Urban Planning
2024 • Volume 9 • Article 8790
https://doi.org/10.17645/up.8790

cogitatio

REVIEW

Open Access Journal

Walkability and Parental Safety Perceptions as Determinants of Children's School Commutes: A Systematic Review

Catarina Cadima and Paulo Pinho

Research Centre for Territory, Transports and Environment (CITTA), University of Porto, Portugal

Correspondence: Catarina Cadima (ccadima@fe.up.pt)

Submitted: 2 June 2024 **Accepted:** 23 September 2024 **Published:** 25 November 2024

Issue: This review is part of the issue "Children's Wellbeing in the Post-Pandemic City: Design, Planning, and Policy Challenges" edited by Garyfallia Katsavounidou (Aristotle University of Thessaloniki) and Sílvia Sousa (Porto Energy Agency / University of Porto), fully open access at https://doi.org/10.17645/up.i350

Abstract

Walking is the oldest, most affordable, and environmentally healthy mode of transport. Its importance is widely recognised in the scientific and political fields, with active school travel being a consensual target goal. Children's active school travel promotes physical activity, independence, and social interaction. Additionally, it contributes to mitigating traffic congestion, reducing air pollution, and enhancing societal well-being. Despite these positive effects, children's commuting patterns and outdoor activities are becoming more restricted due to the continuous growth of motorised traffic and car-oriented urban environment conditions. As a result, school walkability indexes are emerging in literature, although few consider parental safety perceptions. This review offers a comprehensive overview of the existing evidence, examining and summarising quantitative and qualitative studies on school walkability and the impact of parental barriers on children walking to school. The updated information provided in this review highlights the link between the urban environment, parental fear of traffic, and children's school travel behaviour. Using the PRISMA method and a series of in-depth interviews, we developed a comprehensive walkability model. The literature review highlights the importance of geographical differences and social and environmental diversities, requiring different solutions to promoting active commuting to school. Distance and quality of infrastructure are critical factors, but not exclusive. Our interview results suggest that social norms, parents' fear of car traffic, and educational background can influence the results. This study offers insights into perceived walkability, particularly regarding school walkability in a Portuguese context.

Keywords

active commuting; children's travel behaviour; parental perception; school walkability

1. Introduction

In recent decades, children's commuting patterns and outdoor activities have become more restricted due to the continuous growth of motorised traffic and car-oriented urban environments (Larouche et al., 2018). Children's well-being is closely related to the built environment around them, which is shaped by families' daily routines and the health of their urban context. The design of streetscapes, planning decisions, and the policies of national government, municipalities and schools are all crucial in encouraging a shift towards decarbonising urban mobility through active modes of transport, particularly the improvement of children's play areas and safe routes to school.

Encouraging a shift towards decarbonising urban mobility through public transport, shared micro-mobility and active modes of transport, particularly walking, is a crucial challenge for many European cities. They increasingly face the problems urbanisation brings, such as traffic congestion, and challenges regarding road safety, energy dependency, social injustice, and air pollution. In many European car-dependent cities, people with low incomes, those with a physical disability, children, and the elderly have fewer opportunities to access services, parks, recreation, and commerce because they cannot drive. However, children being able to travel to school independently provides intrinsic benefits, such as opportunities for socialisation, exploration, and contact with their city, supporting their social, civic, and cognitive needs.

Additionally, promoting walking and cycling to and from school has the potential to reduce obesity and improve the health of school-aged children (Hino et al., 2021; S. Lee et al., 2020; Mitra, 2013). Active commuting to school (ACS), such as walking and cycling, supports the development of children's social skills and autonomy (Aranda-Balboa et al., 2020), is affordable and environmentally clean, improves air quality (Chillón et al., 2011), and helps to reduce peak-hours congestion (Zhu & Lee, 2009), as well as other benefits.

Despite these benefits, children's ACS and outdoor activities have decreased in recent years (Larouche et al., 2018), particularly in developed countries. Some geographical differences exist, however, with children independently and actively commuting to school in locations such as Japan and the Netherlands, and some cities in Spain, Chile, and Canada. Understanding children's travel behaviour is essential to the overall well-being of society (Hino et al., 2021; Rodríguez-Rodríguez et al., 2021).

Research has demonstrated that promoting ACS among children requires supportive streetscapes and development that safely accommodate children walking and/or cycling. Therefore, researchers have developed school walkability indices. Our understanding of walkability is that it is a construct that expresses the ease with which pedestrians can access destinations in a community (Sallis, 2009). By assessing the environment around schools and neighbourhoods, planning professionals can evaluate the quality of the pedestrian environment for children. This allows for objective, effective and comprehensive pedestrian-related strategies and interventions with the goal of securing improved walking conditions through the planning system.

Although there is a growing body of literature on school walkability and built environment factors (both macro and micro), few studies evaluate multiple levels of attributes, such as parents' social norms. Some authors suggest that parents' safety perceptions, beliefs, and travel-related behaviours may significantly influence the choice of their child's mode of travel to school (Terrón-Pérez et al., 2018). Parents and caregivers are often

viewed as the primary decision-makers in children's commuting behaviours (Huertas-Delgado et al., 2018), with their influence considered the leading social indicator of ACS (Aranda-Balboa et al., 2020; Kerr et al., 2006). Given that the responsibility for selecting the mode of transport to school primarily lies with parents, understanding their concerns and preferences regarding ACS is crucial (Huertas-Delgado et al., 2019; Ozbil et al., 2021; Zavareh et al., 2023).

School walkability indicators for improving children's ACS are not well established in the literature, with some gaps in identifying the main determinants which support policymakers and urban designers in decision-making. Empirical evidence on the factors influencing children's travel behaviour to school is both scarce and complex, requiring further investigation (Ozbil et al., 2021). Additionally, the literature highlights a lack of studies that adequately assess the relevance of existing walkability indices for schools (Chalikavada et al., 2021; Cottagiri et al., 2021; Kunaratnam et al., 2022). Moreover, parents' practices, authority, and safety perceptions are highly contextual and influenced by social factors, meaning that more research is needed to explore and fully understand these differences.

In Portugal, municipalities are transitioning to low-carbon models, aiming to become increasingly green and achieve greater efficiency in resource management, with benefits for quality of life, the environment, and public health (República Portuguesa, 2023). However, the shift from current mobility patterns, which are dominated by individual transport, has been hindered by the evident difficulty in identifying and implementing the necessary measures for change, as well as by the lack of information in this area. This has led to a series of disjointed initiatives that undermine the success and applicability of their intended goals. Nevertheless, some isolated projects and initiatives have been successful. Therefore, we explored these projects to understand their successes, challenges, and the lessons that can be learned from them.

Despite the growing number of studies in this area, there is a need for more research that systematises recent trends and findings on the key indicators influencing children's ACS and how these have been impacted by the development of a motorised society. This study aims to address these gaps by reviewing recent evidence and evaluating which determinants are critical to promoting children's ACS. We seek to answer the following research questions found in recent literature regarding the factors influencing children's ACS:

Q1: What are the most frequently used indicators/determinants in recent studies?

Q2: What are the main findings of recent studies?

Q3: What main features may be important to explore in future studies?

This study contributes to the literature on this topic by (1) identifying influential authors, papers, journals, and countries; (2) synthesising and systematising recent findings, and connecting these findings with the methods used; (3) investigating the association between children's ACS, walkability indicators, and parental barriers; (4) supporting a comprehensive understanding of the indicators that influence children's travel behaviour to school, particularly within the Portuguese context, to guide more objective, effective, and holistic pedestrian-related strategies and interventions for children; and (5) identifying limitations in the existing literature.

The next section of this study outlines the methods used to address the objectives above, followed by the presentation and discussion of the main results, the introduction of a conceptual framework for future studies, and, finally, a summary of the main conclusions.

2. Methods

2.1. Systematic Literature Review

This systematic literature review aims to collect, interpret, and evaluate the methods and findings of relevant scientific work on school walkability indicators that promote children's ACS. A comprehensive overview of the existing evidence, including both quantitative and qualitative analyses, is provided. We employed a systematic review approach based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Tricco et al., 2018). PRISMA follows a four-phase framework: identification, screening, eligibility, and inclusion. Figure 1 illustrates the review process and the eligibility criteria.

Database Search: A systematic search was conducted to examine original articles published between 2014 and 2024 in the following databases: Web of Science Core Collection, Scopus, and Limo. The search strategy included seven categories of key concepts in the field: "active commuting/travel behaviour/mobility," "children," "school," "walkability," "parents/caregivers," "perceptions/barriers," and "pedestrian/urban/physical environment."

Eligibility Criteria: Data collection was conducted between November 2023 and April 2024. To ensure scientific credibility, we applied the following eligibility criteria: (a) Published in a peer-reviewed journal and original research; (b) Published between 2014 and 2024; (c) Written in English; (d) Utilised an appropriate study design, either cross-sectional or longitudinal, and could employ quantitative, qualitative, or mixed methods approaches; (e) Participants included children aged 2–14 years, and their parents/caregivers or relatives; (f) Focused on children's ACS and its main determinants (including information on children's ACS); (g) Explored the association between children's walking and the built environment/school walkability and/or parents' perceptions and barriers; and (h) Examined the correlation between children's walking and at least two groups of indicators (including built environment, comfort, safety, social environment, and context).

Screening: After the initial identification process, 52 of the 1,479 identified studies were selected based on title screening, abstract screening, and keyword relevance; these studies were further evaluated for inclusion or exclusion according to the eligibility criteria. Additionally, the included studies' references were reviewed, resulting in the inclusion of three more studies. These 55 studies were then further screened by reviewing the full texts in accordance with the eligibility criteria, with 27 studies retained. A common reason for exclusion was the age of the children studied.

Bibliometric Analysis: Finally, we conducted a bibliometric analysis to uncover key terms, indicators, trends in children's mobility patterns, methods (tools), and geographical disparities. Data extracted included Authors, Publication date, Source, Title, Abstract, Participants, Location, Mobility patterns (e.g., walking or cycling), Potential & Limitations (Gaps/Arguments), Main findings, Methods, and Indicators used.

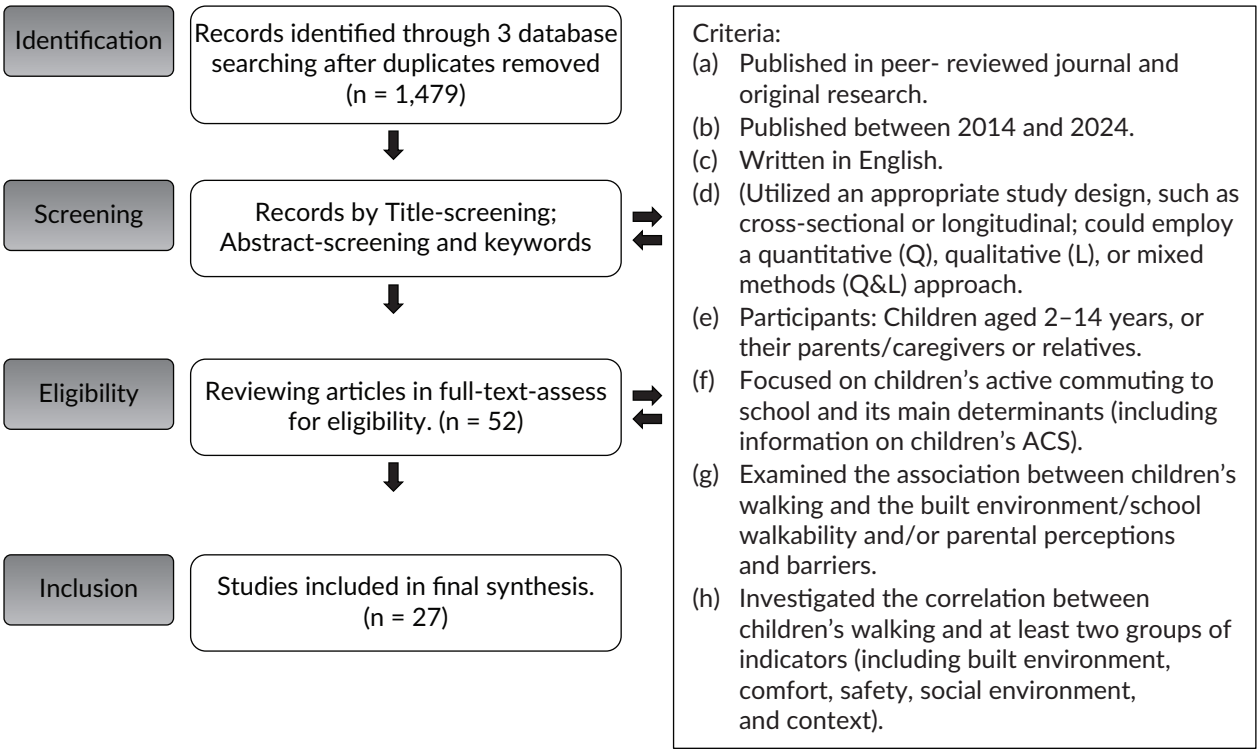

Figure 1. Flow of articles through the review process.

2.2. In-Depth Interviews

We also conducted interviews to establish a stable set of indicators for Portuguese schools. It is essential to conceptualise, categorise, and summarise these indicators to support and inform future interventions aimed at increasing active transport to schools among Portuguese children. We explored a variety of perspectives, including those of parents and caregivers, as well as practitioners, researchers, technical experts, and decision-makers. Parents were selected from focus groups conducted in a related, forthcoming study. This group was considered suitable for the research, as they provided accurate criteria and valuable contributions, enabling a holistic point of view and facilitating qualitative analysis through in-depth interviews. Table 1 below outlines the interviewee selection criteria, and Table 2 presents the guiding structure for the interviews. The main objective was to identify a stable set of indicators tailored to the specific context of Portuguese schools.

Table 1. Interviewees and their selection criteria.

No. (date)	Interviewees	Selection criteria
Inter.1(05.12.22)	Practitioner, *Ergonomist (PhD)*	Has practical experience in developing laws, local projects, and plans for pedestrian mobility.
Inter.2(26.03.23)	Researcher Activist, *Geographer (PhD candidate)*	Works directly with children in the "Pedibus" program within the Municipality.
Inter.3(27.03.23)	Expert, *Urban Planner (PhD)*	Has knowledge of urban planning, strategies to improve mobility, accessibility and city transportation systems.
Inter.4(08.05.23)	Pedagogical-Director, *Psychologist (PhD)*	Understands children's and parents' mobility habits and values in a school that facilitates ACS interventions by providing safe and supportive environments.
Inter.5(08.05.23)	Parent *(University degree)*	Exhibits outlier decision-making and travel behaviours: walks their child to school, then travels to work by bus.
Inter.6(29.05.23)	Couple *(University degree)*	Exhibits typical decision-making and travel behaviour: father drives the child to school, while the mother (a foreigner), who takes the child to school less frequently, uses the bus or metro (as they live outside of walking distance).
Inter.7(21.07.23)	School-Director, *Teacher (University degree)*	Has knowledge and experience regarding the evolution of school legislation and children's and parents' mobility habits and values.
Inter.8(10.11.23)	Couple *(University degree)*	Exhibits somewhat atypical decision-making and travel behaviours: father drives the child to school, while the mother, who only occasionally takes the child to school, walks them the 5 minutes to school.

Table 2. Interview structure.

Guiding questions	
Part-1	Introduction and gaining consent
Part-2	Background
	How important is it to promote children's ACS through walking? What were your childhood experiences of ACS?
	How did you go to school as a child? Was it a pleasant journey?
Part-3	Indicators
	How did you choose your child's school, and your home location?
	How do you decide how children should travel to school?
	What are the challenges to children's ACS, and how did you discover them?
	Are there any challenges to children's ACS that are specific to your local area?
	At what age do you think your child will be able to go to school on their own?
	Is there any kind of support, programme in your area of residence or school that promotes children's ACS?
Part-4	Problems
	If you lived in another context, where most children walked or cycled, would you let your child commute actively to school?
	What are your main fears?
	What would you change in your particular context to let your child commute actively to school?

3. Results and Discussion

3.1. Exploratory Analysis

This section describes the work conducted and the results obtained. First, an exploratory analysis of the reviewed documents was conducted, examining the number of documents and citations per year, country, publisher, journal, author, and type of document. Second, a bibliometric analysis was performed. This section also addresses and discusses the research questions outlined in the introduction of this review.

A total of 1,479 unique records were identified from the three databases, with additional manual searches performed (Figure 1). More than 1,427 records were excluded because they did not meet one or more of the inclusion criteria. After examining the full text of 52 papers, 25 were excluded due to not being empirically based, not meeting the age criteria for children, or lacking a correlation between walking, walkability, or parents' perceptions. The final analysis included 27 papers that met all the inclusion criteria.

Table 3, below, outlines selected information and main findings from the 27 peer-reviewed journals. These studies span various disciplines: health (n = 18, 67%), geography (n = 4, 15%), transportation (n = 3, 11%), and urban planning (n = 2, 7%). The studies were conducted in 19 different countries, including Canada (n = 4, 13.3%), Spain (n = 4, 13.3%), the U.K. (n = 3, 10%), Australia (n = 2, 6.7%), China (n = 2, 6.7%), New Zealand (n = 2, 6.7%), the U.S. (n = 2, 6.7%), Denmark (n = 1), Chile (n = 1), Croatia (n = 1), Ecuador (n = 1), Iran (n = 1), Israel (n = 1), Italy (n = 1), Japan (n = 1), the Netherlands (n = 1), Poland (n = 1), Portugal (n = 1), and Turkey (n = 1).

Regarding the settings of the studies, the majority (n = 24, 89%) were conducted in urban areas, with two studies including participants from both rural and urban areas, and one study undertaken in a suburban area. The sample sizes varied from 96 to 1,802, and all studies were exploratory, rather than hypothesis-driven. Most of the studies used quantitative approaches (n = 18, 67%); (n = 9, 33%) employed a mixed-method approach (quantitative and qualitative data), and none used a purely qualitative approach.

To collect data, most studies either used a questionnaire (n = 22, 81%), from that eleven only used a questionnaire (37%), six combined a questionnaire with GIS tools (22%; most tools were from existing literature, such as Neighbourhood Environment Walkability Scale [NEWS], Walk Score, TREK, GIS-WI, and LWI), four (15%) combined questionnaire with travel diaries or interviews and GIS. Additionally, one study used a focus group followed by a questionnaire. Other studies used various combinations (n = 5, 19%), two used GIS tools, one included a study travel diary with interviews and GIS, one conducted a mapping activity and GIS and, finally, one used interview combined with GIS tools (Figure 2).

Finally, most studies use the term Active Commuting to School (ACS) or Active School Travel (AST) to refer to activities such as walking or cycling. In more than half of the reviewed studies, children were found to actively commute to school (n = 16, > 50%). However, we observed varying levels of ACS within the same countries, indicating that children's commuting patterns should be further explored in different contexts. Additionally, some studies reveal differences in travel patterns based on age, distinguishing between children and adolescents.

The reviewed studies varied in terms of the main indicators studied. Almost all of them examined the relationship between ACS and the built environment (n = 26, 96% although five of these only considered distance/proximity). Twenty studies explored safety indicators (74%), 19 examined social environments (70%), and eight controlled for children's age and gender (30%). Fifteen studies investigated comfort indicators (56%), 12 looked at contextual indicators (44%), and one study explored ACS in relation to micro-scale features such as green areas and safety and children's characteristics.

For further details, please refer to Table 5 in the Supplementary File, which summarises the outcomes presented in this review. The table is structured by study and year of publication, location, average ACS levels, sample size, main findings, methods used (quantitative [Q] and qualitative [L]), and the indicators that influence children's travel behaviour to school.

3.2. Primary Finding Review Studies

The literature review clearly indicates that both the built environment and social norms, particularly safety perceptions and attitudinal factors, significantly influence children's travel behaviour to school (Curtis et al., 2015; Rothman et al., 2015). Multiple determinants contribute to whether a child actively travels to school. Table 3 summarises the main findings from the literature review.

A growing body of literature indicates that children's ACS is influenced by built environment characteristics (macro-level indicators) such as distance, density, street connectivity, and land use diversity. Moreover, the relationship between the built environment and children compared to adolescents differs (Molina-García et al., 2020).

Distance is one of the most frequently studied built environment indicators in the reviewed literature (Aranda-Balboa et al., 2020; Macdonald et al., 2019). Children living farther from school are less likely to actively commute (McDonald, 2008; Mitra et al., 2016). Curtis et al. (2015) argues that distance is related to factors like density, school availability, or the quality of the school (for example, the range of activities offered). For policymakers, understanding these multi-scale influences is crucial, as the impact of distance cannot be separated from factors like school location, density, land use mix, and street connectivity. Distance is a key determinant, and studies report varying measures of what is a walkable distance for children (including 10 minutes, 800 m, and 1.5 km). According to Bejleri et al. (2011), most studies use simplified proxies for distance, such as linear distance, block length or size, and street or intersection density. While these measures provide a good indication of the overall characteristics of a neighbourhood's street network, they do not always accurately reflect the specific conditions pedestrians face on their daily journeys.

Some studies suggest that a well-designed pathway may have a greater impact on promoting ACS than distance alone. In this context, distance can be measured more accurately when studies also consider attractive factors and perceived barriers. Attractive, or comfort, factors include walking paths and/or shortcuts, tree density, safe crossing routes, urban equipment, signage, and appropriate design for speed reduction. Christiansen et al. (2014) found that pedestrian paths, safe crossings, route safety, low to moderate traffic flows, and low-speed traffic influence perceived safety and ACS.

Table 3. Main determinants that influence children's ACS.

Key indicators (other indicators studied)	Support literature
Built environment (macro-level) Distance (Density, street connectivity, use, and school location)	(Carver et al., 2019; Christiansen et al., 2014; Curtis et al., 2015; Hino et al., 2021; Huertas-Delgado et al., 2017, 2018; Ikeda et al., 2020; Kunaratnam et al., 2022; J. Lee, 2020; S. Lee et al., 2020; Lopes et al., 2014; Macdonald et al., 2019; Mah et al., 2017; Masoumi et al., 2020; Michail et al., 2021; Molina-García et al., 2020; Moran et al., 2017; Noonan et al., 2017; Ozbil et al., 2021; Race et al., 2017; Rodríguez-Rodríguez et al., 2021; Rothman et al., 2015; Rybarczyk et al., 2023; Shaaban & Abdur-Rouf, 2019; Smith et al., 2024; Terrón-Pérez et al., 2018; X. Wang et al., 2022; Yang et al., 2020; Zavareh et al., 2023)
Comfort (micro-level) Pedestrian and cycling pathways and shortcuts, and ability to avoid major road crossings (Tree density, parks, squares, and urban furniture)	(Carver et al., 2019; Christiansen et al., 2014; J. Lee, 2020; S. Lee et al., 2020; Masoumi et al., 2020; Molina-García et al., 2020; Zavareh et al., 2023)
Safety and Perceived Safety, traffic speed, dangerous crossings and intersections, and crime-related concerns	(Christiansen et al., 2014; Hino et al., 2021; Huertas-Delgado et al., 2017, 2018; Masoumi et al., 2020; Michail et al., 2021; Molina-García et al., 2020; Ozbil et al., 2021; Race et al., 2017; Rothman et al., 2015)
Social Environment Children's characteristics: age, gender, origin, and social behaviour (Parents' travel behaviours, social support, time constraints, schedules, level of convenience, income, and education)	(Curtis et al., 2015; Ikeda et al., 2020; Kunaratnam et al., 2022; Lopes et al., 2014; Macdonald et al., 2019; Mah et al., 2017; Masoumi et al., 2020; Ozbil et al., 2021; Race et al., 2017; Rodríguez-Rodríguez et al., 2021; Smith et al., 2024; Terrón-Pérez et al., 2018; X. Wang et al., 2022; Zavareh et al., 2023)
Contextual School policy and community, government and municipal programs and interventions	(Hino et al., 2021; Huertas-Delgado et al., 2018; Ikeda et al., 2020; Lopes et al., 2014; Love et al., 2020; Macdonald et al., 2019; Michail et al., 2021; Molina-García et al., 2020; Noonan et al., 2017; Smith et al., 2024)

Parental perceived safety factors and barriers can include hazardous walking conditions, such as long distances between crosswalks and fences (Bejleri et al., 2011; Christiansen et al., 2014). A growing body of literature has begun to explore safety concerns, often reporting issues like: crash and crime rates, traffic exposure, and traffic speed. Additional barriers identified in the literature include time-consuming traffic signals for pedestrians at crosswalks, poor road safety perceptions, unavailable or unsafe pavements, and general insecurity. Conversely, attractive factors that enhance comfort and pleasure during the commute include the presence of pedestrian paths and shortcuts, low traffic volume roads, and green areas.

Several studies have examined both the parental barriers and the attractive factors which promote ACS (Huertas-Delgado et al., 2018). Other studies have explored the associations between parental perceptions and travel behaviour across various contexts, including the U.S. (J. Lee, 2020; S. Lee et al., 2020), Denmark (Christiansen et al., 2014), Latin America (Huertas-Delgado et al., 2018), and Spain (Huertas-Delgado et al., 2017). Rothman et al. (2015) found that parents' concerns regarding traffic along the school route, rather than at the school, affected the choice of school transportation mode. Therefore, identifying and addressing

AUTHORS	YEAR (area)	METHODS	INDICATORS				
			A	B	C	D	E
Carver et al.	2019 (health)	Q Questionaire (TREK)	•	n	•	©	•
Christiansen et al.	2014 (geography)	Q&L Questionaire Travek diary (TREK)	•	n	•	•	•
Curtis et al.	2015 (Urban Planning)	Q Questionaire	•	n	•	•	n
Hino et al.	2021 (health)	Q Questionaire (NEWS-Y)	•	•	•	©	•
Huertas-Delgado et al.	2018 (health)	Q Questionaire – PACO project	*	•	•	©	•
Huertas-Delgado et al.	2017 (health)	Q Questionaire – PACO project	*	n	•	•	n
Ikeda et al.	2020 (society)	Q&L Questionnaire, Semi-structured interview (TREK)	•	•	•	•	•
Kunaratnam et al.	2022 (transportation)	Q Observers (Walk Score®)	•	n	n	•	n
Lee	2020 (Urban Planning)	Q&L Questionaire, Travek diary & devices (GPS)	•	n	n	•	n
Lee et al.	2020 (health)	Q GIS-based school Walkability Index (WI)	•	•	•	©	•
Lopes et al.	2014 (geography)	Q Questionnaire 6 (CIM) Sense of community	•	•	•	©	•
Macdonald et al.	2019 (OA)	Q&L. (GPS) Observational study (SPACE) & 8 interviews	•	n	n	©	•
Mah et al.	2017 (health)	Q Questionnaire (NEW-Y)	*	n	•	•	n
Masoumi et al.	2020 (health)	Q Questionnaire	•	•	•	•	n
Michail et al.	2021 (health)	Q Questionnaire	•	n	n	•	•
Molina-García et al.	2020 (health)	Q Questionnaire	•	•	•	•	n
Moran et al.	2017 (health)	Q&L Mapping activity (GIS WI)	•	•	•	©	n
Noonan et al.	2017 (health)	Q Questionnaire (NEW-Y)	•	n	•	•	n
Ozbil et al.	2021 (health)	Q Questionnaire (*GIS Space-syntax*)	•	•	•	•	n
Race et al.	2017 (health)	Q&L Questionnaire, focus groups (Walk Score®)	•	•	•	•	n
Rodríguez-Rodríguez et al.	2021 (health)	Q Questionnaire – PACO project	*	n	n	•	n
Rothman et al.	2015 (health)	Q Questionnaire	•	•	•	•	n
Smith et al.	2024 (health)	Q Questionnaire Longitudinal (at 6 years and 8 years)	*	n	n	•	•
Terró-Pérez et al.	2018 (health)	Q&L Focus groups followed by Questionnaire	•	•	•	©	•
Wang et al.	2022 (geography)	Q&L Questionnaire, 24-h Travel diary & GIS – street view images	•	•	•	•	n
Yang et al.	2020 (geography)	Q&L Interviews & (GIS)	n	•	n	•	n
Zavareh et al.	2023 (transportation)	Q Questionnaire (ROC)	•	•	•	•	n

LEGEND: LOCATION: US United States. UK United Kingdom. FINDINGS: (P&W) Parental safety perception and Built environment/walkability (P) Parental safety perception; (W) Built environment/ walkability. METHODS: Q quantitative studies; L qualitative studies; Q&L mix-methods with qualitative and quantitative data analysis. INDICATORS: A Built environment (distance, density, street connectivity, mix-used); B Comfort (trees density and green areas, pedestrian and cycling paths, urban furniture – seats, wcs); C Safety (Traffic speed, crime-related safety, dangerous behaviours of drivers – park near or on the cross-zebra and sidewalks); D Social Environment (social support, time constrains, schedules or convenience); E Contextual (School policy and teaching and Municipal programmes). *Only considered distance. © only control children's characteristics: age, gender.

Figure 2. Reviewed studies (n = 27).

the specific road design issues along school routes which cause parents' perceptions of traffic danger may have a significant impact on increasing the number of children walking to school (Rothman et al., 2015).

Lopes et al. (2014) evaluated the impact of urbanisation on children's independent mobility in Portugal, revealing that parents' fear of traffic is the most frequent concern for children's safety outdoors. Masoumi et al. (2020) found significant differences in the level of independent school mobility between Poland and the Netherlands. In a study conducted in Ecuador, where ACS rates were low, the main barriers reported were crime and traffic speed (Huertas-Delgado et al., 2018). Aranda-Balboa et al. (2020) and Rodríguez-Rodríguez et al. (2021) claim that parental fear of traffic may vary across different contexts and cultures.

Factors such as age, gender, and parental attitudes play a crucial role in children's travel behaviour to and from school. Household dynamics, including the negotiation of travel permissions between parents and children, as well as social norms and values, also influence these behaviours. Curtis et al. (2015) found that boys often have more freedom to travel to school independently than girls. Studies applying ecological models to explore multiple levels of influence—policy, community, organisational, social, and individual—underscore the importance of human-environment interactions in understanding and changing travel behaviours.

In Denmark, high levels of ACS have been attributed to the persistent efforts of the Danish government and municipalities to promote safe route programs and awareness campaigns (Christiansen et al., 2014). As noted by Moran et al. (2017), children who walk to school are able to mentally map their route home, while those transported by car may not develop the same spatial understanding of their surroundings. Fusco et al. (2012) highlight that listening to children's perspectives offers valuable insights for research and policymaking aimed at promoting active travel behaviours. The social capital of the school and community, along with the influence of school culture, had the most significant impact on the effectiveness of interventions, as reported by Ikeda et al. (2018, 2019, 2020) and Love et al. (2020).

Over the years, numerous methodologies have been developed to measure built environment features (both macro and micro), particularly to measure walkability. These methods have predominantly focused on quantitative approaches using spatial data, such as that gathered from GPS devices, GIS-based tools, and space syntax, and socio-economic data gathered from surveys and questionnaires. In addition, various tools and techniques, such as auditing tools, travel diaries, checklists, inventories, level-of-service scales, group mapping workshops, and walk-along interviews have been introduced. Our review emphasises the importance of incorporating qualitative methods, which capture perceived walkability, as well, particularly in the context of school walkability that involves parents' decision-making processes.

3.3. Walkability Tools

Our scoping review found that most of the studies reviewed rely on existing walkability tool. The next section will synthesise some of these studies, as presented in Table 4. There is a substantial body of academic literature on walkability and, over the past decades, several indexes have been extensively studied to quantify and evaluate the walkability of neighbourhoods and communities. Environmental factors' impact on walkability have been measured using tools such as Walk Score, the Walkability Index, and TREK. However, there is evidence to indicate a weaker connection between Walk Score and walking habits in children than adults (Kunaratnam et al., 2022; Molina-García et al., 2020).

One of the most widely used self-reporting measures of walkability is the NEWS. Despite its popularity, some researchers argue that it is not easily or objectively measured, and that GIS provide a more objective alternative (Hinckson et al., 2017; R. Wang et al., 2022). On the other hand, some authors contend that GIS-based measurements often overlook micro-scale factors, such as street safety, noise, and comfort (Gorrini et al., 2023). To address these challenges and gain a comprehensive understanding of how streets' physical characteristics and design affect walkability, researchers have begun using auditing tools, or a combination of them. More recently, approaches have used tools like Google Street View and artificial intelligence to support the measurement and evaluation of walking environments (De Vos et al., 2023).

Table 4. Walkability index tools used in the school walkability studies.

Tool	Author	Tool objective	Indicators used
NEWS	Saelens et al. (2003)	To analyse the influence of built environmental attributes on walkability.	Pedestrian infrastructure, residential density, land use mix, access, street connectivity, traffic safety, security from crime, aesthetics.
NEWS-Y	Rosenberg et al. (2009)	To explore associations between the Walkability Scale-Youth (NEWS-Y) and context-specific and overall physical activity among youth.	Land use mix-diversity, recreation availability, pedestrian/automobile traffic safety, crime safety, aesthetics, walking/cycling facilities, street connectivity, land use mix-access, residential density.
NEWS-CC	He et al. (2021)	To adapt the NEWS-Y for Chinese children, adding nine new items capturing specific environmental attributes.	67 items covering: land use mix-diversity (20), recreational facilities (14), residential density (6), aesthetics (5), land use mix-access (2), street connectivity (2), walking facilities (4), crime safety (6), traffic safety (4), pollution (4). Also, 27 items in the subscales of aesthetics, land use mix-access, street connectivity, walking facilities, crime safety, traffic safety, and pollution.
GIS-WI (WI)	Frank et al. (2005)	To measure land use mix, street connectivity, and residential density.	Residential density, street connectivity, and land use mix within a 1 km buffer area, combined to create a walkability index.
TREK	Giles-Corti et al. (2011)	To examine road connectivity and vehicular traffic exposure within 2 km of public primary schools, and its impact on children's walking habits.	Connected street networks, street design, school siting, vehicular traffic exposure.
Walk Score	Chudyk et al. (2017)	To objectively measure walkability based on proximity to facilities using a 10-point scale.	Combines: (1) shortest distance to preselected destinations, (2) block length, (3) intersection density.

3.4. Results From the In-Depth Interviews

In this section, we present the main results from the series of in-depth interviews that were conducted to establish a stable set of indicators tailored to the Portuguese context.

In Portugal, the distance between children's homes and schools can exceed 4 km. As the School Director noted (Int. 7), parents can choose between the school nearest to their home or their workplace. The schools' extracurricular offerings, and the proximity of the one school to the workplace are key factors in the decision-making. These findings suggest that future studies should explore the primary factors that influence parents' school selection to better understand the reasons for this distance between school and home.

Despite various initiatives, programmes, and strategies in Portugal, children's outdoor play and independence are declining. Road traffic accidents are one of the leading causes of death for children aged 0–19 (APSI, 2022), with many of these incidents occurring near schools. Portugal has the highest rate of pedestrian deaths

in Western Europe. The ASRN's report for 2022 recorded 32,788 accidents (ASRN, 2023), and Portugal has the lowest percentage of children (age 6–9) walking to school—18% compared to Denmark's 34%, Poland's 37%, France's 40%, and Croatia's 42% (Steward, 2022). Traffic speed is considered the primary indicator of perceived safety and is directly linked to accidents, road size, and noise.

According to parents' interviews (Int. 5, 6, and 8), pedestrian infrastructure and crossings are often unsafe. It is common for parents to stop their cars on pavements to drop off their children, particularly near the main entrances of schools and kindergartens at the beginning and end of the school day. Combined with the fact that scooters use pedestrian spaces at high speeds, this means that these areas are considered unsafe. As pointed out by two directors and an urban planning expert (Int. 3, 4, and 7), these behaviours violate the law, yet they are widely tolerated, effectively making them an accepted practice in the community. These problematic behaviours impact parents' perceptions of safety and heighten their fear of traffic. Many parents are concerned about their children crossing hazardous areas, even if the distance to school is short. In an interview (Int. 8), parents revealed that, despite living close to the school, they do not allow their child to walk alone because it is comfortable for them to drive the child to school on their way to work.

The decision-making process is complex and often influenced by parents' backgrounds, social norms, and travel behaviours. For instance, in one interview (Int. 6), a couple explained their preferences for taking their child to school. The father drives the child to school and then continues to work, while the mother prefers using public transport. The mother mentioned that she dislikes driving due to the stress of traffic and that the travel time is similar. She also noted that she has been a frequent user of public transport since she was young, and in their city, it is free and better than where she grew up. During another interview (Int. 5), a mother explained that she prefers to walk her daughter to school due to the convenience of a bus stop located directly in front of the school, which provides a direct route to the city centre location where she works. She also mentioned that the difficulty of finding parking in the city centre is a major factor in her decision. The design of the city and the school zone directly impacts the daily lives of residents, including their school choices (Giles-Corti et al., 2011). According to the expert (Int. 3), political decision-makers should consider public transport accessibility, neighbourhood conditions, and walkability when selecting locations for new schools.

According to the pedagogical director, children need to learn about the dangers of being independent, and how to behave when walking alone or in groups. Mobility education is an effective way to promote autonomy for children at school as it teaches them "how to cross streets, travel in groups, respect traffic signs, and avoid dangerous areas" (Int. 4). The urban planner also emphasised the importance of children getting to know their city and surroundings, not only for their natural development and sense of community—a point also noted by the geographer—but also for emergencies such as pandemics, climate disasters, or wars. Finally, as the pedagogical director stated, walking to school can be an opportunity for parents and children to spend quality time together.

4. A Conceptual Framework for Future Research

The scoping review underscores the importance of the urban environment in shaping children's travel behaviours to and from school. The findings suggest that distance is the most widely accepted indicator, although some authors argue that perceived distance may be more significant. This means that the presence of safe routes with pedestrian paths, major roads, and unsafe crosswalks can significantly impact parents'

decisions and their fear of traffic. In Portugal, this is a pressing issue that needs to be addressed. The high rates of pedestrian injuries and the dominant car-centric culture suggest that these indicators may play a critical role in influencing children's travel behaviours to school and should be further explored.

Consequently, the government and several municipalities are progressively investing in policy measures to encourage children to walk. However, there are still relatively few studies in this area. Additionally, the current "backseat generation" and car-dependent mobility patterns present challenges, including time constraints and the lack of coordination needed to identify appropriate policy measures that influence targeted travel behaviours. Figure 3 presents the theoretical framework for exploring the main determinants of children's daily transportation behaviours to school. Following this, we will outline our perspective on the most important groups of indicators to include in research that examines factors influencing children's walking or biking to and from school.

Figure 3 presents the conceptual framework, based on insights from interviews, existing school walkability studies, and the systematic review, which will serve to guide future studies tailored to the Portuguese context:

> Built Environment: Urban areas should be planned with appropriate levels of density, street connectivity, and land-use mix to ensure children have access to essential services within a walkable distance from home. New school locations should consider pedestrian infrastructure and public transport accessibility and ensure strategic placement within the urban landscape (Vincent et al., 2017).
>
> Comfort: Standard quality criteria for walking paths, including shade from trees, protection from cars, and continuous pavements, must be met. Comfort elements for children, such as urban furniture, shelters, and access to public restrooms, should also be provided to make walking more enjoyable.

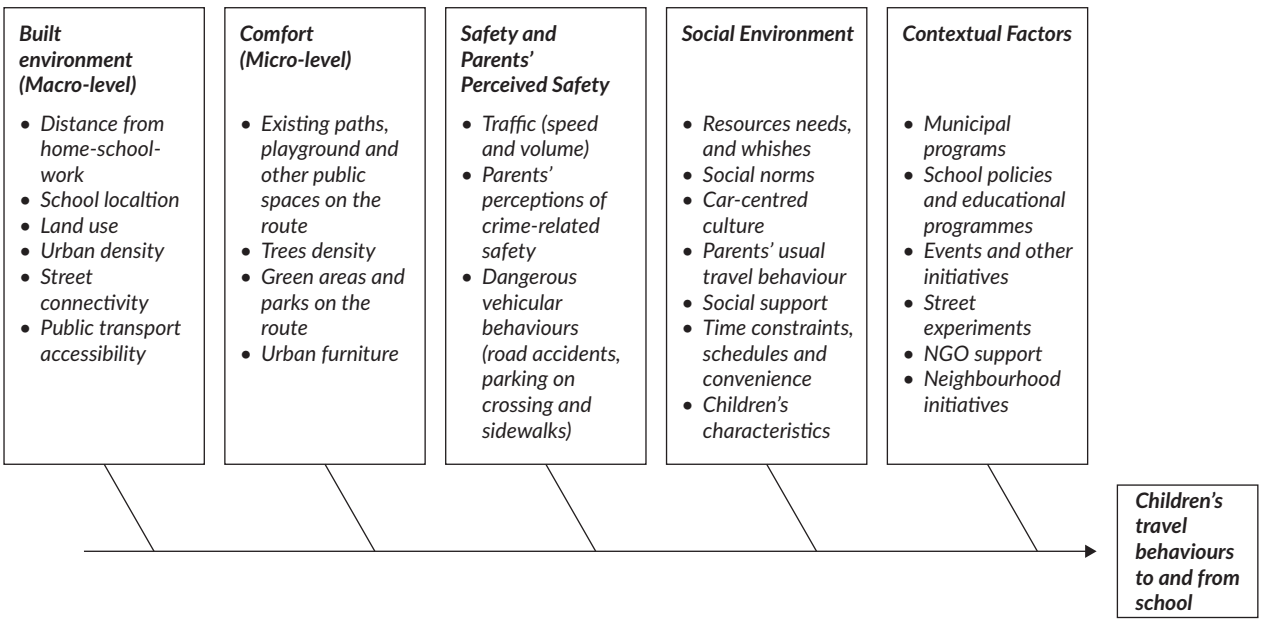

Figure 3. Conceptual framework of children's daily travel behaviours to school as a function of built environment characteristics (macro and micro), parental safety perceptions, social norms, and contextual factors.

Safety: Controlling traffic speed, reducing road size, installing clear signage for children, ensuring safe crossings, and providing adequate lighting at junctions for visibility are critical safety factors. Addressing parental fear of traffic is crucial, as it heavily influences their choice of travel mode for their children.

Social Environment: Factors such as parents' fears, the convenience of taking the child to school, time constraints, and social norms all influence the choice of school and mode of travel.

Contextual Factors: Local programs, school policies, and government strategies play an important role. Schools can serve as facilitators of ACS interventions by providing safe and supportive environments and reinforcing ACS habits and values.

Future research, particularly in the Portuguese context, should dive deep into parents' perceptions and backgrounds. Focus groups and walk-along interviews are excellent methods to engage parents and children in discussions about transitioning to healthier travel behaviours. Research suggests these approaches provide opportunities to raise awareness and advocate for social and political rights (Christiansen et al., 2014; Moran et al., 2017).

Our case study revealed that addressing unsafe practices near schools—such as exceeding speed limits, parking on pavements, or stopping next to pedestrian crossings—can have positive impacts on children's personal and social development. Urban planning practices should adopt these findings and explore innovative ways to involve children and their families in active travel when designing new policy instruments, regulations, and other interventions.

5. Conclusion

This study provides a scoping review and updated information on existing evidence regarding school walkability and the barriers parents face in promoting active travel to school among children. It offers a comprehensive overview of various studies, and highlights the key differences between them, to establish a conceptual framework. This framework, based on a specific case study, aims to inform future research to support more objective, effective, and expansive strategies, policies, and interventions related to children's ACS. Guided by previous literature, a series of interviews were conducted. The interviewed parents expressed concerns about allowing their children to walk alone, citing bad driver behaviour as a significant issue, despite the pedestrian infrastructure being rated as fairly adequate. These findings suggest that studies focusing solely on physical attributes may produce misleading results. Therefore, it is crucial to include parental perceptions, travel behaviour and backgrounds in research. Additionally, the importance of contextual factors—such as legislation, local programs, and school strategies—should not be overlooked. Finally, we hope that this study supports and encourages future research into school walkability and active travel interventions for children.

Acknowledgments

The authors gratefully acknowledge the valuable contributions of the participants.

Funding

This work was financially supported by the Base Funding allocated by the FCT/MCTES (PIDDAC) to CITTA—Research Centre for Territory, Transports and Environment (UIDB/04427/2020). The contribution by Catarina Cadima was supported by the Portuguese Foundation for Science and Technology (FCT), through the 2021.01013.CEECIND grant, "School Walkability Improvement Tool: Bridging the Portuguese Planning Gap."

Conflict of Interests

The authors declare no conflict of interests.

Supplementary Material

Supplementary material for this review is available online in the format provided by the authors (unedited).

References

APSI. (2022). *30 anos de segurança infantil—Outubro 2022*.

Aranda-Balboa, M. J., Huertas-Delgado, F. J., Herrador-Colmenero, M., Cardon, G., & Chillón, P. (2020). Parental barriers to active transport to school: A systematic review. *International Journal of Public Health*, *65*(1), 87–98. https://doi.org/10.1007/s00038-019-01313-1

ASRN. (2023). *Resultados síntese de sinistralidade 2022 (Vítimas a 30 dias)*.

Bejleri, I., Steiner, R. L., Fischman, A., & Schmucker, J. M. (2011). Using GIS to analyze the role of barriers and facilitators to walking in children's travel to school. *Urban Design International*, *16*(1), 51–62. https://doi.org/10.1057/udi.2010.18

Carver, A., Barr, A., Singh, A., Badland, H., Mavoa, S., & Bentley, R. (2019). How are the built environment and household travel characteristics associated with children's active transport in Melbourne, Australia? *Journal of Transport and Health*, *12*, 115–129. https://doi.org/10.1016/j.jth.2019.01.003

Chalikavada, R., Broder, J. C., O'Hara, R. L., Xue, W., & Gasevic, D. (2021). The association between neighbourhood walkability and after-school physical activity in Australian schoolchildren. *Health Promotion Journal of Australia*, *32*(2), 182–188. https://doi.org/10.1002/hpja.356

Chillón, P., Evenson, K. R., Vaughn, A., & Ward, D. S. (2011). A systematic review of interventions for promoting active transportation to school. *International Journal of Behavioral Nutrition and Physical Activity*, *8*, Article 10. https://doi.org/10.1186/1479-5868-8-10

Christiansen, L. B., Toftager, M., Schipperijn, J., Ersbøll, A. K., Giles-Corti, B., & Troelsen, J. (2014). School site walkability and active school transport—Association, mediation and moderation. *Journal of Transport Geography*, *34*, 7–15. https://doi.org/10.1016/j.jtrangeo.2013.10.012

Chudyk, A. M., McKay, H. A., Winters, M., Sims-Gould, J., & Ashe, M. C. (2017). Neighborhood walkability, physical activity, and walking for transportation: A cross-sectional study of older adults living on low income. *BMC Geriatrics*, *17*, 1–14. https://link.springer.com/article/10.17269/s41997-020-00440-0

Cottagiri, S. A., De Groh, M., Srugo, S. A., Jiang, Y., Hamilton, H. A., Ross, N. A., & Villeneuve, P. J. (2021). Are school-based measures of walkability and greenness associated with modes of commuting to school? Findings from a student survey in Ontario, Canada. *Canadian Journal of Public Health*, *112*, 331–341. https://doi.org/10.17269/s41997-020-00440-0

Curtis, C., Babb, C., & Olaru, D. (2015). Built environment and children's travel to school. *Transport Policy*, *42*, 21–33. https://doi.org/10.1016/j.tranpol.2015.04.003

De Vos, J., Lättman, K., van der Vlugt, A. L., Welsch, J., & Otsuka, N. (2023). Determinants and effects of perceived walkability: A literature review, conceptual model and research agenda. *Transport Reviews*, *43*(2), 303–324. https://doi.org/10.1080/01441647.2022.2101072

Frank, L. D., Schmid, T. L., Sallis, J. F., Chapman, J., & Saelens, B. E. (2005). Linking objectively measured physical activity with objectively measured urban form: Findings from SMARTRAQ. *American Journal of Preventive Medicine*, *28*(2), 117–125.

Fusco, C., Moola, F., Faulkner, G., Buliung, R., & Richichi, V. (2012). Toward an understanding of children's perceptions of their transport geographies: (Non) active school travel and visual representations of the built environment. *Journal of Transport Geography*, *20*(1), 62–70. https://doi.org/10.1016/j.jtrangeo.2011.07.001

Giles-Corti, B., Wood, G., Pikora, T., Learnihan, V., Bulsara, M., Van Niel, K., Timperio, A., McCormack, G., & Villanueva, K. (2011). School site and the potential to walk to school: The impact of street connectivity and traffic exposure in school neighborhoods. *Health and Place*, *17*(2), 545–550. https://doi.org/10.1016/j.healthplace.2010.12.011

Gorrini, A., Presicce, D., Messa, F., & Choubassi, R. (2023). Walkability for children in Bologna: Beyond the 15-minute city framework. *Journal of Urban Mobility*, *3*, Article 100052. https://doi.org/10.1016/J.URBMOB.2023.100052

He, G., Huang, W., Salmon, J., & Wong, S. H. (2021). Adaptation and evaluation of the neighborhood environment walkability scale for youth for Chinese children (NEWS-CC). *BMC Public Health*, *21*, 1–10.

Hinckson, E., Cerin, E., Mavoa, S., Smith, M., Badland, H., Stewart, T., Duncan, S., & Schofield, G. (2017). Associations of the perceived and objective neighborhood environment with physical activity and sedentary time in New Zealand adolescents. *International Journal of Behavioral Nutrition and Physical Activity*, *14*(1), Article 145. https://doi.org/10.1186/s12966-017-0597-5

Hino, K., Ikeda, E., Sadahiro, S., & Inoue, S. (2021). Associations of neighborhood built, safety, and social environment with walking to and from school among elementary school-aged children in Chiba, Japan. *International Journal of Behavioral Nutrition and Physical Activity*, *18*(1). https://doi.org/10.1186/s12966-021-01202-y

Huertas-Delgado, F. J., Chillón, P., Barranco-Ruiz, Y., Herrador-Colmenero, M., Rodríguez-Rodríguez, F., & Villa-González, E. (2018). Parental perceived barriers to active commuting to school in Ecuadorian youth. *Journal of Transport and Health*, *10*, 290–296. https://doi.org/10.1016/j.jth.2018.05.102

Huertas-Delgado, F. J., Herrador-Colmenero, M., Villa-González, E., Aranda-Balboa, M. J., Cáceres, M. V., Mandic, S., & Chillón, P. (2017). Parental perceptions of barriers to active commuting to school in Spanish children and adolescents. *European Journal of Public Health*, *27*(3), 416–421. https://doi.org/10.1093/eurpub/ckw249

Huertas-Delgado, F. J., Molina-García, J., Van Dyck, D., & Chillon, P. (2019). A questionnaire to assess parental perception of barriers towards active commuting to school (PABACS): Reliability and validity. *Journal of Transport and Health*, *12*, 97–104. https://doi.org/10.1016/j.jth.2018.12.004

Ikeda, E., Hinckson, E., Witten, K., & Smith, M. (2018). Associations of children's active school travel with perceptions of the physical environment and characteristics of the social environment: A systematic review. *Health and Place*, *54*, 118–131. https://doi.org/10.1016/j.healthplace.2018.09.009

Ikeda, E., Hinckson, E., Witten, K., & Smith, M. (2019). Assessment of direct and indirect associations between children active school travel and environmental, household and child factors using structural equation modelling. *International Journal of Behavioral Nutrition and Physical Activity*, *16*(1). https://doi.org/10.1186/s12966-019-0794-5

Ikeda, E., Mavoa, S., Cavadino, A., Carroll, P., Hinckson, E., Witten, K., & Smith, M. (2020). Keeping kids safe for active travel to school: A mixed method examination of school policies and practices and children's school travel behaviour. *Travel Behaviour and Society*, *21*, 57–68. https://doi.org/10.1016/J.TBS.2020.05.008

Kerr, J., Rosenberg, D., Sallis, J. F., Saelens, B. E., Frank, L. D., & Conway, T. L. (2006). Active commuting to school: Associations with environment and parental concerns. *Medicine & Science in Sports & Exercise*, *38*(4), 787–794. https://doi.org/10.1249/01.mss.0000210208.63565.73

Kunaratnam, V., Schwartz, N., Howard, A., Mitra, R., Saunders, N., Cloutier, M. S., Macpherson, A., Fuselli, P., & Rothman, L. (2022). Equity, walkability, and active school transportation in Toronto, Canada: A cross-sectional study. *Transportation Research Part D: Transport and Environment*, *108*, Article 103336. https://doi.org/10.1016/j.trd.2022.103336

Larouche, R., Mammen, G., Rowe, D. A., & Faulkner, G. (2018). Effectiveness of active school transport interventions: A systematic review and update. *BMC Public Health*, *18*(1). https://doi.org/10.1186/s12889-017-5005-1

Lee, J. (2020). Urban form, children's active travel to/from school, and travel related physical activity. *International Review for Spatial Planning and Sustainable Development*, *8*(1), 21–38. https://doi.org/10.14246/IRSPSD.8.1_21

Lee, S., Lee, C., Nam, J. W., Abbey-Lambertz, M., & Mendoza, J. A. (2020). School walkability index: Application of environmental audit tool and GIS. *Journal of Transport & Health*, *18*, Article 100880. https://doi.org/https://doi.org/10.1016/j.jth.2020.100880

Lopes, F., Cordovil, R., & Neto, C. (2014). Children's independent mobility in Portugal: Effects of urbanization degree and motorized modes of travel. *Journal of Transport Geography*, *41*, 210–219. https://doi.org/10.1016/j.jtrangeo.2014.10.002

Love, P., Villanueva, K., & Whitzman, C. (2020). Children's independent mobility: The role of school-based social capital. *Children's Geographies*, *18*(3), 253–268. https://doi.org/10.1080/14733285.2019.1634244

Macdonald, L., Mccrorie, P., Nicholls, N., & Olsen, J. R. (2019). Active commute to school: Does distance from school or walkability of the home neighbourhood matter? A national cross-sectional study of children aged 10–11 years, Scotland, UK. *BMJ Open*, *9*(12). https://doi.org/10.1136/bmjopen-2019-033628

Mah, S. K., Nettlefold, L., Macdonald, H. M., Winters, M., Race, D., Voss, C., & McKay, H. A. (2017). Does parental support influence children's active school travel? *Preventive Medicine Reports*, *6*, 346–351. https://doi.org/10.1016/j.pmedr.2017.04.008

Masoumi, H., van Rooijen, M., & Sierpiński, G. (2020). Children's independent mobility to school in seven European countries: A multinomial logit model. *International Journal of Environmental Research and Public Health*, *17*(23), 1–20. https://doi.org/10.3390/ijerph17239149

McDonald, N. C. (2008). Children's mode choice for the school trip: The role of distance and school location in walking to school. *Transportation*, *35*(1), 23–35. https://doi.org/10.1007/s11116-007-9135-7

Michail, N., Ozbil, A., Parnell, R., & Wilkie, S. (2021). Children's experiences of their journey to school: Integrating behaviour change frameworks to inform the role of the built environment in active school travel promotion. *International Journal of Environmental Research and Public Health*, *18*(9). https://doi.org/10.3390/ijerph18094992

Mitra, R. (2013). Independent mobility and mode choice for school transportation: A review and framework for future research. *Transport Reviews*, *33*(1), 21–43. https://doi.org/10.1080/01441647.2012.743490

Mitra, R., Papaioannou, E. M., & Nurul Habib, K. M. (2016). Past and present of active school transportation: An explanation of the influence of the built environment in Toronto, Canada, from 1986 to 2006. *Journal of Transport and Land Use*, *9*(2), 25–41. https://doi.org/10.5198/jtlu.2015.537

Molina-García, J., Campos, S., García-Massó, X., Herrador-Colmenero, M., Gálvez-Fernández, P., Molina-Soberanes, D., Queralt, A., & Chillón, P. (2020). Different neighborhood walkability indexes for active commuting to school are necessary for urban and rural children and adolescents. *International Journal of Behavioral Nutrition and Physical Activity*, *17*(1). https://doi.org/10.1186/s12966-020-01028-0

Moran, M. R., Eizenberg, E., & Plaut, P. (2017). Getting to know a place: Built environment walkability and children's spatial representation of their home-school (h-s) route. *International Journal of Environmental Research and Public Health*, *14*(6). https://doi.org/10.3390/ijerph14060607

Noonan, R. J., Boddy, L. M., Knowles, Z. R., & Fairclough, S. J. (2017). Fitness, fatness and active school commuting among Liverpool schoolchildren. *International Journal of Environmental Research and Public Health*, *14*(9). https://doi.org/10.3390/ijerph14090995

Ozbil, A., Yesiltepe, D., Argin, G., & Rybarczyk, G. (2021). Children's active school travel: Examining the combined perceived and objective built-environment factors from space syntax. *International Journal of Environmental Research and Public Health*, *18*(1), 1–22. https://doi.org/10.3390/ijerph18010286

Race, D. L., Sims-Gould, J., Lee, C., Frazer, D., Voss, C., Naylor, P. J., & McKay, H. A. (2017). Urban and suburban children's experiences with school travel—A case study. *Journal of Transport and Health*, *4*, 305–315. https://doi.org/10.1016/j.jth.2017.01.011

República Portuguesa. (2023). *Resolução do Conselho de Ministros n.º 67/2023, de 7 de julho*. https://diariodarepublica.pt/dr/detalhe/resolucao-conselho-ministros/67-2023-215338988

Rodríguez-Rodríguez, F., Gálvez-Fernández, P., Huertas-Delgado, F. J., Aranda-Balboa, M. J., Saucedo-Araujo, R. G., & Herrador-Colmenero, M. (2021). Parent's sociodemographic factors, physical activity and active commuting are predictors of independent mobility to school. *International Journal of Health Geographics*, *20*(1). https://doi.org/10.1186/s12942-021-00280-2

Rosenberg, D., Ding, D., Sallis, J.F., Kerr, J., Norman, G.J., Durant, N., Harris, S. K., & Saelens, B. E. (2009). Neighborhood Environment Walkability Scale for Youth (NEWS-Y): Reliability and relationship with physical activity. *Preventive Medicine*, *49*(2/3), 213–218.

Rothman, L., Buliung, R., To, T., Macarthur, C., Macpherson, A., & Howard, A. (2015). Associations between parents' perception of traffic danger, the built environment and walking to school. *Journal of Transport and Health*, *2*(3), 327–335. https://doi.org/10.1016/j.jth.2015.05.004

Rybarczyk, G., Ozbil, A., Yesiltepe, D., & Argin, G. (2023). Walking alone or walking together: A spatial evaluation of children's travel behavior to school. *Environment and Planning B: Urban Analytics and City Science*, *50*(9), 2560–2578. https://doi.org/10.1177/23998083231161612

Saelens, B. E., Sallis, J. F., & Frank, L. D. (2003). Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. *Annals of Behavioral Medicine*, *25*(2), 80–91.

Sallis, J. F. (2009). Measuring physical activity environments: A brief history. *American Journal of Preventive Medicine*, *36*(4), S86–S92. https://doi.org/10.1016/j.amepre.2009.01.002

Shaaban, K., & Abdur-Rouf, K. (2019). Development, validation, and application of School Audit Tool (SAT): An effective instrument for assessing traffic safety and operation around schools. *Sustainability*, *11*(22). https://doi.org/10.3390/su11226438

Smith, M., Cavadino, A., Zhang, Y., McGlashan Fainu, H., Zhao, J., Morton, S., Hopkins, D., Carr, H., & Clark, T. C. (2024). Socio-environmental factors associated with shifts in children's travel mode between 6 and 8 years. *Journal of Transport and Health*, *36*. https://doi.org/10.1016/j.jth.2024.101811

Steward, C. (2022). *Europe: Share of children who walk or bike to school 2015–2017, by country*. Statista. https://www.statista.com/statistics/865660/children-who-bike-or-walk-to-school-europe-by-country

Terrón-Pérez, M., Molina-García, J., Martínez-Bello, V. E., & Queralt, A. (2018). Active commuting to school

among preschool-aged children and its barriers: An exploratory study in collaboration with parents. *Journal of Transport and Health*, *8*, 244–250. https://doi.org/10.1016/j.jth.2017.12.007

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., Straus, S. E. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, *169*(7), 467–473. https://doi.org/10.7326/M18-0850

Vincent, J. M., Miller, R., & Dillon, L. (2017). School siting and walkability: Experience and policy implications in California. *California Journal of Politics and Policy*, *9*(3). https://doi.org/10.5070/p2cjpp9336923

Wang, R., Wang, Y., & Zhang, Y. (2022). International methods and local factors of walkability: A bibliometric analysis and review. *Journal of Urban Planning and Development*, *148*(4). https://doi.org/10.1061/(ASCE)UP.1943-5444.0000872

Wang, X., Liu, Y., Zhu, C., Yao, Y., & Helbich, M. (2022). Associations between the streetscape built environment and walking to school among primary schoolchildren in Beijing, China. *Journal of Transport Geography*, *99*. https://doi.org/10.1016/j.jtrangeo.2022.103303

Yang, Y., Lu, Y., Yang, L., Gou, Z., & Zhang, X. (2020). Urban greenery, active school transport, and body weight among Hong Kong children. *Travel Behaviour and Society*, *20*, 104–113. https://doi.org/10.1016/j.tbs.2020.03.001

Zavareh, M. F., Barati, M., Mamdoohi, A. R., & Abraham, M. (2023). The role of walkability, socio-economic and parental cognitive characteristics in long walking journeys to school. *Transportation Research Record*, *2677*(1), 1473–1489. https://doi.org/10.1177/03611981221104805

Zhu, X., & Lee, C. (2009). Correlates of walking to school and implications for public policies: Survey results from parents of elementary school children in Austin, Texas. *Journal of Public Health Policy*, *30*(Suppl. 1), S177–S202. https://doi.org/10.1057/jphp.2008.51

About the Authors

Catarina Cadima is a researcher at the Research Centre for Territory, Transports and Environment (CITTA), University of Porto, Portugal. Her scientific activity has involved spatial planning, economic geography, and sustainable mobility. Her research focuses on active commuting, decision-making processes, mode choice, and the impact of contextual factors (financial and natural hazards, wars, and pandemic crises) on mobility and social inequalities. Catarina is starting the SWIT Project, which involves school mobility management, exploring the links between policymaking and experiments in co-creation with the community, arts, and children, within the scope of the Scientific Employment.

Paulo Pinho (Porto, 1956) is professor emeritus at the University of Porto and founder and director, until his retirement in 2022, of CITTA, the Research Centre in Territory, Transports and Environment. He was co-founder and director for several years of the doctoral program in Spatial Planning (FEUP-FCTUC) and the master's in Environmental Planning and Urban Design (FEUP-FAUP). Between 2015 and 2019 he was the secretary general of AESOP, the Association of European Schools of Planning. He is a researcher and consultant in the areas of urban, environmental, and transport planning.