BUILT ENVIRONMENT BARRIERS AND FACILITATORS TO PHYSICAL ACTIVITY IN INDIAN CITIES: A SCOPING REVIEW

Nagabhoina Tejendra and Pankaj Verma

Department of Architecture and Planning, Visvesvaraya National Institute of Technology (VNIT), Nagpur, India

Abstract. Extensive research in developed countries confirms the influence of the urban built environment (BE) on physical activity (PA), but similar studies in low- and middle-income countries, such as India, are limited. A scoping review was conducted through a systematic search of the Web of Science, Scopus and PubMed databases, as well as additional sources, to identify articles on BE, PA and BE influence on PA conducted in India up to June 2024. Twenty-seven articles were chosen based on PRISMA-ScR guidelines. Four themes across demographic groups and locations were classified, namely walking and cycling infrastructure, safety from traffic and crime, access to PA resources, and aesthetics and environmental quality, together with age- and gender-specific findings. Several research gaps were also identified, such as reliance on self-reported questionnaires, limited use of objective assessment tools, under-representation of specific demographic groups, and insufficient studies on diverse BE types and PA environments. The scoping review provided a comprehensive synthesis of barriers and facilitators of PA in Indian cities. The findings highlighted the need for context-specific and demographic-sensitive research to assist urban designers in understanding the impact of the built environment on residents' physical activity.

Keywords: assessment tool, barrier, built environment, facilitator, physical activity, urban context

Correspondence: Nagabhoina Tejendra, Department of Architecture and Planning, Visvesvaraya National Institute of Technology (VNIT), South Ambazari Road, Nagpur 440010, India
Tel: +91 8179172690 E-mail: tejendranagabhoina@gmail.com

INTRODUCTION

Physical activity (PA) plays a significant role in maintaining physical and mental health, reducing the risk of non-communicable diseases (Strain *et al*, 2024), premature mortality, and more than twenty-five chronic medical conditions (Warburton and Bredin, 2017). PA is "any bodily movement produced by skeletal muscles that requires energy expenditure" (Caspersen *et al*, 1985). The World Health Organization (WHO) recommends at least 150-300 minutes of moderate intensity or 75-150 minutes of vigorous intensity aerobic PA per week for adults and an average of 60 minutes per day of moderate-to-vigorous intensity physical activity (MVPA) for children and adolescents (Warburton and Bredin, 2017). Individuals failing to meet these PA recommendations are considered insufficiently physically active (Strain *et al*, 2024). With the increasing global prevalence of insufficient PA in nearly 50% of countries across the world (Strain *et al*, 2024), physical inactivity is a significant risk factor for many non-communicable diseases (NCDs) (Katzmarzyk *et al*, 2022; Santos *et al*, 2023) and deaths by ill health worldwide (WHO, 2022a).

Although the burden of insufficient PA is higher in countries with high incomes (WHO, 2018), a more significant proportion of physically inactive people reside in low- and middle-income countries (LMICs) (Katzmarzyk *et al*, 2022), such as India. In India, nearly half of the population is physically inactive (Anjana *et al*, 2014; Podder *et al*, 2020). Studies have reported insufficient PA among Indian children (Bhawra *et al*, 2023), adolescents (WHO, 2022b), adults (Singh *et al*, 2021; Mohanty *et al*, 2022), and there also are gender-based variations in insufficient PA (Singh *et al*, 2021; Ramamoorthy *et al*, 2022). As India's urban population is expected to increase from 32% in 2014 to 50% by 2050 (Bocquier, 2005), the expected higher physical inactivity among the urban population (65%) compared to the rural population (50%) is a

worrying trend (Anjana *et al*, 2014).

Built environment (BE) characteristics influence the PA of inhabitants (Elshahat *et al*, 2020; Zhang *et al*, 2024). BE is the human-made physical parts of the environment where people live and work, such as homes, streets, parks, open spaces, and transport infrastructure (Elshahat *et al*, 2020). Recently, there has been an interest in the roles of BE and PA relevant to policy and implementation (Salvo *et al*, 2018) as urban BE planning and design significantly impact PA and public health (Koohsari *et al*, 2013). It is also a low-cost and effective way of promoting health (Zhong *et al*, 2022; Duijvestijn *et al*, 2023). Some BE characteristics influencing PA, such as walkability (Siqueira Reis *et al*, 2013; Arifwidodo and Chandrasiri, 2024), residential density (Wang *et al*, 2019b; Wang *et al*, 2021), land use mix (Wei *et al*, 2016; Noordzij *et al*, 2021), street connectivity (Koohsari *et al*, 2014; Jia *et al*, 2021), availability of green open spaces (Lee *et al*, 2015; Wang *et al*, 2019a), and PA facilities (Eriksson *et al*, 2012; Halonen *et al*, 2015). There is a vast amount of evidence on the association between BE and PA from Australia and countries in Europe and North America, with recent evidence from some LMICs (Elshahat *et al*, 2020). While the evidence from developed countries shows consistent findings on the role of BE in facilitating or constraining the PA, the conclusions of LMICs vary significant across different PA domains (home-based, leisure, occupational, and travel) (Elshahat *et al*, 2020). The findings from developed countries may not be generalized to LMICs like India (Adlakha *et al*, 2016b) as the BE and PA relationships in LMICs are context-specific and distinct from those in developed countries (Adlakha *et al*, 2017). Factors such as access to PA facilities, gender, perceived self-efficacy, physical environment, self-confidence, social support, and socioeconomic status (Sharma *et al*, 2024b), cultural and contextual factors (Rio and Saligan, 2023), and sociodemographic differences between urban and suburban populations influence how people perceive and interact

with their BE, which shapes their PA patterns (Zou and Wang, 2025).

Research on BE and PA in LMICs, such as India, is limited (Adlakha *et al*, 2016b; Tarun *et al*, 2017). Recent studies reported significant associations between BE and PA in Indian cities. Examples include positive association of travel PA in urban neighborhoods with land use mix and residential density (Adlakha *et al*, 2017), increased odds of female travel PA with land use mix and street connectivity (Adlakha and Parra, 2020); inverse association of crime safety with aesthetics and active commuting (Adlakha *et al*, 2018); availability of parks and fitness-related resources in facilitating PA (Gautam *et al*, 2023), and significant association between perception of higher air pollution with low moderate-to-vigorous (MV)PA, and between perceived higher crime rate and low MVPA (Patel *et al*, 2024). In India, the PA variations are evident across various regions in the country (Podder *et al*, 2020). Indian cities are highly dense and exhibit differences from the cities in developed nations. The cultural and socioeconomic differences between people and the historical and political processes in India influence urbanization patterns and urban forms (Dutta *et al*, 2013). India exhibits vast diversity in geography, resource, climate, and ecology, which lead to varied economic activities and livelihoods (Qureshi, 2023).

Understanding the existing evidence on BE influence on PA, barriers and facilitators to PA, scope, and limitations concerning various population groups, physical settings, and assessment tools can help guide further research and formulate policies and interventions for promoting PA in Indian cities. To the best of our knowledge, no review from India has summarised the findings of the urban BE influence on PA. Hence, we conducted a scoping review as a preliminary step to summarize the extent of existing literature and identify research gaps (Arksey and O'Malley, 2005).

MATERIALS AND METHODS

Research questions and review protocol

The scoping review addressed three main research questions: (i) What BE characteristics/features are barriers and facilitators to PA in Indian cities?; (ii) What assessment tools are used to measure BE influences on PA in Indian urban areas?; (iii) What knowledge gaps exist in the domain of BE and PA in Indian cities, and what is the future research scope? A scoping review method was adopted as it helps map the literature on emerging or evolving topics, identify the types of evidence available, key characteristics related to the domain, and knowledge gaps (Munn *et al*, 2018; Mak and Thomas, 2022), and summarize and disseminate research findings (Peters *et al*, 2015). This study followed the scoping review process and protocols based on the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) (Tricco *et al*, 2018). The protocol for this scoping review was registered with the International Platform of Registered Systematic Review and Meta-analysis Protocols (INPLASY) (Registration no. INPLASY202480045) (Tejendra and Verma, 2024).

Choice of literature database, search strategy and selection

A database search was conducted for literature on three databases, ie, Scopus, Web of Science and PubMed, which are most relevant to the research questions of the scoping review. A combination of keyword search strategies using the Boolean operators was formulated to identify pertinent research articles in the databases. The keyword combination ("neighborhood" OR "built environment" OR "gated community" OR "public space" OR "urban area" OR "park" OR "street" OR "playground" OR "housing" OR "ward" OR "transport") AND ("physical activity" OR "walkability" OR "exercise" OR "physical fitness" OR "recreation") AND ("India" OR "Indian city"

OR "Indian") was used to retrieve articles from the databases. Table 1 shows the search strategy used with the Scopus database as an example.

Eligibility criteria

Studies' eligibility criteria were: (i) conducted in urban areas of India; (ii) cross-sectional and longitudinal; (iii) empirical and literature review; (iv) typologies (qualitative/quantitative/mixed-method research); (v) participants' self-reported/objective PA; (vi) involving all groups and genders; (vii) characteristics/features of BE affect on PA in Indian cities; (viii) explaination of the influence of BE on PA where BE assessments but not PA assessments were conducted; and (ix) in the English language only. Articles that studied PA from a medical or clinical perspective were excluded.

Data extraction

Both authors independently conducted the data extraction, and through discussions and consensus, the data were finalised and tabulated. The general characteristics are presented in Table 2, which lists names of the articles, focus demographic groups of each article (children, adolescents, older adults, women, and men), and sample data of each article. Data were categorized into BE types (BE Type), physical activity tools (PA Tool), BE assessment tools (BE Tool), physical activity types (PA Type), PA assessment types (perceived/objective), and BE assessment types (perceived/observed) (Table 3). Mendeley Desktop (https://www.mendeley.com) and ATLAS.ti (https://atlasti.com) applications were used to store, review and code the data for subsequent retrieval.

Reporting of results and analysis

Frequency analysis was used to report the general characteristics of the articles. Tables and Sankey diagrams were used to categorize and present the interlinkage. Content analyses were conducted to identify the barriers and facilitators to BE of different age groups and genders. Narrative and descriptive reporting were used to present the findings on the barriers, facilitators

Table 1

Search strategy of SCOPUS database for inclusion in scoping review

Database search sequence	Keyword combination	Limit	Number of records
#1	Article title, abstract, keywords: ("neighborhood" OR "built environment" OR "gated community" OR "public space" OR "urban area" OR "park" OR "street" OR "playground" OR "housing" OR "ward" OR "transport")	NA	3,535,825
#2	Article title, abstract, keywords: ("physical activity" OR "walkability" OR "exercise" OR "physical fitness" OR "recreation")	NA	1,129,658
#3	Article title, abstract, keywords: ("India" OR "Indian city" OR "Indian")	NA	918,255
#4	#1 AND #2 AND #3	NA	1,086
#5	#1 AND #2 AND #3	Year: From inception till 2024 Language: English Document type: article, review, conference proceeding, book chapter, book	1,042

NA: not any

and assessment tools related to BE. The results were systematically analyzed to identify the limitations, knowledge gaps and future research scope.

RESULTS

Search results

The search was limited to articles on Indian cities published up to June 2024. The initial search using the keyword combination provided 1,951 articles (1,042 articles from Scopus database, 372 from Web of Science, 517 from PubMed databases, and 20 from other sources), among which 565 duplicates were excluded. Both authors independently screened titles and abstracts and excluded irrelevant articles, recording the reasons. The differences were resolved through discussion and a review of the full paper to arrive at a consensus. At this stage, 1,303 articles were eliminated, and 83 were selected for full-text review. Both authors independently carried out the full-text review using the established eligibility criteria (described in the following subsection). Based on consensus on each article's relevancy and contribution to the research questions, 27 articles were finally chosen for evidence synthesis (Fig 1). Quality assessment was not conducted as it is not a primary focus of the scoping review methodology (Pham *et al*, 2014).

Characteristics of reviewed articles

Most articles (96%) selected for the review were journal papers, with only one article (4%) being a conference proceedings, and all were published between 2004 and 2024. Fifteen articles (56%) were studies of adults, 3 (11%) of adolescents, 2 (7%) each of children, both children and adolescents, and older adults, 1 (4%) each of females and males and 1 (4%) of inputs from experts. The studies were conducted in Bengaluru, Chennai city, Delhi NCR region, Hyderabad, Kerala state (Kottayam District, Thiruvananthapuram city and the entire state), Kharagpur, Kolar city, Mumbai, Pune, Rourkela, and all states of India (Fig 2).

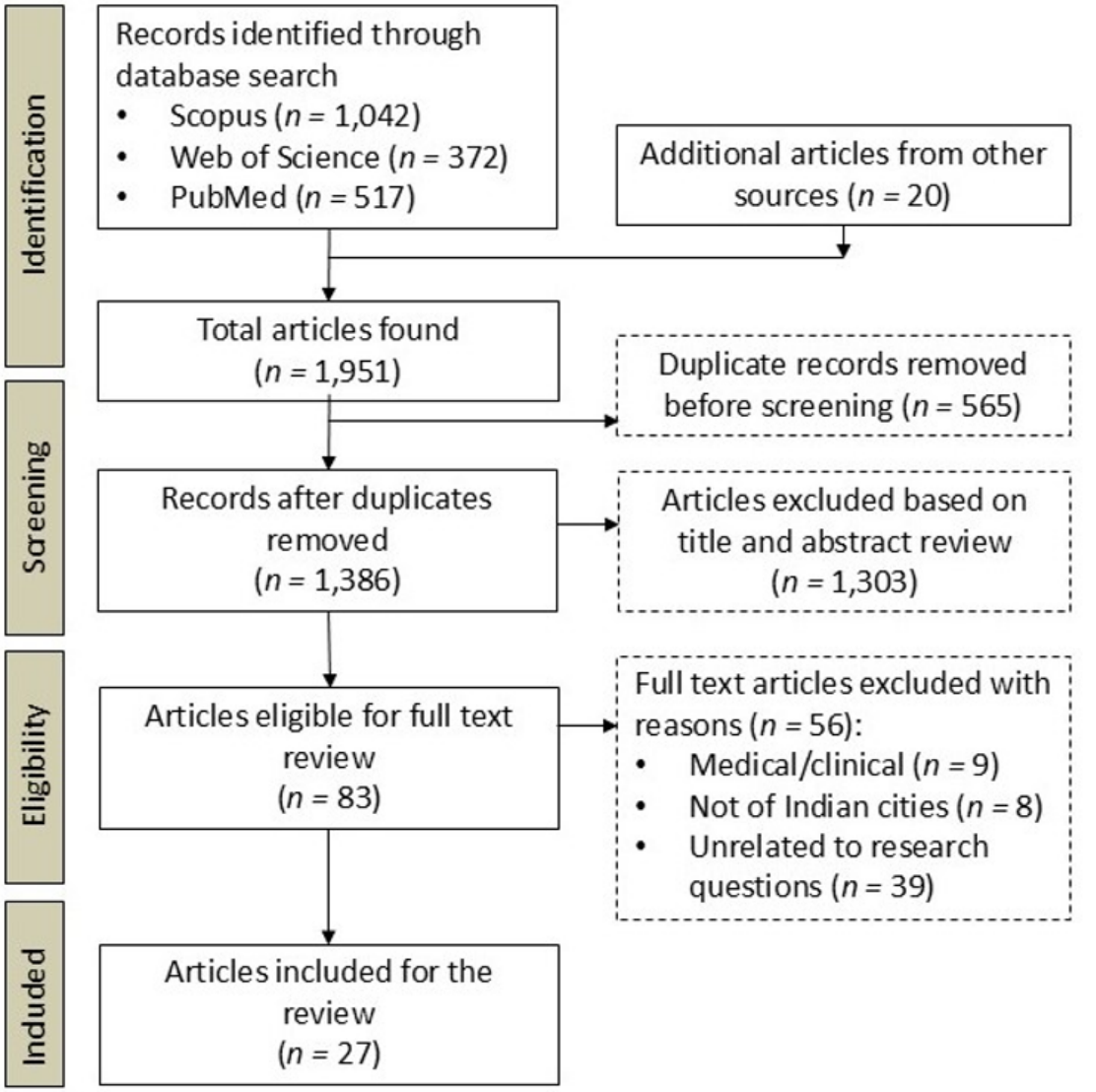


Fig 1 - PRISMA flow diagram of articles' selection for scoping review

PRISMA: preferred reporting items for systematic reviews and meta-analyses

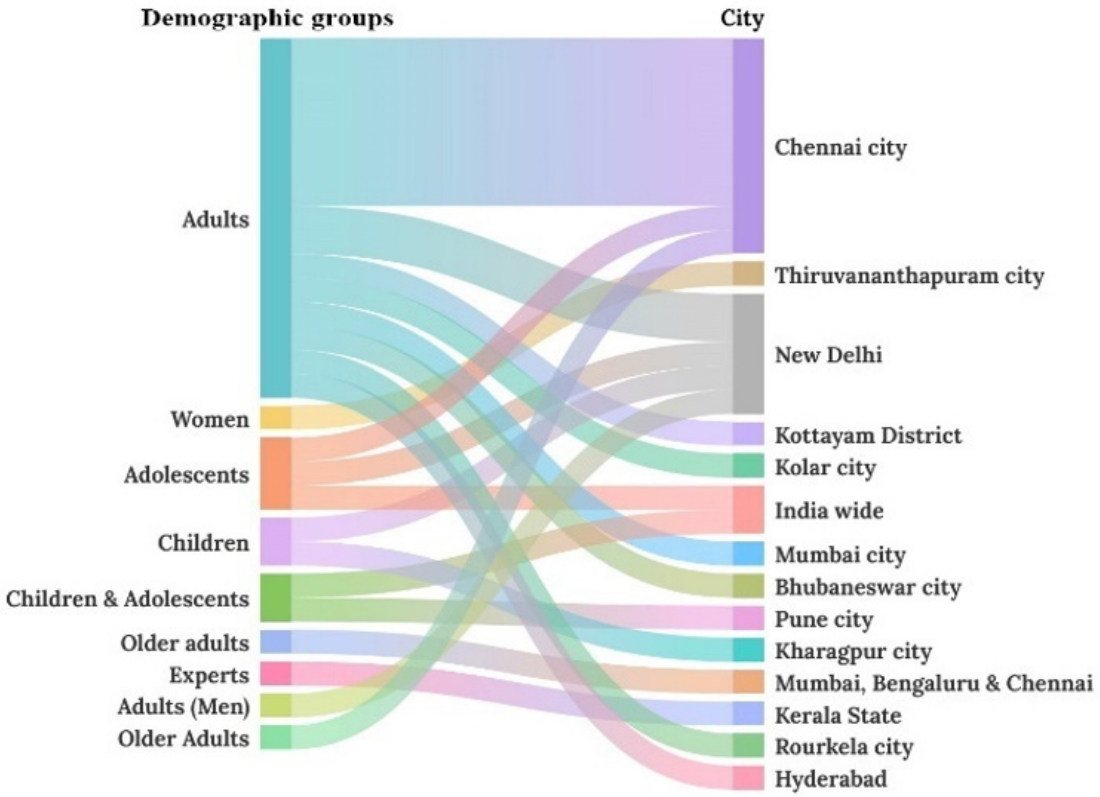


Fig 2 - Sankey diagram of test demographic groups and cities in articles (*n* = 27) of scoping review

The Sankey diagrams visually represent the relationship between two groups, with the thickness of the connecting flows indicating the relative number of studies associated with each group.

Study design used in articles selected

All articles included in the scoping review employed a cross-sectional study design. Most studies (25/27, 92%) used perception-based methods to assess the BE's influence on PA (Table 3). One article employed an observation-based method, and the other a mix of perception and observation methods. No objective assessments were employed. Only 9/27 (33%) studies assessed PA, all being self-

Table 3

Built environment and physical activity types, tools and assessment types

No.	Reference	Study design	BE type	BE tool	BE assessment type	PA type	PA tool	PA assessment type
1.	Adlakha *et al*, 2016a	C-S	4 neighborhoods, Chennai city	Semi-structured interviews	PR	Overall PA	N/A	N/A
2.	Adlakha *et al*, 2016b	C-S	4 neighborhoods, Chennai city	NEWS-India	PR	MVPA, leisure and travel PA	IPAQ-LF	SR
3.	Adlakha *et al*, 2021	C-S	155 wards, Chennai city	NEWS-India	PR	MVPA, leisure and travel PA	IPAQ-LF	SR
4.	Adlakha *et al*, 2017	C-S	8 wards, Chennai city	NEWS-India	PR	MVPA, leisure and travel PA	IPAQ-LF	SR
5.	Adlakha and Parra, 2020	C-S	8 wards, Chennai city	NEWS-India	PR	MVPA, leisure and travel PA	IPAQ-LF	SR
6.	Adlakha *et al*, 2018	C-S	155 wards, Chennai city	NEWS-India	PR	Active commuting	N/A	N/A
7.	Mathews *et al*, 2016	C-S	Thiruvananthapuram City Corporation	FGD	PR	Overall PA	N/A	N/A
8.	Satija *et al*, 2018	C-S	2 schools, Delhi NCR	FGD	PR	Overall PA	N/A	N/A

Table 3 (cont)

No.	Reference	Study design	BE type	BE tool	BE assessment type	PA type	PA tool	PA assessment type
9.	Garg and Raman Kutty, 2019	C-S	Kottayam district, Kerala State	FGD	PR	Overall PA	N/A	N/A
10.	Gautam *et al*, 2023	C-S	18 wards, Kolar city	PARA	PR and OB	Overall PA	GPAQ	SR
11.	Tarun *et al*, 2017	C-S	16 schools, Delhi NCR	SPEEDY	OB	Overall PA	N/A	N/A
12.	Rajaraman *et al*, 2015	C-S	India (country-wide)	FGD	PR	Overall PA	N/A	N/A
13.	Rathi *et al*, 2023	C-S	Mumbai city	FGD	PR	Recreational PA	N/A	N/A
14.	Mohanty *et al*, 2022	C-S	30 wards. Bhubaneswar city	SDQ	PR	Overall PA	IPAQ- SF	SR
15.	Bhawra *et al*, 2023	C-S	Review of articles and reports, and 1 primary study, Pune city	SDQ	PR	Overall PA	SDQ	SR
16.	Patel *et al*, 2024	C-S	41 schools in 28 urban and rural areas, India	SDQ	PR	MVPA	SDQ	SR
17.	Das and Banerjee, 2023	C-S	Kharagpur Municipality	Interview	PR	Mobility, play and recreation	N/A	N/A

Table 3 (cont)

No.	Reference	Study design	BE type	BE tool	BE assessment type	PA type	PA tool	PA assessment type
18.	Subramanian and Jana, 2018	C-S	Bengaluru, Chennai and Mumbai cities	SDQ and Survey	PR	Recreational open space	N/A	N/A
19.	Amraotkar and Gangopadhyay, 2023	C-S	2 urban parks, Chennai city	SDQ	PR	Park visit	N/A	N/A
20.	Rahiman V and Naseer, 2022	C-S	Kerala State	Delphi technique	PR	Walkability	N/A	N/A
21.	Aneesh and Mahanta, 2022	C-S	Rourkela city	SDQ	PR	Overall PA	BAR	SR
22.	Gupta *et al*, 2022	C-S	Metro stations, Delhi NCR	SDQ	PR	Walkability	N/A	N/A
23.	Majumdar *et al*, 2021	C-S	10 locations, Hyderabad city	SDQ	PR	Walkability	N/A	N/A
24.	Sharma and Chaudhary, 2021	C-S	Outdoor gyms, Delhi	SDQ	PR	Outdoor gym usage	N/A	N/A
25.	Kingsly *et al*, 2020	C-S	Diverse regions, Chennai city	SDQ using NEWS and NEWS-Y	PR	Active school travel	N/A	N/A

Table 3 (cont)

No.	Reference	Study design	BE type	BE tool	BE assessment type	PA type	PA tool	PA assessment type
26.	Singhal and Siddhu, 2014	C-S	New Delhi	SDQ	PR	Overall PA	N/A	N/A
27.	Prithviraj and Sundaram, 2023	C-S	A densely populated neighborhood, Chennai city	NEWS-India	PR	Walkability	N/A	N/A

BAR: Bouchard activity record; BE: Built environment; C-S: cross-sectional study; FGD: focus group discussion; GPAQ: global physical activity questionnaire; IPAQ: The International Physical Activity Questionnaire; IPAQ-LF: The International Physical Activity Questionnaire-Long Form; IPAQ-SF: The International Physical Activity Questionnaire-Short Form; MVPA: moderate-to-vigorous intensity physical activity; NCR: National Capital Region of Delhi; NEWS: neighborhood environment walkability scale; NEWS-India: neighborhood environment walkability scale-India; NEWS-Y: neighborhood environment walkability scale for youth; N/A: no assessment; OB: observation-based; PA: physical activity; PARA: physical activity resource assessment; PR: perception-based; SDQ: self-developed questionnaire; SPEEDY: sport, physical activity, and eating behavior- environmental determinants in young people audit tool; SR:self-reported

reported (perception-based), with no objective PA assessment.

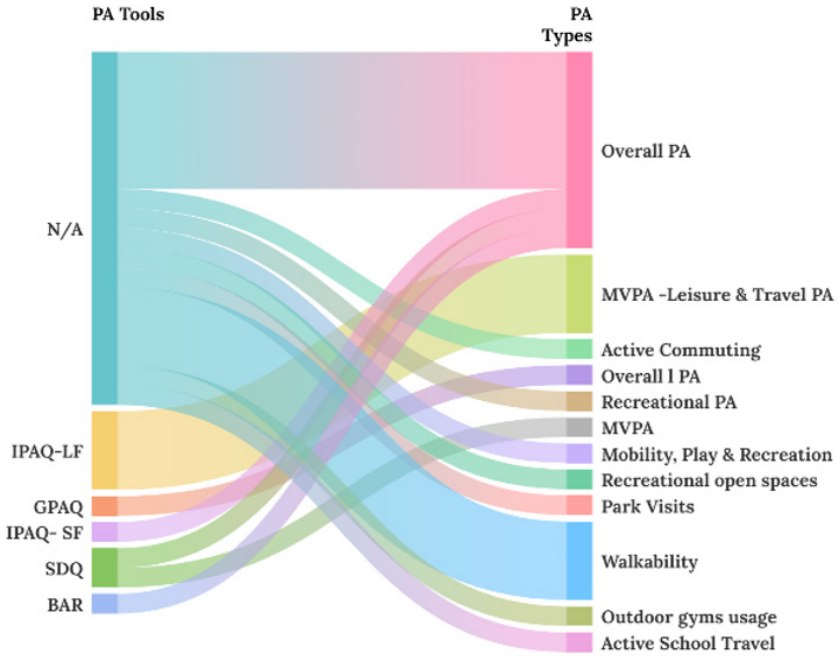
PA types and assessments

Regarding PA types, 15/27 (56%) of the studies covered the overall PA (MVPA and Overall PA) of the participants, and the remaining 12 studies (44%) focused on walkability, recreational PA, recreational spaces, active school travel, PA in public spaces, and outdoor gym usability (Fig 3A). As for PA assessments, only nine studies assessed the PA of participants, with five using the internationally validated questionnaires, namely Bouchard Activity Record (BAR) (one study) (Aneesh and Mahanta, 2022), Global Physical Activity Questionnaire (GPAQ) (one study) (Gautam *et al*, 2023), International Physical Activity Questionnaire-Long Form (IPAQ-LF) (four studies) (Adlakha *et al*, 2016b; Adlakha *et al*, 2017; Adlakha and Parra, 2020; Adlakha *et al*, 2021), IPAQ-SF International Physical Activity Questionnaire-Short Form (one study) (Mohanty *et al*, 2022), and two using self-developed questionnaires (SDQ) (Bhawra *et al*, 2023; Patel *et al*, 2024). All PA assessments were self-reported, and no objective evaluations were carried out (Fig. 3A).

BE types and assessments

Regarding BE types, 13/27 (48%) studies selected entire cities as study areas, three of a few wards in a city, two of neighborhoods within a city, and two of schools located in a single city. The remaining seven studies were conducted in diverse settings, namely an entire district of a state, three metro cities, a densely populated neighborhood, various locations across India, two urban parks, and schools nationwide, and an entire state (Fig 3B). As for BE assessments, 11 studies used SDQ (Singhal and Siddhu, 2014; Subramanian and Jana, 2018; Kingsly *et al*, 2020; Majumdar *et al*, 2021; Sharma and Chaudhary, 2021; Aneesh and Mahanta, 2022; Gupta *et al*, 2022; Mohanty *et al*, 2022; Amraotkar and Gangopadhyay, 2023; Bhawra *et al*, 2023; Patel *et al*, 2024), six used Neighborhood Environment Walkability Scale-

A



B

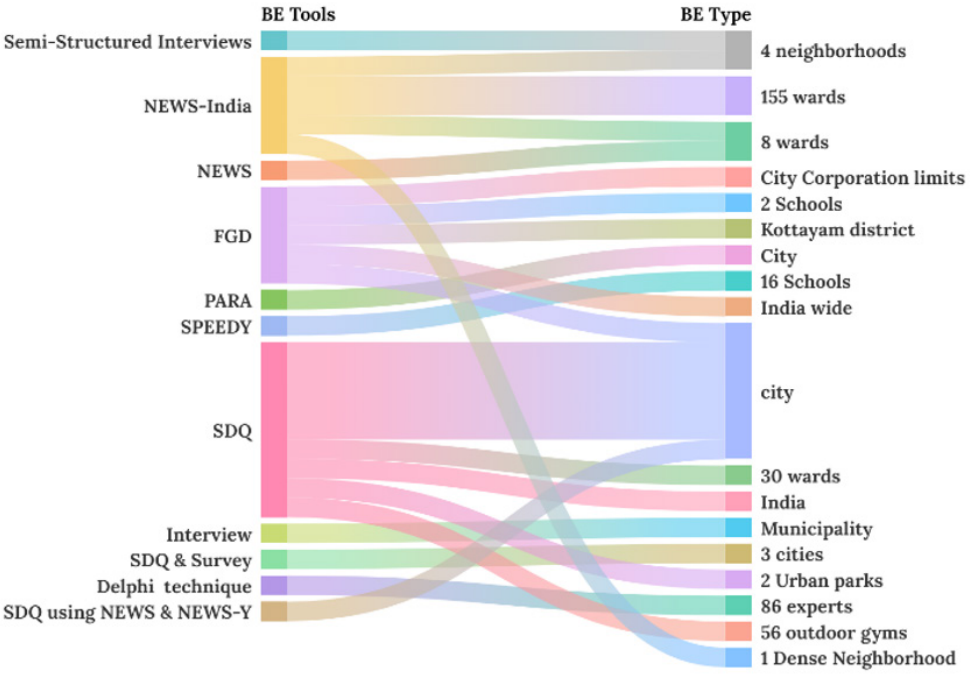


Fig 3 - Sankey diagrams of (A) PA tools and PA type, (B) BE tools and BE types and (C) PA tools and BE tools

C

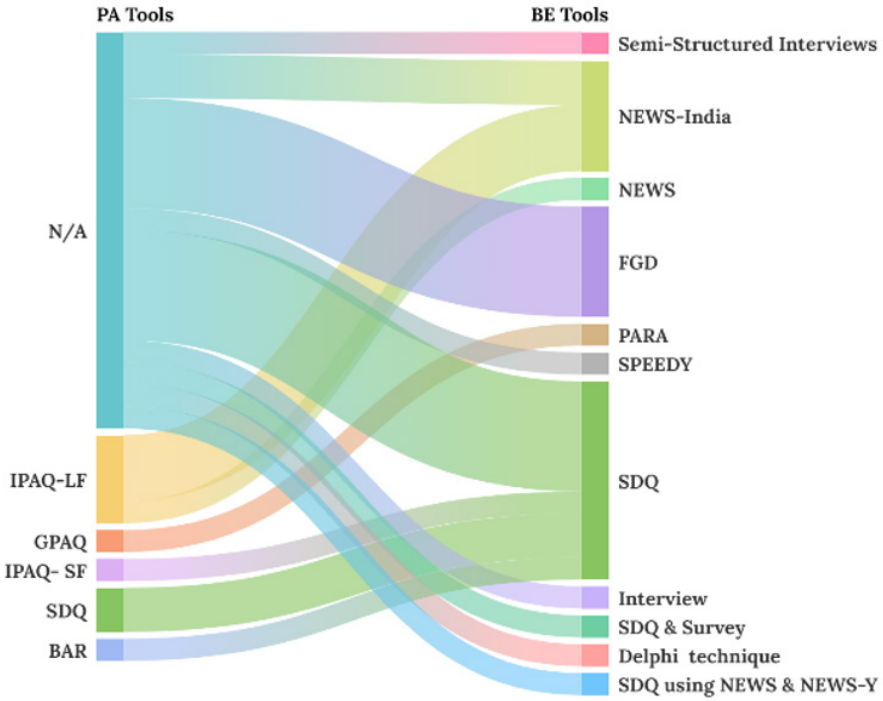


Fig 3 - (cont)

Sankey diagrams of (A) PA tools and PA type, (B) BE tools and BE types and (C) PA tools and BE tools

BAR: Bouchard activity record; BE: built environment; C-S: cross-sectional study; FGD: focus group discussion; GPAQ: global physical activity questionnaire; IPAQ: International Physical Activity Questionnaire; IPAQ-LF: International Physical Activity Questionnaire-Long Form; IPAQ-SF: International Physical Activity Questionnaire-Short Form; MVPA: moderate-to-vigorous intensity physical activity; NEWS: neighborhood environment walkability scale; NEWS-India: neighborhood environment walkability scale-India; NEWS-Y: neighborhood environment walkability scale for youth; N/A: not assessed; PA: physical activity; PARA: physical activity resource assessment; SDQ: self-developed questionnaire; SPEEDY: sport, physical activity and eating behavior-environmental determinants in young people audit tool

The Sankey diagram is explained in the legend to Fig 2.

India Questionnaire (NEWS-India) (Adlakha *et al*, 2016b; Adlakha *et al*, 2017; Adlakha *et al*, 2018; Adlakha and Parra, 2020; Adlakha *et al*, 2021; Prithviraj and Sundaram, 2023), five used focus group discussions (FGD) (Rajaraman *et al*, 2015; Mathews *et al*, 2016; Satija *et al*, 2018; Garg and Raman Kutty, 2019; Rathi *et al*, 2023), two used interview methods (Adlakha *et al*, 2016a; Das and Banerjee, 2023), one each used Physical Activity Resource Assessment (PARA) (Gautam *et al*, 2023), Sport, Physical Activity and Eating behavior-Environmental Determinants in Young People Audit Tool (SPEEDY) (Tarun *et al*, 2017), and Delphi technique (Rahiman V and Naseer, 2022). Only NEWS-India, PARA, and SPEEDY were reliable and internationally validated assessment tools (Fig 3B).

BE influence on PA assessment

Almost all studies (25/27, 92%) employed perception-based assessments to examine the BE influence on PA; of the remaining two, one used observation-based assessment, and the other employed a combination of perception- and observation-based methods (Fig 3C).

Common BE barriers and facilitators to PA

Across demographic groups, including children, adolescents, adults, women, men, and older adults, several BE characteristics consistently influenced PA participation (Tables 2 and 3). These common barriers and facilitators could be summarised under four themes as follows.

Theme I: Theme I constituted walking and cycling infrastructure, within which the availability, continuity, and quality of walking and cycling infrastructure were among the most consistently reported influences on PA. Studies have reported that conditions such as the absence, poor condition, discontinuity, or narrowness of footpaths discourage walking. Similarly, lack of designated bicycle lanes, undefined pedestrian crossings, uneven walking surfaces, parked vehicles obstructing paths, and poor maintenance discouraged walking and cycling for transport

and recreation (Tarun *et al*, 2017; Kingsly *et al*, 2020; Bhawra *et al*, 2023; Prithviraj and Sundaram, 2023). Conversely, the presence of continuous and adequately wide sidewalks, kerb separation between sidewalks and roads, pedestrian signals, zebra crossings, bicycle lanes, and well-maintained walkways facilitated walking and cycling (Adlakha *et al*, 2018; Majumdar *et al*, 2021; Rahiman V and Naseer, 2022; Patel *et al*, 2024). In addition to the walking and cycling infrastructure, the urban planning and design aspects, such as street connectivity, residential density, and access to diverse land uses, increased the likelihood of travel-related PA (Adlakha *et al*, 2018; Adlakha and Parra, 2020; Gupta *et al*, 2022; Rahiman V and Naseer, 2022).

Theme II: Theme II constituted safety from traffic and crime. Multiple studies reported that the high traffic volumes, speeding vehicles, lack of traffic calming measures, unsafe road crossings, lack of road markings, and pedestrian–vehicular conflicts discouraged outdoor PA and active travel (Adlakha *et al*, 2016a; Tarun *et al*, 2017; Kingsly *et al*, 2020; Prithviraj and Sundaram, 2023). Perceived facilitators of walking and cycling included improved street lighting, visible road safety and warning signage, traffic calming interventions, marked pedestrian crossings, and implementation of road safety measures (Tarun *et al*, 2017; Patel *et al*, 2024). Perceived crime and lack of safety were identified as important barriers to PA across all age groups (Singhal and Siddhu, 2014; Garg and Raman Kutty, 2019; Adlakha and Parra, 2020; Bhawra *et al*, 2023; Prithviraj and Sundaram, 2023).

Theme III: Theme III constituted access to physical activity resources. Limited availability, poor distribution, lack of facilities, overcrowding, and inadequate maintenance of PA resources, such as parks, playgrounds, sports facilities, and open spaces, were widely reported barriers to PA (Adlakha *et al*, 2016a; Gautam *et al*, 2023; Rathi *et al*, 2023). The perceived PA facilitators

included proximity to parks and playgrounds, availability of sports and outdoor fitness equipment, free or affordable access to PA resources, regular maintenance, supervision, and adequate lighting (Subramanian and Jana, 2018; Sharma and Chaudhary, 2021; Amraotkar and Gangopadhyay, 2023). However, one study from Bhubaneswar reported contextual variations indicating no association between adult PA levels and the availability of PA facilities within 500 m of the home (Mohanty *et al*, 2022).

Theme IV: Theme IV constituted aesthetics and environmental quality. Studies found that poor aesthetics and environmental quality, such as the unclean streets, visual disorder, overcrowding, and lack of greenery, discouraged walking and recreational PA (Adlakha *et al*, 2016b; Prithviraj and Sundaram, 2023). High levels of air pollution were also reported as barriers to outdoor PA (Singhal and Siddhu, 2014; Bhawra *et al*, 2023). In contrast, attractive natural surroundings, greenery, biodiversity, pleasant walking routes, and well-designed urban parks were found to be associated with higher PA participation and greater user satisfaction (Mathews *et al*, 2016; Amraotkar and Gangopadhyay, 2023; Patel *et al*, 2024).

Age- and gender-specific barriers and facilitators to PA

Apart from the common built environment influences, studies have also reported some age- and gender-specific barriers and facilitators to PA (Table 2).

For children, school-related environments played an important role in shaping PA. Walking and cycling to school were associated with increased PA in children (Owen *et al*, 2012). A primary study from Pune showed that nearly 60% of children and adolescents walk to school, highlighting the importance of active transportation (Bhawra *et al*, 2023). Specific barriers included the lack of bus stops near schools, limited use of school premises for informal activities, the absence of playground equipment, and poor

Table 2

Details of articles chosen for scoping review

No.	Reference	Objective	Demographic group	Data sample
1.	Adlakha *et al*, 2016a	Qualitative section explored the perception of BE and walkability	Adult	14 residents and 7 key informants
2.	Adlakha *et al*, 2016b	Examined the associations between weight status, PA, and neighborhood BE in four neighborhoods wih varying walkability and socioeconomic status	Adult	370 adults
3.	Adlakha *et al*, 2021	Determined the associations among adult obesity and overweighdt and BE	Adult	370 adults from 155 wards of Chennai city
4.	Adlakha *et al*, 2017	Identified the BE associations with leisure and travel PA	Adult	370 adults from 8 wards stratified by walkability and SES
5.	Adlakha and Parra, 2020	Investigated the gender-based differences in BE perceptions towards the walkability and travel PA	Adult	370 adults from 155 wards stratified by walkability and SES
6.	Adlakha *et al*, 2018	Identified the neighborhood environment characteristics and active commuting	Adult	370 adults from 155 wards of Chennai city
7.	Mathews *et al*, 2016	Investigated the barriers and facilitators of PA among women in Thiruvananthapuram city	Adult	28 adults (26 women and 2 men) participated in 4 FGDs
8.	Satija *et al*, 2018	Investigated the barriers and facilitators for PA among school children in Delhi	Adolescent	174 students 12-16 years of age participated in 16 FGDs

Table 2 (cont)

No.	Reference	Objective	Demographic group	Data sample
9.	Garg and Raman Kutty, 2019	Investigated the perceptions, barriers, and facilitators of PA among adults in Kerala.	Adult	28 adults participated in 4 FGDs
10.	Gautam *et al*, 2023	Assessed the availability of PA resources and facilities in Kolar City and also investigated the perceptions of adults toward PA	Adult	521 adults from Kolar city
11.	Tarun *et al*, 2017	Identified the characteristics of outdoor school environments that encourage PA among children	Child	Structured observations by researchers
12.	Rajaraman *et al*, 2015	Investigated the perceived barriers, facilitators, benefits, and advantages of PA among adolescents in India and Canada	Adolescent	8 FGDs in India and 5 FGDs in Canada
13.	Rathi *et al*, 2023	Investigated the barriers and facilitators for exercise participation in urban adults	Adult	9 FGDs with 26 men and 29 women in Mumbai
14.	Mohanty *et al*, 2022	Investigated PA patterns, prevalence, predictors, and their relation with NCDs among the urban population.	Adult	1,203 adults from Bhubaneswar, India
15.	Bhawra *et al*, 2023	Investigated the living patterns among children and adolescents in India.	Child and adolescent	1,042 children 5-17 years of age
16.	Patel *et al*, 2024	Investigated the influence of perceived air pollution and BE on the MVPA of children	Child and adolescent	1,042 children 5-17 years of age
17.	Das and Banerjee, 2023	Identified the parameters for assessing child-friendliness in urban neighborhoods	Child	40 children 9-13 years of age

Table 2 (cont)

No.	Reference	Objective	Demographic group	Data sample
18.	Subramanian and Jana, 2018	Assessed the accessibility and usability of urban open spaces for older adults.	Older adult	51 recreational open spaces in 3 metro cities
19.	Amraotkar and Gangopadhyay, 2023	Investigated the important parameters for user satisfaction in urban parks.	Adult	243 park users in 2 parks of Chennai
20.	Rahiman V and Naseer, 2022	Investigated the important parameters for walkability to public transport	Expert	86 experts from Kerala State
21.	Aneesh and Mahanta, 2022	Investigated the barriers and motivators for PA among adults	Adult	100 adults from Rourkela city
22.	Gupta *et al*, 2022	Investigated the role of neighborhood design in access mode choice to metro train stations	Adult	600 metro users from metro catchment area of Delhi
23.	Majumdar *et al*, 2021	Suggested a way to determine the factors affecting safety and walkability at sidewalks and crosswalks based on pedestrian satisfaction.	Adult	400 pedestrians
24.	Sharma and Chaudhary, 2021	Investigated the perceived benefits and barriers to outdoor gym usage among adults from Delhi NCR.	Adult	56 outdoor gym stakeholders from Delhi.
25.	Kingsly *et al*, 2020	Investigated the neighborhood environment barriers to active school travel among adolescents	Adolescent	324 adolescents from Chennai city

Table 2 (cont)

No.	Reference	Objective	Demographic group	Data sample
26.	Singhal and Siddhu, 2014	Investigated the barriers to LTPA in men	Adults (male)	603 men recruited from Delhi
27.	Prithviraj and Sundaram, 2023	Investigated the relationship between BE characteristics and walkability among older adults	Older adult	221 older adults from a densely populated neighborhood in Chennai city

BE: built environment; FGDs: focus group discussions; LTPA: leisure time physical activity; MVPA: moderate-to-vigorous intensity physical activity; NCDs: non-communicable diseases; NCR: National Capital Region; PA: physical activity; SES: socioeconomic status

maintenance and aesthetics of school environments (Tarun *et al*, 2017). Parental concerns regarding children's safety from traffic and strangers strongly restricted independent and active mobility. Parents emphasized the need for improved street lighting, safer traffic conditions, enhanced play structures in existing parks, and better neighborhood play spaces to support children's PA (Das and Banerjee, 2023).

Similar to children, adolescents perceived the school environment as the most important enabler for PA and expressed that more time for recreation, better equipment and facilities, and structured timings could promote PA (Satija *et al*, 2018). A comparative study between Indian and Canadian adolescents reported that Indian adolescents, regardless of income, experienced stronger parental safety restrictions and limited access to outdoor spaces compared to their Canadian counterparts (Rajaraman *et al*, 2015). Some gender-specific responses to environmental stressors were also observed, such as perceptions of air

pollution being linked to reduced MVPA in boys but not in girls. Conversely, a perceived higher crime rate was related to lower MVPA in girls but not in boys (Patel *et al*, 2024).

Among adults, socioeconomic status (SES) emerged as a key influence on PA behavior. Adults living in low-SES neighborhoods reported higher travel-related PA but lower LTPA, possibly due to limited access to recreational opportunities, excessive traffic, narrow streets, and a lack of green spaces (Adlakha *et al*, 2016b). In contrast, adults in high-SES neighborhoods reported higher LTPA but also a higher prevalence of insufficient overall PA (Ramamoorthy *et al*, 2022). Higher PA levels were also noticed in highly walkable neighborhoods (Adlakha *et al*, 2021). Perceived residential density, street connectivity, land-use mix diversity, safety from crime, and aesthetics were higher in high-walkability and high-SES neighborhoods (Adlakha *et al*, 2016b). Weather conditions were also reported as barriers to recreational PA among adults (Garg and Raman Kutty, 2019).

For older adults, age-specific needs related to comfort, accessibility and universal design were the particular concerns. The perceived attractiveness of the recreational open spaces was found to increase the use among older adults. Providing amenities such as free-of-cost entry, security, paved walkways, seating benches, toilets, shading, and the implementation of universal design features like handrails, ramps, tactile flooring, signage, and maps can have a positive impact on the older adults' perception of recreational open spaces (Subramanian and Jana, 2018). The older adults from low-income groups in dense urban neighborhoods reported some specific barriers, such as uneven surfaces, parked vehicles, fear of crime, lack of seating and shade, mobility-related difficulties, and accessibility constraints, which significantly affected walkability and outdoor PA participation (Prithviraj and Sundaram, 2023).

Studies reported some

gender-specific barriers faced by women, which included the cultural restrictions on outdoor PA, lack of motivation and interest, time constraints, stray dogs, unfamiliarity with walking culture, and discomfort walking alone (Mathews *et al*, 2016). Weather conditions, inadequate street lighting, longer distances to the parks, and perceived lack of safety on streets for women were the significant barriers to regular walking and going to parks and gyms for PA (Aneesh and Mahanta, 2022). Facilitators specific to women included seeing other women walk, walking in pairs, fixed timings at PA facilities, and improved perceptions of safety. The availability and accessibility of facilities and of fixed timings were reported as stronger motivators for women than for men (Mathews *et al*, 2016; Aneesh and Mahanta, 2022). Land-use mix, access, and street connectivity were also found to increase the odds of women's travel PA (Adlakha and Parra, 2020).

Only one study specifically focused on the PA of men (Singhal and Siddhu, 2014). Men reported distinct social and personal barriers, such as lack of a partner for exercise, embarrassment, dislike of being watched, work-related fatigue, lack of time, and absence of workplace exercise facilities.

DISCUSSION

The scoping review summarized the findings of BE influence on PA in Indian cities, with specific focus on BE barriers and facilitators to PA, assessment tools and knowledge gaps. All studies included in the scoping review were conducted within the last decade, indicating a growing body of research in this domain. Nearly half of the studies conducted in India were from Chennai and New Delhi, indicating the dominance of Indian metro cities as study areas. Approximately half of the studies included adults as participants, with a smaller proportion focusing on other demographic groups, such as children, adolescents, older adults, and women. All studies in the scoping review employed a cross-sectional design, with a

predominant use of perception-based assessment tools. The common BE barriers and facilitators identified were categorized into four themes, namely walking and cycling infrastructure, safety from traffic and crime, access to physical activity resources, and aesthetics and environmental quality. Further, age- and gender-specific barriers and facilitators were also summarised.

With respect to walking and cycling infrastructure, key issues included the unavailability, poor condition, inadequate quality, and insufficient maintenance of sidewalks and cycle tracks. In LMICs such as India, walking has been identified as the most preferred type of PA; however, barriers related to walking and cycling infrastructure, together with socioeconomic conditions and vehicle ownership, have been shown to discourage walking as a mode of transport (Gupta *et al*, 2022). Alongside BE characteristics, studies from India (Gupta *et al*, 2022; Saleem and Jaiswal, 2024) and Latin America (Ferrari *et al*, 2021) also emphasized the importance of sociodemographic and socioeconomic indicators of active transportation. Although some studies from India have highlighted that improved infrastructure facilitates walking and cycling (Adlakha *et al*, 2018; Majumdar *et al*, 2021; Patel *et al*, 2024), similar associations were not consistently observed among similar LMICs (Elshahat *et al*, 2020). These relationships appear to be context-specific and may not be able to be generalized.

Lack of safety from traffic and crime was a barrier to PA in Indian cities, consistent with findings from other LMICs, such as Nigeria (Oyeyemi *et al*, 2012). However, inconsistencies were also observed in the associations among various PA domains. In LMICs, the perceived crime safety is not significantly associated with leisure PA but shows a negative association with travel PA (Elshahat *et al*, 2020). A literature review focusing on developing countries reported a higher association of traffic safety with PA (Day, 2018); whereas non-significant

associations were reported in another review on LMICs (Elshahat *et al*, 2020). These variations may be attributed to the differences in how traffic safety is perceived among LMICs (Elshahat *et al*, 2020).

The widespread perception of limited access to PA resources as a barrier to PA reflected the continued scarcity of recreational and PA resources in Indian cities. For example, a study conducted in Kolar city reported only 36.3 PA resources per one lakh population (Gautam *et al*, 2023). The per capita green space in many Indian cities remains much lower than WHO recommendations and other planning guidelines (USGBC, 2014; Govindarajulu, 2014; Gautam *et al*, 2023). PA resources, such as outdoor gyms, have been recognized as important facilitators of PA due to their physical, social and mental well-being benefit (Sharma and Chaudhary, 2021). Beyond availability, the quality of PA resources was also found to influence their use. Along with the availability and accessibility to recreational facilities, the condition of the facilities/equipment, maintenance and safety of the facilities were also important factorsfor PA. A study from Peninsular Malaysia suggests that PA environment benefits people if the environment is creative, comfortable, safe, and user-friendly (Abd-latif *et al*, 2017).

Poor aesthetics and adverse environmental quality were commonly perceived as barriers to PA in Indian cities. Evidence from other LMICs has consistently shown that high perceived aesthetics is positively associated with PA, especially for leisure PA (Jáuregui *et al*, 2017; Lv and Wang, 2023). Perceived high pollution was also identified as a barrier to outdoor PA in India. Rapid economic growth and expanding infrastructure in Indian cities have contributed to increasing air pollution levels (Sharma *et al*, 2024a). A recent review identifies environmental factors, such as weather conditions, influence travel and leisure activities (Böcker *et al*, 2013). Evidence from a study in southern Chile also suggests that noise acts as a barrier to PA (Zumelzu *et al*,

2022). These findings suggest the need for further investigation of environmental factors and their influence in the Indian context.

For children and adolescents, the specific barriers to PA were lack of active transportation infrastructure for walking and cycling to schools, perceived crime in PA areas, lack of PA opportunities at schools and near homes, lack of play equipment, and parental concerns. A review in high-income countries highlights the importance of schools, homes, recreational facilities, green spaces, and active transportation for youth PA (Prince *et al*, 2019). Similar to findings from India, a study from the USA reported that parental perception of neighborhood safety is related to higher participation in PA among children (Heredia *et al*, 2024). Contrary to the general assumption that providing a highly walkable environment will promote PA, a study from Wales reports that children who live in highly walkable locations are more likely to be obese, and different contextual factors affect their health-promoting behavior (Pouliou *et al*, 2024). No such findings were reported in India, indicating the need for more comparative studies among LMICs.

Notable age- and gender-specific PA barriers and facilitators were reported in studies from India. Among adults, high-SES neighborhoods were associated with higher LTPA, whereas low-SES neighborhoods reported higher travel-related PA. These associations were consistent with findings from studies in other LMICs (Elshahat *et al*, 2020). Similar findings have been observed in a study from Finland, which shows high self-reported PA among high-income populations, together with gender-specific variations (Kari *et al*, 2015). In India, high-SES neighborhoods were also associated with higher perceived BE features, such as land-use mix diversity, street connectivity, safety from crime, and aesthetics.

Among older adults, specific PA barriers were related to lack of comfort, inaccessibility, uninviting design, fear of crime, lack of seating and shade, and less walkability. A systematic review

of older adults' PA reports that neighborhood's walkability, access to the destinations and recreational facilities, crime and personal safety, presence of greenery, and access to open spaces and commercial destinations positively influence PA (Barnett *et al*, 2017). It is also noteworthy that a study from the USA finds that low-active older adults perceive more barriers to regular PA compared to high-active group (Kalata *et al*, 2025); however, no such findings have been reported in studies from Indian cities.

The gender-based PA barriers for women and girls identified in the scoping review, were cultural restriction, lack of motivation and interest, time constraint, and perceived higher crime rate. These findings were in agreement with those from a recent study conducted in Saudi Arabia, wheret females are more likely to report cultural and religious reasons as barriers to PA compared to males (Abdelhay *et al*, 2025). A study from Jordan reports that male adolescents perceive more barriers to PA than females (Alhroub *et al*, 2024). In contrast to the general findings in India that perception of lack of safety and embarrassment of being watched are experienced only by women, one study from New Delhi reported that men also perceive these factors as barriers to PA (Singhal and Siddhu, 2014). These gender-specific differences in perceived barriers require further investigation from the BE perspective.

Overall, the scoping review findings indicated that BE characteristics influencing PA vary according to age, gender, SES, and type of BE. In LMICs, these relationships often differ from those observed in higher-income countries (Adlakha *et al*, 2017).

All studies evaluated in the scoping review used self-reporting questionnaires (IPAQ-SF, IPAQ-LF, GPAQ, and BAR) to assess participants' PA, which has the potential for over positive self-bias (Aandstad, 2023). Although these questionnaires are internationally accepted, there are some limitations to bear in mind. IPAQ-SF may not be a viable tool for measuring absolute

or relative PA, as it overestimates PA and lacks acceptable correlations with objectively measured PA (Lee *et al*, 2011). For instance, IPAQ-LF has a moderate validity against objectively measured PA (Wanner *et al*, 2016) as does GPAQ against objectively measured MVPA, but the latter has poor association with sedentary behavior (Cleland *et al*, 2014). The findings indicate that no objective assessments have been conducted on PA among respondents.

Regarding BE influence on PA, most studies in the scoping review employed perception-based and observation-based tools. While NEWS and NEWS-India were mostly used, PARA and SPEEDY focused on PA resources and facilities through observation-based audits. NEWS is one of the most extensively used international questionnaires; however, its limitation is that it was primarily developed to measure built and a few social environment factors relevant to walking and cycling (Oyeyemi *et al*, 2013).

The scoping review systematically identified, analyzed and synthesised research from India, offering several notable strengths. Firstly, it provided the first comprehensive synthesis of evidence regarding BE influence on PA in Indian cities. Secondly, it mapped the types of examined BE and the geographical distribution of the study sites, identified commonly used PA and BE assessment tools, and summarized the relationships between BE and PA. And thirdly, it outlined the study characteristics, categorised the findings based on demographic groups to clarify population-specific patterns, and positioned the Indian findings within the broader international situation to identify the scope of further research.

However, the limitations of the scoping review must be acknowledged. Firstly, it included only studies on healthy individuals and did not examined how BE influenced people with communicable or noncommunicable diseases. Secondly, it did not include studies on persons with disabilities, whose PA patterns and environmental needs may

differ significantly from healthy individuals. Thirdly, while synthesising findings on travel and leisure PA, it did not address links between BE and occupational PA due to the absence of such studies. Fourthly, although India is characterised by substantial regional, cultural, and contextual diversity, these variations could not be fully examined due to limited evidence. And fifthly, as most included studies relied on perception-based and self-reported measures, the potential for researcher and participant bias represented an inherent limitation of the findings.

The scoping review did confirm that BE/PA research in India was limited in quantity. Future research should expand the geography to capture the cultural and climate diversity of the country (Raman and Dempsey, 2012), and explore the effects of varying urban characteristics (Fathi *et al*, 2020) on PA and health. Research should also examine occupational PA, which is an understudied domain in the Indian context, investigate interactions among BE, infrastructure, policy, and worsening urban air pollution (Sharma *et al*, 2024a). Demographic-specific research is needed for children, adolescents, and adults (young and old). In terms of research design, future investgations should incorporate longitudinal studies, objective PA assessments (Arvidsson *et al*, 2012), observational studies (Brownson *et al*, 2009), and GIS-based (Pontin *et al*, 2022) and street-level assessments using Google Street View or deep learning based approaches (Phan *et al*, 2020). Development and validation of PA and BE assessment tools relevant to the Indian context are also needed. Together with the physical features of BE, future studies should explore the incorporation of urban design qualities, environmental aspects, PA resources, and social environment factors to develop more comprehensive questionnaires. The impact of BE interventions under national urban initiatives, such as the Smart Cities Mission (Housing and Land Rights Network, 2017), should be evaluated to understand their role in PA promotion.

Integrating interdisciplinary approaches with BE-oriented policies aligned with the WHO Global Action Plan on PA (WHO, 2018) can help support the creation of more active, equitable and health-promoting urban environments.

In conclusion, this scoping review provided the first comprehensive synthesis of data on the influence of BE on PA in various Indian urban settings. The review identified and categorised commonly perceived BE barriers and facilitators to PA under four themes, namely walking and cycling infrastructure, safety from traffic and crime, access to physical activity resources, and aesthetics and environmental quality. It also discussed the age- and gender-specific barriers and facilitators to PA perceived by children, adolescents, adults, and older adults. The scoping review revealed several knowledge gaps in the existing literature, particularly with respect to demographic groups, BE types, study designs, PA types, and BE and PA assessment tools. It also highlighted the over reliance on cross-sectional and perception-based methodologies, as well as the absence of context-sensitive and comprehensive BE and PA assessment tools tailored to individual Indian cities. Given that research on BE and PA is comparatively recent in India, the scoping review summarised the existing findings, and provided a structured foundation for future research and policy-relevant studies. In the context of India's high prevalence of physical inactivity and its growing emphasis on urban health (Shrivastava *et al*, 2023), this study highlighted the need for PA-oriented BE planning and design that is sensitive to socioeconomic, age and gender differences.

ACKNOWLEDGEMENTS

The authors acknowledge the support provided by the Department of Architecture and Planning, Visvesvaraya National Institute of Technology (VNIT), Nagpur, India, in conducting this research.

CONFLICT OF INTEREST DISCLOSURE

The authors declare no conflict of interest.

REFERENCES

Aandstad A. Relationship between self-reported and objectively measured physical fitness in young men and women. *Eur J Sport Sci* 2023; 23(2): 301-9.

Abdelhay O, Altamimi M, Abdelhay Q, *et al*. Correction: Perceived barriers to physical activity and their predictors among adults in the Central Region in Saudi Arabia: gender differences and cultural aspects. *PLoS One* 2025; 20(9): e0331572.

Abd-Latif R, Nor MM, Omar-Fauzee MS, Ahmad AR. Influence of recreational facilities among adolescents towards leisure time physical activity (LTPA). *Asian J Environ Behav Stud* 2017; 2(4): 65-73.

Adlakha D, Brownson RC, Hipp JA. Built environment correlates of overweight and obesity among adults in Chennai, India. *Cities Health* 2021; 5(3): 289-97.

Adlakha D, Hipp JA, Brownson RC. Adaptation and evaluation of the Neighborhood Environment Walkability Scale in India (NEWS-India). *Int J Environ Res Public Health* 2016a; 13(4): 401.

Adlakha D, Hipp JA, Brownson RC. Neighborhood-based differences in walkability, physical activity, and weight status in India. *J Transp Health* 2016b; 3(4): 485-99.

Adlakha D, Hipp JA, Brownson RC, Eyler AA, Lesorogol CK, Raghavan R. "Can we walk?" Environmental supports for physical activity in India. *Prev Med* 2017; 103S: S81-9.

Adlakha D, Hipp JA, Sallis JF, Brownson RC. Exploring neighborhood environments and active commuting in Chennai, India. *Int J Environ Res Public Health* 2018; 15(9): 1840.

Adlakha D, Parra DC. Mind the gap: gender differences in walkability, transportation and physical activity in urban India. *J Transp Health* 2020; 18: 100875.

Alhroub N, Al-Sarairhe I, Awamleh RA, *et al*. Physical activity barriers among adolescents in Jordan: a cross-sectional study. *SAGE Open Nurs* 2024; 10: 23779608241272688.

Amraotkar S, Gangopadhyay D.

Assessing user satisfaction of urban parks for sustainable cities: a pilot study of two urban parks in Chennai, India. *IOP Conf Ser Earth Environ Sci* 2023; 1210(1): 012039.

Aneesh M, Mahanta N. Physical activity levels, motivators and barriers to exercise among men and women aged 30 to 50 years in Rourkela, India. *J Midlife Health* 2022; 13(4): 278-87.

Anjana RM, Pradeepa R, Das AK, *et al*. Physical activity and inactivity patterns in India – results from the ICMR-INDIAB study (Phase-1) [ICMR-INDIAB-5]. *Int J Behav Nutr Phys Act* 2014; 11(1): 26.

Arifwidodo SD, Chandrasiri O. Neighbourhood walkability and physical activity during the COVID-19 pandemic. *Int J Environ Res Public Health* 2024; 21(4): 387.

Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005; 8(1): 19-32.

Arvidsson D, Kawakami N, Ohlsson H, Sundquist K. Physical activity and concordance between objective and perceived walkability. *Med Sci Sports Exerc* 2012; 44(2): 280-7.

Barnett DW, Barnett A, Nathan A, *et al*. Built environmental correlates of older adults' total physical activity and walking: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act* 2017; 14(1): 103.

Bhawra J, Khadilkar A, Krishnaveni GV, Kumaran K, Katapally TR. The 2022 India Report Card on physical activity for children and adolescents. *J Exerc Sci Fit* 2023; 21(1): 74-82.

Böcker L, Dijst M, Prillwitz J. Impact of everyday weather on individual daily travel behaviours in perspective: a literature review. *Transp Rev* 2013; 33(1): 71-91.

Bocquier P. World urbanization prospects: an alternative to the UN model of projection compatible with the mobility transition theory. *Demogr Res* 2005; 12: 197-236.

Brownson RC, Hoehner CM, Day K, Forsyth A, Sallis JF. Measuring the built environment for physical activity: state of the science. Am J Prev Med 2009; 36(4 Suppl): S99-123.e12.

Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions

and distinctions for health-related research. *Public Health Rep* 1985; 100(2): 126-31.

Cleland CL, Hunter RF, Kee F, Cupples ME, Sallis JF, Tully MA. Validity of the global physical activity questionnaire (GPAQ) in assessing levels and change in moderate-vigorous physical activity and sedentary behaviour. *BMC Public Health* 2014; 14: 1255.

Das R, Banerjee A. Identifying the parameters for assessment of child-friendliness in urban neighborhoods in Indian cities. *J Urban Aff* 2023; 45(2): 217-35.

Day K. Physical environment correlates of physical activity in developing countries: a review. *J Phys Act Health* 2018; 15(4): 303-14.

Duijvestijn M, de Wit GA, van Gils PF, Wendel-Vos GCW. Impact of physical activity on healthcare costs: a systematic review. *BMC Health Serv Res* 2023; 23(1): 572.

Dutta S, Bardhan S, Bhaduri S. Patterns of urbanization and environmental quality in the context of Indian cities. *Environ Urban ASIA* 2013; 4(2): 287-99.

Elshahat S, O'Rorke M, Adlakha D. Built environment correlates of physical activity in low- and middle-income countries: a systematic review. *PLoS One* 2020; 15(3): e0230454.

Eriksson U, Arvidsson D, Sundquist K. Availability of exercise facilities and physical activity in 2,037 adults: cross-sectional results from the Swedish neighborhood and physical activity (SNAP) study. *BMC Public Health* 2012; 12: 607.

Fathi S, Sajadzadeh H, Sheshkal FM, *et al*. The role of urban morphology design on enhancing physical activity and public health. *Int J Environ Res Public Health* 2020; 17(7): 2359.

Ferrari G, Guzmán-Habinger J, Chávez JL, *et al*. Sociodemographic inequities and active transportation in adults from Latin America: an eight-country observational study. *Int J Equity Health* 2021; 20(1): 190.

Garg S, Raman Kutty V. "Do I need exercise?" A qualitative study on factors affecting leisure-time physical activity in India. *The Qual Rep* 2019; 24(5): 1065-82.

Gautam S, Kruthika BN, Akashanand, Roy A, Banandur PS, Anniappan

Banavaram A. Assessment of resources for physical activity and understanding people's perception and practices regarding physical activity in an Indian city. *BMC Public Health* 2023; 23(1): 1969.

Govindarajulu D. Urban green space planning for climate adaptation in Indian cities. *Urban Clim* 2014; 10(Part 1): 35-41.

Gupta A, Bivina GR, Parida M. Does neighborhood design matter for walk access to metro stations? An integrated SEM-Hybrid discrete mode choice approach. *Transp Policy* 2022; 121: 61-77.

Halonen JI, Stenholm S, Kivimäki M, *et al*. Is change in availability of sports facilities associated with change in physical activity? A prospective cohort study. *Prev Med* 2015; 73: 10-4.

Heredia NI, Hunt ET, Lanza K. Influence of parental nativity and perceived neighborhood environment on physical activity and screen time of United States youth. *Prev Med* 2024; 183: 107973.

Housing and Land Rights Network. India's smart cities mission: smart for whom? cities for whom? 2017 [cited 2024 Jun 20]. Available from: URL: https://hlrn.org.in/documents/Smart_Cities_Report_2017.pdf

Jáuregui A, Salvo D, Lamadrid-Figueroa H, Hernández B, Rivera JA, Pratt M. Perceived neighborhood environmental attributes associated with leisure-time and transport physical activity in Mexican adults. *Prev Med* 2017; 103S: S21-6.

Jia P, Zou Y, Wu Z, *et al*. Street connectivity, physical activity, and childhood obesity: A systematic review and meta-analysis. *Obes Rev* 2021; 22(Suppl 1): e12943.

Kalata C, Reyes R, Kuhail K, Larson JL, Chen W. Barriers to physical activity in low-income older adults living in senior housing. *Healthcare (Basel)* 2025; 13(10): 1159.

Kari JT, Pehkonen J, Hirvensalo M, *et al*. Income and physical activity among adults: evidence from self-reported and pedometer-based physical activity measurements. *PLoS One* 2015; 10(8): e0135651.

Katzmarzyk PT, Friedenreich C, Shiroma EJ, Lee IM. Physical inactivity and non-communicable

disease burden in low-income, middle-income and high-income countries. *Br J Sports Med* 2022; 56(2): 101-6.

Kingsly A, Timperio A, Veitch J, *et al*. Individual, social and environmental correlates of active school travel among adolescents in India. *Int J Environ Res Public Health* 2020; 17(20): 7496.

Koohsari MJ, Badland H, Giles-Corti B. (Re)Designing the built environment to support physical activity: bringing public health back into urban design and planning. *Cities* 2013; 35: 294-8.

Koohsari MJ, Sugiyama T, Lamb KE, Villanueva K, Owen N. Street connectivity and walking for transport: role of neighborhood destinations. *Prev Med* 2014; 66: 118-22.

Lee ACK, Jordan HC, Horsley J. Value of urban green spaces in promoting healthy living and wellbeing: prospects for planning. *Risk Manag Healthc Policy* 2015; 8: 131-7.

Lee PH, Macfarlane DJ, Lam TH, Stewart SM. Validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF): a systematic review. *Int J Behav Nutr Phys Act* 2011; 8: 115.

Lv H, Wang R. Association between the built environment and moderate to vigorous leisure-time physical activity among Suzhou adolescents: a cross-sectional study. *BMC Public Health* 2023; 23(1): 1313.

Majumdar BB, Sahu PK, Patil M, Vendotti N. Pedestrian satisfaction-based methodology for prioritization of critical sidewalk and crosswalk attributes influencing walkability. *J Urban Plann Dev* 2021; 147(3): 04021032.

Mak S, Thomas A. Steps for conducting a scoping review. *J Grad Med Educ* 2022; 14(5): 565-7.

Mathews E, Lakshmi JK, Ravindran TK, Pratt M, Thankappan KR. Perceptions of barriers and facilitators in physical activity participation among women in Thiruvananthapuram City, India. *Glob Health Promot* 2016; 23(4): 27-36.

Mohanty S, Sahoo J, Epari V, Ganesh GS, Panigrahi SK. Prevalence, patterns, and predictors of physical inactivity in an urban population of India. *Cureus* 2022; 14(6): e26409. -

Munn Z, Peters MDJ, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic review or scoping review? Guidance for authors when

choosing between a systematic or scoping review approach. *BMC Med Res Methodol* 2018; 18(1): 143.

Noordzij JM, Beenackers MA, Groeniger JO, *et al*. Land use mix and physical activity in middle-aged and older adults: a longitudinal study examining changes in land use mix in two Dutch cohorts. *Int J Behav Nutr Phys Act* 2021; 18(1): 29.

Owen CG, Nightingale CM, Rudnicka AR, *et al*. Travel to school and physical activity levels in 9-10 year-old UK children of different ethnic origin; Child Heart and Health Study in England (CHASE). *PLoS One* 2012; 7(2): e30932.

Oyeyemi AL, Adegoke BO, Sallis JF, Oyeyemi AY, De Bourdeaudhuij I. Perceived crime and traffic safety is related to physical activity among adults in Nigeria. *BMC Public Health* 2012; 12: 294.

Oyeyemi AL, Sallis JF, Oyeyemi AY, Amin MM, De Bourdeaudhuij I, Deforche B. Adaptation, test-retest reliability, and construct validity of the Physical Activity Neighborhood Environment Scale in Nigeria (PANES-N). *J Phys Act Health* 2013; 10(8): 1079-90.

Patel J, Katapally TR, Khadilkar A, Bhawra J. The interplay between air pollution, built environment, and physical activity: Perceptions of children and youth in rural and urban India. *Health Place* 2024; 85: 103167.

Peters MDJ, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews. *Int J Evid Based Healthc* 2015; 13(3): 141-6.

Pham MT, Rajić A, Greig JD, Sargeant JM, Papadopoulos A, McEwen SA. A scoping review of scoping reviews: advancing the approach and enhancing the consistency. *Res Synth Methods* 2014; 5(4): 371-85.

Phan L, Yu W, Keralis JM, *et al*. Google street view derived built environment indicators and associations with state-level obesity, physical activity, and chronic disease mortality in the United States. *Int J Environ Res Public Health* 2020; 17(10): 3659.

Podder V, Nagarathna R, Anand A, Patil SS, Singh AK, Nagendra HR. Physical activity patterns in India stratified by zones, age, region, BMI and implications for COVID-19: a nationwide study.

Ann Neurosci 2020; 27(3-4): 193-203.

Pontin FL, Jenneson VL, Morris MA, Clarke GP, Lomax NM. Objectively measuring the association between the built environment and physical activity: a systematic review and reporting framework. *Int J Behav Nutr Phys Act* 2022; 19(1): 119.

Pouliou T, Pedrick-Case R, Bailey R, *et al*. Neighbourhood walkability and body mass index in children: Evidence from the Millennium Cohort Study in Wales. *J Transp Health* 2024; 38: 101855.

Prince SA, Butler GP, Rao DP, Thompson W. Evidence synthesis - where are children and adults physically active and sedentary? - A rapid review of location-based studies. *Health Promot Chronic Dis Prev Can* 2019; 39(3): 67-103.

Prithviraj D, Sundaram L. Exploring the walkability of senior citizens in a densely populated neighborhood of Chennai, India - a structural equation modeling approach. *Sustainability* 2023; 15(18): 13868.

Qureshi MH. Cultural diversity in India. *J Develop Policy Pract* 2023; 8(1): 13-23.

Rahiman V R, Naseer MA. Walkability to public transport: prioritization of parameters for walkability assessment in the urban areas of Kerala, India. *Eur Transp/Trasp Eur* 2022: 89: 3.

Rajaraman D, Correa N, Punthakee Z, *et al*. Perceived benefits, facilitators, disadvantages, and barriers for physical activity amongst South Asian adolescents in India and Canada. *J Phys Act Health* 2015; 12(7): 931-41.

Ramamoorthy T, Kulothungan V, Mathur P. Prevalence and correlates of insufficient physical activity among adults aged 18-69 years in India: findings from the National Noncommunicable Disease Monitoring Survey. *J Phys Act Health* 2022; 19(3): 150-9.

Raman S, Dempsey N. Cultural diversity and spatial structure in the Indian urban context. *J Urban Des* 2012; 17(3): 425-47.

Rathi N, Bhandarkar R, Kulkarni M. Recreational physical activity in urban India: perceptions and a pilot intervention. *Behav Change* 2023; 40(2): 133-53.

Rio CJ, Saligan LN. Understanding physical activity from a cultural-contextual lens. *Front Public Health* 2023; 11: 1223919.

Saleem S, Jaiswal A. Indicators for active transportation in Tier II Indian cities: a case of Bhopal, India. *J Adv Transp* 2024; 2024: 2175645.

Salvo G, Lashewicz BM, Doyle-Baker PK, McCormack GR. Neighbourhood built environment influences on physical activity among adults: a systematized review of qualitative evidence. *Int J Environ Res Public Health* 2018; 15(5): 897.

Santos AC, Willumsen J, Meheus F, Ilbawi A, Bull FC. The cost of inaction on physical inactivity to public health-care systems: a population-attributable fraction analysis. *Lancet Glob Health* 2023; 11(1): e32-9.

Satija A, Khandpur N, Satija S, *et al*. Physical activity among adolescents in India: a qualitative study of barriers and enablers. *Health Educ Behav* 2018; 45(6): 926-34.

Sharma G, Gupta M, Gargava P, Kota SH. Mapping air quality trends across 336 cities in India: Insights from three decades of monitoring (1987-2019). *Environ Int* 2024a; 191: 108979. -

Sharma M, Gaidhane A, Choudhari SG. A comprehensive review on trends and patterns of non-communicable disease risk factors in India. *Cureus* 2024b; 16(3): e57027. -

Sharma R, Chaudhary M. Perceptions of outdoor gymnasiums in National Capital Region, India: creating active environments for health promotion. *Health Promot Int* 2021; 36(1): 89-100.

Shrivastava S, Kothari A, Bhushan H. Urban health in India: from smaller steps to a big leap. *J Glob Health Econ Policy* 2023; 3: e2023006.

Singh H, Singh S, Singh A, Baker JS. Physical activity levels among the adults of Majha region of Punjab, India: a cross-sectional study. *Am J Hum Biol* 2021; 33(6): e23533.

Singhal N, Siddhu A. Barriers to leisure-time physical activity in Asian Indian men. *Public Health* 2014; 128(8): 749-51.

Siqueira Reis R, Hino AA, Ricardo Rech C, Kerr J, Curi Hallal P. Walkability and physical activity: findings from Curitiba, Brazil. *Am J Prev Med* 2013; 45(3): 269-75.

Strain T, Flaxman S, Guthold R, *et al*. National, regional, and global trends in insufficient physical activity among adults from 2000

to 2022: a pooled analysis of 507 population-based surveys with 5.7 million participants. *Lancet Glob Health* 2024; 12(8): e1232-43.

Subramanian D, Jana A. Assessing urban recreational open spaces for the elderly: a case of three Indian cities. *Urban For Urban Green* 2018; 35: 115-28.

Tarun S, Arora M, Rawal T, Benjamin Neelon SE. An evaluation of outdoor school environments to promote physical activity in Delhi, India. *BMC Public Health* 2017; 17(1): 11.

Tejendra N, Verma P. A scoping review protocol for "Built Environment Barriers and Facilitators to Physical Activity in Indian Cities: a scoping review", 2024 [cited 2024 Nov 05]. Available from: URL: https://inplasy.com/inplasy-2024-8-0045/

Tricco AC, Lillie E, Zarin W, *et al*. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med* 2018; 169(7): 467-73.

U.S. Green Building Council Inc (USGBC). LEED Reference guide for neighborhood development v4, 2014 [cited 2024 Jul 05]. Available from: URL: https://www.usgbc.org/sites/default/files/section/files/v4-guide-excerpts/Excerpt_v4_ND.pdf

Wang H, Dai X, Wu J, Wu X, Nie X. Influence of urban green open space on residents' physical activity in China. *BMC Public Health* 2019a; 19(1): 1093.

Wang J, Yang Y, Peng J, Yang L, Gou Z, Lu Y. Moderation effect of urban density on changes in physical activity during the coronavirus disease 2019 pandemic. *Sustain Cities Soc* 2021; 72: 103058.

Wang Z, Qin Z, He J, *et al*. The association between residential density and physical activity among urban adults in regional China. *BMC Public Health* 2019b; 19(1): 1279. -

Wanner M, Probst-Hensch N, Kriemler S, Meier F, Autenrieth C, Martin BW. Validation of the long international physical activity questionnaire: influence of age and language region. *Prev Med Reports* 2016; 3: 250-6.

Warburton DER, Bredin SSD. Health benefits of physical activity : a systematic review of current systematic reviews. Curr Opin *Cardiol* 2017; 32(5): 541-56.

Wei YD, Xiao W, Wen M, Wei R.

Walkability, land use and physical activity. *Sustainability* 2016; 8(1): 65.

World Health Organization (WHO). Global action plan on physical activity 2018-2030: more active people for a healthier world, 2018 [cited 2024 Jun 15]. Available from: URL: https://iris.who.int/server/api/core/bitstreams/33339c9c-3a9f-46d4-9f12-ae9ff0dfdc6a/content

World Health Organization (WHO). Invisible numbers: the true extent of noncommunicable diseases and what to do about them, 2022a [cited 2024 Jul 10]. Available from: URL: https://iris.who.int/server/api/core/bitstreams/33824126-cf22-4365-a7ec-ff24fbdf9ebb/content

World Health Organization (WHO). Physical activity profile India, 2022b [cited 2024 Jun 15]. Available from: URL: https://cdn.who.int/media/docs/default-source/country-profiles/physical-activity/physical-activity-ind-2022-country-profile.pdf?sfvrsn=4208cb78_5&download=true

Zhang Y, Koene M, Chen C, Wagenaar C, Reijneveld SA. Associations between the built environment and physical activity in children, adults and older people: a narrative review of reviews. *Prev Med* 2024; 180: 107856.

Zhong J, Liu W, Niu B, Lin X, Deng Y. Role of built environments on physical activity and health promotion: a review and policy insights. *Front Public Health* 2022; 10: 950348.

Zou Y, Wang D. Differences in the influence of the built environment and physical activity on obesity in urban and suburban contexts. *Soc Sci Med* 2025; 372: 117955.

Zumelzu A, Estrada M, Moya M, Troppa J. Experiencing public spaces in southern Chile: analysing the effects of the built environment on walking perceptions. *Int J Environ Res Public Health* 2022; 19(19): 12577.