Study protocols

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Walkability and physical activity: a protocol for systematic review and meta-analysis

Associação entre walkability e atividade física: um protocolo para revisão sistemática e meta-análise

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ABSTRACT

The appropriate area for walking, related to the flow of walking, on the sidewalks and crossing (walkability) influences the practice of physical activity. However, there is no evidence of meta-analyses that have evaluated this association. Therefore, this study presents a protocol to assess the association between walkability and physical activity. The systematic review protocol was conducted following the PRISMA 2020 guidelines and will includes a search in the following databases: PubMed, SPORTDiscus, LILACS, Web of Science, Scopus, Embase, and Cochrane. It will include observational studies, cross-sectional and longitudinal, that assessed the association between walkability in the neighborhood and physical activity. The process of study selection will be conducted independently by two reviewers. The process will start by reading the titles and abstracts of interest, followed by the full reading of the articles through the Rayyan platform. We will assess the methodological and individual quality across the studies utilizing the Newcastle Ottawa Scale (NOS) and the Chi-Squared test (I^2). To test the influence of variables in the meta-analysis results, we will use, whenever possible, the meta-regression technique. The meta-analysis results will be presented as Odds Ratio (OR) with 95% confidence interval, through a random or fixed-effects model, according to estimate of clinical, statistical, and methodological heterogeneity. If possible, stratifications will be performed according to age group, sex, and physical activity levels. With the expected results, we hope that the knowledge will be useful to encourage the implementation of public policies for walkability in the neighborhood to increase physical activity levels.

Keywords: Walkability; Physical activity; Meta-analysis; Systematic review; Life cycle stages

RESUMO

A área adequada para caminhada, relacionada ao fluxo de caminhada, nas calçadas e travessias (*walkability*) influencia na prática de atividade física. No entanto, não há evidências de meta-análises que tenham avaliado essa associação. Portanto, este estudo apresenta um protocolo para avaliar a associação entre *walkability* e atividade física. O protocolo de revisão sistemática será realizado seguindo as recomendações do PRISMA 2020 e incluirá uma busca nas seguintes bases de dados: PubMed, SPORTDiscus, LILACS, Web of Science, Scopus, Embase e Cochrane. Serão incluídos estudos observacionais, transversais e longitudinais, que avaliaram a associação entre *walkability* na vizinhança e atividade física. O processo de seleção dos estudos será conduzido de forma independente por dois revisores. O processo terá início pela leitura dos títulos e resumos de interesse, seguido da leitura completa dos artigos por meio da plataforma Rayyan. Avaliaremos a qualidade metodológica e individual entre os estudos utilizando a Escala de *Newcastle Ottawa* (NOS) e o teste Qui-Quadrado (I^2). Para testar a influência das variáveis nos resultados da meta-análise, utilizaremos, sempre que possível, a técnica de meta-regressão. Os resultados da meta-análise serão apresentados como *Odds Ratio* (OR) com intervalo de confiança de 95%, por meio de um modelo de efeitos aleatórios ou fixos, de acordo com a estimativa clínica, estatística e metodológica da heterogeneidade. Se possível, serão realizadas estratificações de acordo com faixa etária, sexo e níveis de atividade física. Com os resultados do estudo, esperamos que o conhecimento seja útil para incentivar a implementação de políticas públicas de *walkability* no bairro para aumentar os níveis de atividade física.

Palavras-chave: *Walkability; Atividade física; Meta-análise; Revisão sistemática; Fases do ciclo de vida.*

Introduction

The practice of physical activity should start in childhood, as it has short-term benefits in this population[1]. Cardiorespiratory fitness and improvement in body composition stand out, thus decreasing cardiovascular risk factors, which, in turn, can exert protective benefits related to health in adulthood[2]. Moreover, exercise habits practiced in childhood can continue throughout

adult life, exerting long-term benefits[2]. In adults, regular physical activity may play an important role in reducing cardiovascular diseases and overall mortality[3]. Previous studies also associated physical activity with lower diabetes[4], obesity[5], and metabolic syndrome[6]. In contrast, sedentary behavior and low levels of moderate-vigorous physical activity may be associated with all-cause and cardiovascular mortality[7]. Older adults may also benefit from the effects of physical activity, especially in the accumulation of chronic diseases[8].

Despite this, evidence points out that most adolescents do not reach the guidelines of physical activity, making it necessary to implement policies and programs to increase levels in this population[9]. Data from more than 298 schools, including around 1.6 million students aged 11-17 years, showed that approximately 81% of them were physically inactive, a higher number in girls than in boys, 84.7% and 77.6%, respectively[9]. In Adults from the United States, data from 2008 to 2017 showed an increase in the practice of physical activity during the period analyzed. However, even with the rise, the data are still low, about 25.3% for the urban population and 19.6% for the rural[10].

Among the factors that can influence the practice of physical activity, studies point to the social environment (friends, family, school, and workplace) and specific knowledge of programs and actions for physical activity[11]. An appropriate area for walking related to the fluidity of walking, sidewalks, and crossings - known as walkability - may also be associated with higher physical activity levels in adolescents[12]. Among adults living in Curitiba, Brazil, areas with high walkability were associated with higher physical activity levels than areas with low walkability[13]. On the other hand, in older adults, the neighborhood walkability was not associated with higher levels or intensity of physical activity[14]. The World Health Organization (WHO) has proposed action to ensure that all people have access to safe and supportive environments and diverse opportunities to be physically active, in order to improve individual and community health, and to contribute to the social, cultural, and economic development of all nations (https://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf). Identifying the importance and the factors that are associated with walkability can be fundamental and help managers and governments in the implementation of public policies whose objectives are the implementation of appropriate places for physical activity. A systematic review and meta-analysis study allows for this possibility and will help identify all manuscripts that have evaluated the association between walkability and physical activity.

Since physical activity is important from the first ages to adulthood and the environment in which the subject is inserted can influence its practice, a systematic review and meta-analysis can help understand how much this relationship is associated or not. Therefore, this study presents a protocol to assess the association between walkability and physical activity.

Methods

This a protocol for a systematic review and meta-analysis according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA) and MOOSE guidelines[15,16]. The systematic review and meta-analysis protocol was registered on the International prospective register of systematic reviews (PROSPERO) (CRD42021290914). The research question was created utilizing the PICOS strategy (see Table 1), with the population (P) children, adolescents, adults, and older adults; the intervention (I) walkability; the comparison (C) subgroups analysis according to age (children, adolescents, adults, and older adults), sex (male or female), and physical activity levels; the outcome (O) physical activity levels; and the study design (S) observational studies (case-control, cross-sectional, and longitudinal) or clinical trials. Based on this strategy, the review includes the following research question: 'What is the association between walkability in the neighborhood with the practice of physical activity?'.

We will include studies that met the following criteria: observational study; cross-sectional or longitudi-

Table 1 –PICOS criteria for inclusion and exclusion of studies

	Inclusion criteria	Exclusion criteria
Participants	Humans (children, adolescents, adults, and older adults)	Studies with animals or in vitro, review and opinion articles, repeated studies
Intervention	Walkability	Not applied
Comparison	Subgroup's analysis according to age (children, adolescents, adults, and older adults), sex (male or female)	None
Outcomes	Physical activity	Studies that did not evaluate physical activity levels
Study type	Observational and clinical trials: case-control, cross-sectional and longitudinal	Studies that were not carried out on humans, conference abstracts, and reviews
Language	No limit	
Year of publication	No limit	

nal design; walkability as the main exposure; assessed the association with physical activity; reported results as Odds Ratios (ORs), Relative Risks (RRs), or Hazard Ratios (HRs), crude and/or adjusted models, with 95% confidence interval (CIs). Authors from studies with no data for meta-analysis will be contacted requesting the necessary data. If there are no responses, the studies will only be kept in the systematic review and will not be included in the meta-analysis. The review will not include studies with animals or in vitro, review, and opinion articles. In the case of more than one study using the same database, the most recent will be included.

The searches will be performed until December 2021 and include the following databases: PubMed, SPORTDiscus, LILACS (Latin American and Caribbean Health Sciences Literature), Web of Science, Scopus, Embase, and Cochrane. The Google Scholar platform will also be searched non-systematically to find studies published in gray literature (200 first results). Finally, all references from the included studies will be screened, as well as the relevant systematic reviews.

When possible, we will use the terms from the Medical Subject Heading (MeSH), in addition to relevant keywords related to walkability and physical activity, which will be searched using the options of titles from the databases. To combine the terms of walkability and outcome (physical activity), we will use the Boolean operators 'OR' and 'AND'. Table 2 presents the full search

Table 2 – Search terms that will be utilized in the databases

Pubmed	Search: ((((((((((((Neighborhood[Title]) OR (Neighborhood buffer[Title])) OR (Neighborhood context[Title])) OR (Walking locations[Title])) OR (Space syntax[Title])) OR (Street layout[Title])) OR (Street design[Title])) OR (Urban design[Title])) OR (Urban form[Title])) OR (Urban planning[Title])) OR (Walkability[Title])) OR (Walkable[Title])) AND (((((((((physical activity[Title]) OR (motor activity[Title])) OR (exercise[Title])) OR (walking[Title])) OR (sports[Title])) OR (fitness[Title])) OR (inactivity[Title])) OR (sedentarism[Title])) OR (sedentary[Title]))
SPORTDiscus	S1: TI Neighborhood OR TI Neighborhood buffer OR TI Neighborhood context OR TI Walking locations OR TI Space syntax OR TI Street layout OR TI Street design OR TI Urban design OR TI Urban form OR TI Urban planning OR TI Walkability OR TI Walkable S2: TI physical activity OR TI motor activity OR TI exercise OR TI walking OR TI sports OR TI fitness OR TI inactivity OR TI sedentarism OR TI sedentary S3: (TI physical activity OR TI motor activity OR TI exercise OR TI walking OR TI sports OR TI fitness OR TI inactivity OR TI sedentarism OR TI sedentary) AND (S2 AND S3)
Lilacs	((ti:(Neighborhood)) OR (ti:(Neighborhood buffer)) OR (ti:(Neighborhood context)) OR (ti:(Walking locations)) OR (ti:(Space syntax)) OR (ti:(Street layout)) OR (ti:(Street design)) OR (ti:(Urban design)) OR (ti:(Urban form)) OR (ti:(Urban planning)) OR (ti:(Walkability)) OR (ti:(Walkable))) AND ((ti:(physical activity)) OR (ti:(motor activity)) OR (ti:(exercise)) OR (ti:(walking)) OR (ti:(sports)) OR (ti:(fitness)) OR (ti:(inactivity)) OR (ti:(sedentarism)) OR (ti:(sedentary)))
Web of Science	#1 Neighborhood (Título) or Neighborhood buffer (Título) or Neighborhood context (Título) or Walking locations (Título) or Space syntax (Título) or Street layout (Título) or Street design (Título) or Urban design (Título) or Urban form (Título) or Urban planning (Título) or Walkability (Título) or Walkable (Título) #2 physical activity (Título) or motor activity (Título) or walking (Título) or sports (Título) or fitness (Título) or inactivity (Título) or sedentarism (Título) or sedentary (Título) and exercise (Todos os campos) #1 AND #2
Scopus	((TITLE (neighborhood) OR TITLE (neighborhood AND buffer) OR TITLE (neighborhood AND context) OR TITLE (walking AND locations) OR TITLE (space AND syntax) OR TITLE (street AND layout) OR TITLE (street AND design) OR TITLE (urban AND design) OR SRCTITLE (urban AND form) AND TITLE (urban AND planning) OR TITLE (walkability) OR TITLE (walkable))) AND ((TITLE (physical AND activity) OR TITLE (motor AND activity) OR TITLE (exercise) OR TITLE (walking) OR TITLE (sports) OR TITLE (fitness) OR TITLE (inactivity) OR TITLE (sedentarism) OR SRCTITLE (sedentary)))
Embase	#1 neighborhood:ti OR 'neighborhood buffer':ti OR 'neighborhood context':ti OR 'walking locations':ti OR 'space syntax':ti OR 'street layout':ti OR 'street design':ti OR 'urban design':ti OR 'urban form':ti OR 'urban planning':ti OR walkability:ti OR walkable:ti #2 'physical activity':ti OR 'motor activity':ti OR exercise:ti OR walking:ti OR sports:ti OR fitness:ti OR inactivity:ti OR sedentarism:ti OR sedentary:ti #3 #1 AND #2
Cochrane	#1 (Neighborhood):ti OR (Neighborhood buffer):ti OR (Neighborhood context):ti OR (Walking locations):ti OR (Space syntax):ti #2 (Street layout):ti OR (Street design):ti OR (Urban design):ti OR (Urban form):ti OR (Urban planning):ti #3 (Walkability):ti OR (Walkable):ti #4 (physical activity):ti OR (motor activity):ti OR (exercise):ti OR (walking):ti OR (sports):ti #5 (fitness):ti OR (inactivity):ti OR (sedentarism):ti OR (sedentary):ti #6 #1 OR #2 OR #3 #7 #4 OR #5 #8 #6 AND #7

strategy that will be used in each of the databases.

Initially, reviewers will meet virtually to combine the entire study selection process to standardize for better results. Thus, a pilot with 50 titles and abstracts will be conducted before the official start of the review. The purpose of the pilot is standardization and possible adjustments to the inclusion and exclusion criteria, if necessary.

After performing the searches, the results will be exported to the Endnote x7 tool to exclude duplicates. After this process, the reviewers will export the titles to the Rayyan tool, which will be used for the entire study selection process. The first step will consist of a reading of titles and abstracts, whereas the second will be the complete reading of the articles of interest, based on the inclusion and exclusion criteria. Two reviewers will independently carry out the study selection process, while a third reviewer (expert on the field) will resolve any disagreements. If necessary, the three reviewers will meet to reach a consensus between disagreements. The agreement rate will be evaluated using the Kappa coefficient test. After these processes, we will do the references searches and the non-systematic search in Google Scholar. This process will ensure that all studies published in the literature concerning walkability and physical activity will be found.

Identification (author and year), sample (e.g., 1500 participants from Brazil), Age (mean age), design (cross-sectional or longitudinal), walkability (e.g., walkability index was xx), adjustment (cofounders adjusted for the analysis across the studies), method of mensuration of physical activity (e.g., iPAQ short version), and main findings (e.g., walkability was association with more practice of physical activity) will be extracted from all studies (Table 3).

We will perform the meta-analysis to evaluate the association between walkability in the neighbor and physical activity and express the results as Odds Ratio (OR) with a 95% confidence interval. The Higgins I^2 statistic test will estimate heterogeneity among studies, considering values above 50% and $p < 0.05$ as high heterogeneity[17]. We will perform the meta-analysis through a random or fixed-effects model, according to estimate of clinical, statistical, and methodological heterogeneity.

If a study presents results only stratified by subgroup, we will calculate article-specific OR using a fixed-effects model. In case of more than one study using the same database, we will keep the most recent. Whenever possible, we will use the fully adjusted models provided by the studies to reduce the chances of causality.

The results presented as Relative Risk or Hazard Ratio will be converted to OR using the formula: $OR = (1 - p) * RR) / (1 - RR * p)$, where RR is the relative risk or hazard ratio, and p is the rate of control events. We will perform the analyses using the R language and Meta package[18]. We will perform subgroup analyses according to age (children, adolescents, adults, and older adults), sex (male or female), and physical activity levels, if possible. Furthermore, we intend to perform a sensitivity analysis according to the quality of the studies based on the Newcastle Ottawa Scale (NOS) scale.

We intend to use different methods to measure the individual quality of the studies, the quality of evidence, publication bias assessment, and potential sources of between-study variability. The first one will be the NOS[19]. Two reviewers will evaluate the studies' individual quality, while a third one will solve the disagreements. For longitudinal studies, we will use the original version of the NOS scale. The scale consists of eight items related to study selection, comparability, and outcome. Each item receives a star when the study is considered high quality, except for the comparability item, which can point to two stars. For cross-sectional design, we will use an adapted version of the scale based on a previous publication[20]. This scale consists of seven items also related to selection, comparability, and outcome. At NOS, each item receives a star when the study is rated as high quality on that item, except for the comparability item, which can point to two stars. Thus, the total NOS scale score ranges from 0 to 9 for cohort studies and 0 to 8 for cross-sectional studies. Based on previous publications, we will classify studies with less than five points as poor quality, those with five or six as medium quality, and articles with a score of seven or more as high-quality[21,22].

To assess the quality of evidence, we will be using the Grading of Recommendations, Assessment, Development, and Evaluations (GRADE)[23]. The quality of

Table 3 - Data extraction worksheet.

Identification	Sample	Age	Design	Walkability	Adjustment	Mensuration of physical activity	Main findings

evidence will be classified into four grades: high, moderate, low, or very low[23]. We will also perform Egger's regression tests and funnel plot to determine publication bias for analysis with more than ten studies. Finally, we intend to test potential sources of between-study variability utilizing meta-regression tests, including analyses according to age, sex, and physical activity levels. To minimize the imprecision (uncertainty) of the pooled effect estimate, we will use the inverse-variance method.

Discussion

To the best of our knowledge, this protocol describes the first systematic review and meta-analysis that will evaluate the association between walkability and the practice of physical activity, with results stratified by age, sex, and levels of physical activity. In this manuscript, we described the protocol for a systematic review and meta-analysis which the aim was to evaluate the association between walkability and physical activity. The importance of physical activity is well described in the literature and includes a longer health span, delay in the onset of 40 chronic diseases, and an inverse association with premature mortality[24,25]. Physical activity also promotes a better quality of life and well-being[26]. Moreover, physical activity is independently and inversely associated with Health Resource Utilization, emergency room, home health care, and prescription medicines[27,28].

Highlighting that suitable place are essential to increase physical activity can be helpful for decision-making by managers and governments. Previous studies associated the proximity of residence with public spaces with higher levels of physical activity[29,30]. In Turkish University Students, a study showed that most of the sample associated lack of time as an important barrier to the practice of physical activity[31]. In a study with a population between 55 and 75 years of age, the authors identified that the neighborhood's walkability could support physical activity intervention, helping to increase the levels of movement in this population[32]. These results confirm the importance of walkability for the practice of physical activity since this could occur while these individuals move to their workplace or study.

Supposing the results of the systematic review and meta-analysis are significant. In that case, we expect that public policies would be carried out to encourage the implementation of appropriate areas for the practice of physical activity. Thus, it is likely that young people, including children and adolescents, practice more physical activity and have protection against various diseases, whereas adults and older people become more active with the intuition of postponing the appearance of different conditions and protection against premature mortality. This can be fundamental in the adoption of healthy habits since physical activity is recommended from the first years of life[2]. It has been shown that healthy habits that begin in the early years of life tend to last longer and extend into adulthood [33], which reinforces the importance of physical activity in the early years.

Some limitations of this research need to be highlighted. First, the methods used to measure physical activity will also differ between studies. Second, it is possible that there are not enough studies to perform all the stratified analyses that we want, especially the age and sex stratifications. If this occurs, we hope to encourage new studies with different populations and age groups. Finally, most studies may have a cross-sectional design, which can be inferred in the results by exerting probable causality between exposure and outcome. Important measures such as meta-regression, sensitivity analyses, and quality evaluation of the studies will be performed to minimize the possible limitations of the review.

With the expected results, we hope that the knowledge will be useful to encourage the implementation of public policies for walkability in the neighborhood to increase physical activity levels.

Conflict of interest

The authors declare no conflict of interest.

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Author's contributions

Bruno GBM and Delpino FM conceived and carried out the writing of the first version of the manuscript. Miragem AA, Olsson LAV and Mello ED participated in the writing and critical writing of the manuscript.

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