 95%CI: 1.80-4.93) park density; street connectivity index (OR = 0.56; 95%CI: 0.37-0.87); mixed soil use (OR = 1.71; 95%CI: 1.12-2.59).
Salvador et al.[27]	Walking	Age and schooling	Walking (men) = presence of soccer fields (OR = 4.12; 95%CI: 1.41-12.02); time to walk to a soccer field (OR = 3.43; 95%CI: 1.46-8.10). Walking (women) = presence of town squares (OR = 4.70; 95%CI: 1.43-15.43); time to walk to a health unit (OR = 3.71; 95%CI: 1.19-11.54).
Corseuil et al.[28]	AT	Sex, age schooling and income	Somewhat active = presence of trash (OR = 1.55; 95%CI: 1.04-2.30); absence of public lighting (OR = 2.51; 95%CI: 1.36-4.64). Inactive = absence of parks, multi-sports courts (OR = 1.75; 95%CI: 1.22-2.51); absence of public lighting (OR = 2.43; 95%CI: 1.43-4.15).
Giehl et al.[29]	LTFA	Sex, age, schooling, income and functional capacity	LTPA = presence of walking or cycling facilities (PR = 1.25 95%CI: 1.03-1.43).
Giehl et al.[3]	LTPA/AT	Sex, age and schooling	WT = high population density (OR = 2.19; 95%CI: 1.40-3.42); high street connectivity (OR = 1.85; 95%CI: 1.16-2.94); high presence of sidewalks (OR = 1.77; 95%CI: 1.11-2.83); average (OR = 1.61; 95%CI: 1.04-2.49) and high (OR = 2.11; 95%CI: 1.36-3.27) percentage of paved streets. WL = income of the neighborhood (OR = 1.48; 95%CI: 1.04-2.12); street density (OR = 1.47; 95%CI: 1.02-2.10).
	AFL/AFD	Sex, age, schooling, BMI and perceived health	WT 10-149 min/without = good/even sidewalk (OR = 1.31; 95%CI: 1.00-1.72); presence of trash (OR = 0.64; 95%CI: 0.43-0.94); presence of a pedestrian crosswalk (OR = 1.43; 95%CI: 1.01-2.06); perceived safety during the day (OR = 1.42; 95%CI: 1.02-1.97). WT ≥ 150 min/week = good/even sidewalk (OR = 1.60; 95%CI: 1.20-2.13); public lighting (OR = 2.30; 95%CI: 1.27-4.15); presence of parks or recreational facilities (OR = 1.60; 95%CI: 1.15-2.22). WL 10-149 min/without = perceived safety/security during the day (OR = 1.64). WL ≥ 150 min/week = good/even sidewalk (OR = 1.43; 95%CI: 1.01-2.03); perceived safety during the day (OR: 1.40 95%CI: 1.01-1.96).

PA = physical activity; AT = active transport; LTPA = leisure-time physical activity; BMI = body mass index; WT = walking for transport; WL = walking for leisure.

squares (OR = 2.95; 95%CI: 1.23-7.09), walking time to a Basic Health Unit (OR = 3.60; 95%CI: 1.50-8.61), walking time to a bank (OR = 3.82; 95%CI: 1.26-11.62) and perceived safety (OR = 4.51; 95%CI: 1.29-13.79). For women, the presence of gyms (OR = 2.49; 95%CI: 1.10-5.62), town squares (OR = 3.63; 95%CI: 1.33-9.88) and time to walk to a church (OR = 5.73; 95%CI: 1.43-22.90) were associated with leisure-time PA and terrain incline ≥ 5% (OR = 0.53; 95%CI: 0.30-0.93); mean (OR = 2.78; 95%CI: 1.72-4.48) and high (OR = 2.98; 95%CI: 1.80-4.93) park density; street connectivity index (OR = 0.56; 95%CI: 0.37-0.87); Land use mix (OR = 1.71; 95%CI: 1.12-2.59) and the presence of walking or cycling facilities (OR = 1.25; 95%CI: 1.03-1.43) were also associated with leisure-time PA for both sexes. A well-maintained/even sidewalk (OR = 1.43; 95%CI: 1.01-2.03), and perceived safety during the day (OR = 1.40; 95%CI: 1.01-1.96) were associated with ≥ 150 min/week of leisure-time walking (Table 2).

In regard to the PA outcome for older men, the presence of soccer fields (OR = 2.56; 95%CI: 1.01-6.48) and perceived safety at night (OR = 4.36; 95%CI: 1.04-18.33) were associated with active transport. For elderly women, there was an association with public lighting (OR = 3.10; 95%CI: 1.26-7.61). Furthermore, well-maintained/even sidewalks (OR = 1.60; 95%CI: 1.20-2.13), public lighting (OR = 2.30; 95%CI: 1.27-4.15), presence of public parks or recreational facilities (OR = 1.60; 95%CI: 1.15-2.22) were association with walking as transport ≥ 150 min/week. High population density (OR = 2.19; 95%CI: 1.40-3.42), high street connectivity (OR = 1.85; 95%CI: 1.16-2.94), a large

number of sidewalks (OR = 1.77; 95%CI: 1.11-2.83), and average (OR = 1.61; 95%CI: 1.04-2.49) and high (OR = 2.11; 95%CI: 1.36-3.27) percentage of paved streets displayed an association for both sexes (Table 2).

Discussion

The presence of leisure facilities such as parks, soccer fields, gyms and town squares was consistently associated with engaging in and levels of PA (both leisure time[24,29] and active transport)[23,28]. This also occurred with security characteristics such as public lighting[23,28] and perceived safety[24]. Street connectivity did not produce consistent results, since it was positively and negatively associated with LPA. The studies that stratified the results by sex showed that the presence of health services facilitated more active behavior in both sexes. With respect to leisure facilities for men, soccer courts and fields are the most important characteristics, while for women town squares seems to be a priority. All of these results are similar to those observed in a recent systematic review that did not include South American countries[17]. This appears to confirm that the built environment is related to physical activity regardless of country, when an elderly population is investigated.

A small number of articles were found on the topic, derived from specific projects that gave rise to more than one study, concentrated only in Colombia (Bogota) and Brazil (Florianopolis and São Paulo, in Santa Catarina and São Paulo states, respectively). Thus, research on the relation between the built environment and engaging in and level of PA in older adults remains limited, given that the scarcity of studies restricts the dispersion of exposure variables. This limitation is one of the possible explanations for the inconsistent findings obtained by studies on the built environment and PA[31].

Overall, the studies included in the review showed a positive association between built environment and LPA in seniors. This association changes according to characteristics of the environment investigated. Since all studies were cross-sectional, we were unable to exclude reverse causality as a possible explanation for these findings.

The built environment was assessed by NEWS, a low-cost, easy-to-apply and understand instrument used worldwide[32–36] and validated for Brazil[21]. The Geographic Information System (GIS) was also used to evaluate the built environment. It helps identify characteristics such as mixed soil use, street connectivity and residential density[37], but requires a higher investment since it needs specific software, in addition to a researcher experienced in geoprocessed data. None of the studies assessed the built environment by systematic observation, whereby the observers quantify and quality the characteristics of the environment and use instruments known as audits to record information[38]. Audits can assess characteristics such as sidewalk quality, pedestrian safety, and esthetics, which have also been associated with physical activity[4,17].

PA was evaluated by the International Physical Activity Questionnaire (IPAQ). The IPAQ analyzes all the domains of PA[39], identifying the aspects of the environment that can affect these domains. In addition, the IPAQ provides a reliable comparison of PA volumes between studies with similar populations that used the same measure. The IPAQ has been adapted and validated for Brazil[22] and has contributed significantly to increasing understanding of active behavior in Latin America[40]. Most studies followed the Physical Activity Guidelines for Americans[41] and used the cut-off point of 150 minutes per week of moderate LPA.

The main adjustment variables analyzed were schooling[3,8,23–25,27–30] and sex[3,8,25,28,29]. The articles that conducted stratified analyses by sex identified a number of different characteristics that favor PA for men and women[23,24,27]. Sports facilities such as soccer fields[23,27] and multi-sport courts[24] were associated with the LPA of men, the presence of town squares[24,27] or churches[24] were related to the LPA of women. The literature reports that PA in women is less frequent and intense than that observed in men, and the locations selected to engage in this activity are also different[2,15,16]. Understanding which environmental characteristics explain the active behavior of seniors is an important step to attenuate or reverse the drop in the LPA observed in this population group[17]. An adequate environment for the elderly to perform PA may contribute to intensifying the LPA of seniors[4,17,42].

All the studies met at least 82% of the scale items used[18], demonstrating the improvement of scientific investigations on the issue.

The study exhibits a number of limitations that should be pointed out. Since no searches were conducted in non-indexed journals on the databases selected, studies carried out in the population analyzed may not have been included.

The authors recommend that future research also use systematic observation to assess built environment. This method can identify changes relatively easily and

inexpensively[37], which could increase the likelihood of seniors being more active. Variables such as sex, age, schooling and socioeconomic level should be maintained and their use in future studies may contribute to more accurate results.

Finally, it can be concluded that there is a growing interest in the study of built environment and PA, but research on the subject remains scarce in the South American population. The characteristics of environment associated with PA of older individuals are largely related to availability of leisure facilities, including parks, town squares, gyms, and soccer courts and fields. Security characteristics such as public lighting, and perceived safety were also associated. Knowing the extent to which the built environment can affect the PA of the population may be essential in promoting it. Physical activity promotion programs for elderly should consider the characteristics of the environment described here, since they seem to be efficient in maximizing the LPA of this population.

Conflict of interest

The authors declare no conflict of interest.

Authors` contributions

Paiva HK, participated in the initial conception of the study, search, collection, data analysis and writing of the manuscript. Camargo EM, participated in the search, collection, data analysis and writing of the manuscript. Reis RS, revised the manuscript.

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