

Exploring the relationship between the urban built environment and elderly pedestrian mobility in South Asian cities

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Abstract

Cities in South Asia have traditionally been dominated by pedestrians for their daily trips. As the elderly population is increasing in the last two decades, the dynamics of designing appropriate walkways to serve elderly people are getting more attention from urban planning scholars and policymakers alike. However, few studies in planning in the context of southern cities have considered the significant issue of elderly mobility and walkability in cities in South Asia beyond the realm of large metropolitan cities. In this paper, we attempt to understand the challenges encountered by elderly pedestrians in existing street conditions and summarize information that may be useful for enhancing elderly mobility. Using cases of Rourkela in India and Khulna city in Bangladesh, we have collected both primary and secondary information by conducting a structured questionnaire survey in both cities at a similar period. Further to this, we analyzed statistical models to understand relationships among built environment and mobility issues based on subjective evaluation (i.e., infrastructure, street design, lighting, overcrowding condition, and encroachment). Most of the elderly pedestrians surveyed in both cities demand improvement of micro-scale urban design features and planning guidelines that they assume are absent in the statutory planning documents. This study may be employed as a useful document for city-level planning taking into account elderly perception about the built environment and their mobility concerns in future policy and planning projects. Consequently, a more comprehensive study may be incorporated highlighting elderly pedestrian's mobility within the formal/informal transportation planning system.

1. Introduction

In recent times, there has been increased attention in scholarly literature towards changing elderly demographics in cities (persons above 60 years), and associated challenges about urban planning (Cauwenberg, Holle, et al. 2012; James 1994). Accessibility, as well as mobility of elderly pedestrians on city streets, is critical to maintaining social, economic, and ecological relationships for citizens' well-being (Rahaman, Lourenço, and Viegas 2012; Cunningham and Michael 2004; Nordbakke et al. 2014). Within the urban studies discourse, attention has increased towards universal design approaches for streets to provide accessibility and walkability for all, including the elderly (Iwarsson and Ståhl 2003; Southworth 2005; Bharucha 2017; Koenig 1980).

Elderly pedestrians experience multiple challenges to mobility and accessibility, which affect their physical activity, and travel choices, thus affecting their health and psychological well-being. Some of the key challenges described in recent scholarly literature are related to *individual characteristics* such as sedentary lifestyle (Wang et al. 2016), reduced mobility due to aging (Stahl 1987), functional deterioration, disability (Priya G 2008; Rosso et al. 2016; Rosso et al. 2011), low confidence in walking outdoors (Sugiyama and Thompson 2007); *socio-ecological factors* (i.e., poor street design), low safety perception (Lavery et al. 1990; Cunningham and Michael 2004), physical barriers (Strohmeier 2016), lack of required facilities for the elderly in streets, inadequate public transit access, lack of supportive governance mechanism; and *cultural factors* such as gender, economic status and access to structural resources (Feng 2016; Mollenkopf et al. 2004).

In this paper, we aim to understand various challenges encountered by the elderly related to pedestrian accessibility in cities in the South Asian context. There has been a burgeoning literature on pedestrian accessibility and mobility challenges of the elderly concerning urban planning and transportation, yet most of these studies are heavily drawn towards European and North American contexts or limited to large metropolitan cities in South Asia. In the discipline of urban planning, there is now an increased interest among planning scholars, demanding for more scientific inquiry that is rooted in the social, economic, ecological, political, and cultural contexts that exist in cities in the global south, in other words, search for context-based theories (Watson 2009; Bhan 2019).

Very few cities in South Asia (except metropolitan cities such as Delhi, Bangalore, and Dhaka) have attempted to collect data related to pedestrian accessibility, or have provided guidelines for elderly pedestrian accessibility. The large cities (having a population of around one million or more in this context) have experienced faster growth of elderly in the past decades as documented. For instance, this study aims to fill the research gaps explored from the literature by providing empirical evidence on elderly pedestrian accessibility.

From a theoretical standpoint, most research in urban studies related to elderly activity can be situated within ecological or cognitive-based approaches (Nordbakke et al. 2014; Cunningham and Michael 2004). We aim to make theoretical advances by using socio-ecological approaches- through empirical data on physical, socio-economic, cultural, governance, and institutional level challenges with regards to elderly accessibility across multiple geographical contexts. We contend that findings from this study may help develop the existing theories more robust and useful in different spatial contexts.

Our study aims to build on these evolving ideas by providing empirical evidence from case studies of two cities in South Asia. Few questions that we have inquired are:

- i. *What factors in the built environment influence elderly pedestrian accessibility in South Asian cities?*
- ii. *What are the key challenges faced by the elderly in respect to pedestrian accessibility? and*
- iii. *What recommendations can be made available to improve elderly pedestrian accessibility in cities in the South Asian context?*

In the rest of the paper, we elaborate on various aspects of the study. In Section 2, the literature on elderly accessibility studies in the South Asian context is briefly discussed. Sections 3 and 4 describe the theoretical and conceptual frameworks respectively, while Section 5 introduces the study area. Section 6 described the methodological aspects of the study. Sections 7 and 8 show the results, discussion, and key recommendations that emerge from this study. The paper concludes with our closing arguments in Section 9.

2. Literature Review

2.1 Background

The pace of population aging is faster in developing than in developed countries. Currently, nearly 64% of the elderly are in developing countries (Frye 2013). It is estimated that around one-fifth of the world's elderly population will be in South Asian countries; with India having the second largest population of elderly in the world. The elderly population in India in the year 2011 was nearly 104 million (8 % of the total population), which is expected to rise about 135 million by the year 2025 (Government of India 2011; Rath 2016). This increasing trend has received public and scholarly attention and has encouraged dialogues among stakeholders in cities worldwide including South Asia. However, challenges remain for generating a holistic framework in these cities. From a socio-cultural standpoint, the elderly in South Asian cities (includes rural areas as well) depend on family networks for accessing healthcare, shopping, and for necessary mobility. Consequently, around 40 % of elderly people are somewhat forced to engage in the workforce for their livelihood, and often making the trips by walking (Arokiasamy et al. 2012). These challenges expose them to more vulnerability and risks of accidents on streets in urban areas (Pal et al. 2019; Govt. of India 2019).

2.2 Elderly accessibility in South Asia

At present, most of the studies in the South Asian context are situated within other disciplines such as psychology, health sciences, economics, and transport studies (Banjare, Dwivedi, and Pradhan 2015; J. P. Smith and Majmundar 2012; Badami 2009; Rath 2016). Even within key disciplines such as health sciences and health psychology, scholars contend that issues of the elderly are often neglected in education, research as well as practice (Dhar 2005). Few studies within the urban planning discipline have attempted to study elderly mobility and accessibility challenges in South Asian cities (Patil and Raj 2013; Leather et al. 2011; Parida and Cherian 2017; Bharucha 2017). Patil & Raj, (2013) in their study of accessibility to bus stops for the elderly in Bangalore city in India contend that barrier-free access is a crucial issue that affects elderly mobility in an urban space. Bharucha, (2017) examined the walkability of streets in Mumbai city and found that the absence of microscale urban design elements such as pedestrian infrastructure (i.e., pavements, materials, and surface color) affect pedestrian comfort and safety.

Scholars have recommended several policy recommendations to improve pedestrian accessibility, enhance mobility as well as improve the well-being of the elderly. Leather et al., (2011) in their study of twenty-one cities in Asia contend that pedestrian accessibility should be the core of the urban transport policies to minimize inefficient use of private vehicles while helping curb GHG emissions in these cities. In the context of South Asian cities, Bharucha, (2017), through a study assessing the walkability of Mumbai also recommends people-centric policies in large and metropolitan cities, keeping the safety of pedestrians at the center of the action. James, (1994) has identified the changing demographics of the elderly population in India as a 'grey' problem. The study recommends policy actions that focus on economic growth that can positively affect mobility and the overall well-being of the elderly across India. Flora, (2011) recommended targeting broader policies that focus on the economic and cultural support of the elderly in Bangladesh, including food, clothing, medical care, and housing. Rahman & Ohmori, (2014) in their study of pedestrian accessibility and public transport in Dhaka city recommended

a focus on microscale urban design approaches using universal design as well as barrier-free principles in designing transportation facilities. These recommendations are complemented by Siddiqua & Taher, (2017), who recommend changing existing bye-laws with regards to the physical environment. Sharmeen & Israt, (2013) and Bharucha, (2017) in their study of mobility and accessibility issues around schools in Dhaka city recommend systematic road safety practices through countermeasures as well as better law enforcement.

In general, there seems to be a consensus by most scholars that the issue of pedestrian accessibility for the elderly needs more careful attention by planners, engineers, and professionals. The recommendations in these studies range from systemic and integrated solutions to improve safety and socio-economic status and well-being of the elderly; towards more localized policy actions such as by-law changes, law enforcement, and better microscale urban design approaches to the street as well as integrating public transportation facilities. Overall, findings from the literature point at recommendations related to social factors (age, gender, the purpose of walking, access to facilities, etc.); walkability satisfaction (pedestrian infrastructure, street design and other relevant urban design factors, traffic and noise); and wider governance factors (cultural factors, municipal policies, and actions).

3. Theoretical Framework

Most of the theoretical pathways in the literature related to elderly mobility and accessibility are within the disciplines of psychology; health sciences; ecology and environment; and urban studies including urban transport planning and urban design theories. Cunningham & Michael, (2004), in their review of concepts and theories related to the impact of the built environment on elderly activity, contend that physical environment has often been ignored in scholarly literature, while the focus has been more on social aspects relevant for the elderly population in a place. In general, theories related to elderly accessibility and behavior as pedestrians can be categorized into three groups such as *(i) behavior and learning theories; (ii) contextual theories; and (iii) socio-ecological theories.*

Within the *behavior theories*; the Environmental Press theory by Lawton, Windley, & Byerts, (1982) suggests that the environment causes stress to the elderly within a neighborhood, depending upon the competence of the individual to deal with situations. Social Learning Theory and Social Cognitive theory suggest that it is beneficial to study and model elderly behavior, attitudes, and emotional responses in a certain environment (Sallis et al. 1989). Travel Behaviour theory suggests that the demand for travel by the elderly depends upon the demand for activities such as shopping in nearby shops in a neighborhood (Cervero and Seskin 1995). Some of the important factors that affect the mobility-related behavior of the elderly in a place are age, socio-economic status, personal desire and attitude, the degree of transportation infrastructure, as well as quality of amenities available in the place (Susan L Handy and Clifton 2001; G. C. Smith and Sylvestre 2001; Cervero and Seskin 1995; Feng 2016).

While behavior theories focus on individual characteristics and cognitive abilities, *contextual theories* suggest that wider structural factors such as properties of the space in a built environment, such

as physical, social, or geographical context, can affect individual choices. This may be of importance, especially in cities in South Asia, where socio-economic and cultural factors such as gender, social status, and classes can affect pedestrian behavior. Ecological theories relevant in this debate emphasize the role of the physical environment in controlling or affecting individual behavior traits of the elderly (M Powell Lawton 1977; Owen et al. 2000). *Socio-ecological theories* combine the effects of social and physical aspects of the built environment. They focus on a mix of indicators related to socio-cultural factors, accessibility, and physical factors such as urban design elements and street walkability (Barker 1968).

In this study, we aim to look at the issue critically by employing theoretical frames available within the socio-ecological theory, Travel Behaviour Theory, and contextual theory. In many ways, the socio-ecological theories seem to have congruence with contextual theories, since both have a systems approach to the issue of elderly accessibility, by looking at physical as well as contextual factors and their inter-relationships. The field surveys conducted for this study have been done using this theoretical understanding.

4. Built Environment And Elderly Pedestrian Accessibility: A Conceptual Framework

Accessibility

Accessibility has been used for a long time in scholarly works related to land use planning and transportation. Several scholars have reviewed the concept of accessibility from a location standpoint (Handy & Niemeier, 1997); economic and social benefits of accessibility (Wee and Geurs 2011); person-environment relationships (Iwarsson and Ståhl 2003); as well as the quality of life perspective (Tight et al. 2004). The majority of the accessibility studies that work within land use and accessibility framework, do not take into account the need to incorporate non-motorized modes especially pedestrian needs and issues (Alsnih and Hensher 2003; Tight et al. 2004). Wee & Geurs, (2011) contend that overlooking pedestrian needs in transport studies have resulted in transport-related social exclusion of several groups.

In the past two decades, accessibility literature has widened in terms of scope. Iwarsson & Ståhl, (2003) focus on universal design solutions to improve pedestrian accessibility. They contend that current design approaches are most suitable for the 'normal' population and to some degree of including 'persons with some disability. Tight et al., (2004) provide new insights on challenges to pedestrian accessibility across multiple groups (based on gender, age, class, etc.). Their findings suggest that safety perception and pedestrian environment features such as individual behavior, street design, and municipal governance are important factors that affect pedestrian accessibility in a public space. Koppen, Tveit, Sang, & Dramstad, (2014) identify two key dimensions of accessibility: physical accessibility (related to the physical environment); and socio-cultural or socio-psychological accessibility (related to individual behavior). In the context of accessibility of elderly pedestrians, Stahl et al., (2008) has identified many environmental barriers and risk factors that affect elderly pedestrian behavior, such as uneven surfaces,

poor curb design, heavy traffic, motorists' behavior, and fear of crossing streets as well as of falling. Alsnih & Hensher, (2003) contend that different age groups within the elderly have different accessibility needs and challenges.

Based on our literature review, we use a holistic understanding of the concept of accessibility for their suitability in this study. Also, we take up an explicit position to go beyond an objective measure of accessibility from a mobility approach towards a subjective approach that covers a wide range of discourses across disciplines. Some of the factors that we consider in our primary survey are related to physical accessibility (microscale urban design elements, convenience of facilities nearby); social accessibility (access to public facilities, gender, class, and position in society, safety perception); and socio-ecological accessibility (confidence in local governance efficiency and motorists' behavior).

Built Environment

Multiple meanings of the term 'built environment' have been put forth by scholars in the widely acknowledged urban planning literature. (Cunningham and Michael 2004), in their review of the concept have identified three main components of the built environment that impact elderly physical activity viz. transportation systems, land use patterns, and microscale urban design. Transportation systems refer to the systems that provide important connections between activities. Land use pattern mostly refers to the overall urban form of the city (sprawls, mixed-use, etc.) which is directly linked with the main characteristics of the transportation system in an urban area (Sallis et al. 1989). Micro-scale urban design elements refer to street-level conditions such as sidewalk quality, kerbs, railings, etc. (Patil and Raj 2013). In another study, Stoker et al., (2015) have developed a conceptual framework linking built environment to pedestrian safety. They reimagine the built environment in three levels - regional (urban sprawl, density, regional development); local (pedestrian infrastructure and road design); and street conditions (visibility, traffic volumes, and traffic speed). We use variables related to development patterns, socio-ecological factors, and pedestrian environments in this study (see Fig. 1).

5. Study Area

We selected Rourkela city in India and Khulna city in Bangladesh as the two study areas in this study (see Fig. 2). Table 1 shows the general characteristics of these two cities.

Table 1, Overview of the studied cities.

	Rourkela, India	Khulna, Bangladesh
District and State	Sundergarh district, Odisha	Khulna district
Population	0.64 million (metropolitan)	1.02 million (metropolitan)
City area	95.52 sq. km.	53.78 sq. km.
Density	67 persons per hectare	190 persons per hectare
Urban form	Neighborhood pattern, connected through Ring Road	Linear
Weather condition	Tropical climate Annual precipitation = 1600 mm per year Mean temperatures ~12 to 31 degrees Celsius	Tropical climate Annual precipitation = 1800 mm per year Mean temperatures ~ 12 to 34 degrees Celsius
Economic activities	Iron and Steel industrial hub	Light and heavy industries (such as jute, chemicals, sugar mills, and shipbuilding)
Elderly population (approximate)	60,000 (9.5% approx.)	81,600 (8.0% approx.)
Urban Local Body/Civic Administration	Rourkela Municipal Corporation (Municipal area) Rourkela Steel Plant Administration (Steel Township area)	Khulna City Corporation
Transport modes	Non-motorized transport - 10% Public transit - 8%	Non-motorized transport - 45-50 % Public transit - 5-7 %

Sources: (K.R. Rahaman, Dhar, Maruf Hossain, & Khan, 2009; Rahman, Mohammad, Ali, S. A., & Hossain, Q. S. 2015; Shaheen, M., Puri, S., & Tandon, N. 2016)

Rourkela

Rourkela city was built in the 1950s as an industrial town in the state of Odisha in India. The city has grown significantly in the past five decades from a company town to an urban agglomeration. The city area is under the control of the Rourkela Municipal Corporation (Municipal areas) and the Rourkela Steel Plant Administration (Steel township area). The city has been selected in the 100 cities to be built within India's Smart City Mission, within which few area-based development projects have been proposed in the city which focus on improving pedestrianized spaces for elderly groups (Govt. of India 2017). The city has nearly 60,000 elderly people who are currently at high risk due to increased traffic issues as well as inadequate segregated walkways throughout the city (UNFPA 2011; Pal et al. 2019).

Khulna city is the administrative headquarters of the Khulna division and district in Bangladesh. It is the third-largest city in Bangladesh in terms of population; and has been experiencing rapid growth in recent times (Bhadra, Sazid, and Esraz-UI-Zannat 2015). The city has witnessed considerable industrial growth in the 1950s and 1960s, with the setting up of numerous hardboard, paper, and textile mills; as well as a shipyard established in the year 1957 (Khulna City Corporation 2020). Due to a decline in demand, many of these industries have closed their operations in the late 1990s. The city has nearly 80,000 elderly populations (Bangladesh Bureau of Statistics, 2015). Due to most transportation policies in the city focused on private motorized modes, the elderly in the city are at high risk currently (Mohammad Rahman, Ali, and Hossain 2015; Bhadra, Sazid, and Esraz-UI-Zannat 2015).

6. Material And Methods

In the absence of any baseline quantitative data in both the cities of Rourkela and Khulna, such as pedestrian count, elderly pedestrians, or GIS data; we opted to adopt a qualitative study based on cross-sectional data for this paper, to follow up with a quantitative study. We designed a set of questionnaires to be asked to elderly pedestrians only while they were using the sidewalks in both cases. The schematic diagram in Fig. 3 shows the method we employed in a nutshell.

A key challenge during the preparation of the methodological framework and the relevant questionnaire revolved around the decision to measure objective or subjective measures of the built environment. We found in our review of studies in India and Bangladesh that most studies were focused on an objective evaluation only, ignoring the subjective measures of the built environment (Bharucha 2017; Banjare, Dwivedi, and Pradhan 2015; Bhadra, Sazid, and Esraz-UI-Zannat 2015; K.R. Rahaman, Ahmed, and Islam 2009). In other cases, studies that were attempted to provide a subjective approach failed to provide empirical insights (Prakash 2003; Patil and Raj 2013). In our study, we aimed at generating empirical insights through qualitative field data collected on subjective factors relevant to the concepts of accessibility and the built environment.

We conducted the study the following three consecutive steps:

a. Study area selection: As described earlier in this paper, after a scoping review of multiple cities, we selected Rourkela and Khulna cities owing to their similar elderly pedestrian characteristics and behavior. Within the cities, we identified few major streets where considerable pedestrian activity occurs daily. We selected mainly streets in residential settlements since they attracted more elderly pedestrians compared to those in commercial and industrial areas in the cities.

b. Data Collection: We collected secondary data about the elderly accessibility, mobility, and pedestrians relevant to the selected cities, such as unpublished thesis work, media reports, government reports, academic literature, and other relevant grey literature. We used the primary questionnaire survey as the main method for data collection, complemented by qualitative methods (interviews, direct observation,

visual survey, photographs, and field notes). We designed a questionnaire based on our conceptual framework and the method described in Fig. 2 and Fig. 3 respectively. Data were collected between May and October 2019 in both cities, from a total of 41 elderly respondents (19 respondents in Rourkela, and 22 in Khulna city). There were 32 male and 9 female respondents. The respondents' age varied between 60 to 78 years, with the mean age being 64.9 years. Note that, for both cities, 60 plus years were considered as senior citizens.

An additional choice was provided in the questionnaire to the respondents if they are willing to participate in a personal interview at a later time. Nearly 15 participants agreed to a semi-structured interview, which involved an initial debriefing session, followed by an elaborate discussion on the nature of the choices made by the respondents. This step helped us triangulate different methods and increased the validity of our findings. At least ten follow-up interviews were planned in May-June 2020, but the fieldwork was closed owing to restrictions around the Covid-19 pandemic and lockdowns.

c. Data Analysis: We conducted a statistical analysis of the dataset collected; initially through descriptive statistics, and correlation between elderly accessibility and various factors of the built environment such as pedestrian infrastructure, encroachment, overcrowding, and lighting on streets. We conducted a (Multiple Analysis of Variance) MANOVA tests to calculate the effects of *gender, frequency of walking, and distances traveled* by the elderly on the overall accessibility of the built environment for the elderly. We conducted a visual interpretation of the study areas of data collected through multiple photographic surveys. Additionally, we used field notes and memos from interview data to validate our findings from the statistical survey and to understand the socio-cultural factors such as gender on elderly pedestrian activity on streets in both cities.

7. Results

Based on our earlier review and the schematic diagram in Figure 3, we assumed pedestrian accessibility to be affected by four key factors i.e. pedestrian infrastructure, encroachments on walkways, overcrowding in the street, and lighting levels in the streets.

$$PA = f (PI + ER + O + LL)$$

where, PA - Pedestrian Accessibility;

PI - Pedestrian Infrastructure (includes Walkway width, Kerb height, Ease of crossing street, and Traffic levels);

ER - Encroachment on walkway;

O - Overcrowding; and

LL - Lighting level

Figure 4 indicates the weighted scores of all the parameters selected for analysis in our study. The scores indicate that encroachment on walkways is the most important factor that affects the accessibility of elderly pedestrians in the study area. Additionally, pedestrian infrastructure such as walkway or kerb height, walkway width, and absence of guided intersections (zebra crossings, traffic lights, push buttons for pedestrian crossings, and help from traffic police) also have a significant effect on elderly accessibility. Surprisingly, lighting levels had a relatively lower score which indicates that it does not directly concern accessibility of streets for elderly pedestrians.

Table 2 shows the association between the selected parameters and the gender of the respondents. It was observed that in general, female respondents reported having more concerns with lighting levels, walkway width, and overcrowding compared to male counterparts. This is significant to notice since the overall scores suggested a lower effect of lighting levels.

Table 2, Summary of generated model outcome of gender and elderly pedestrians' evaluation.

Gender and Equation	Observation (N = 41)	RMSE	Coefficient	P- Value
Walkways Width	41	0.35	0.85	0.05
Guided Intersections	41	0.32	0.63	0.11
At Grade Walkways in Place	41	0.34	0.38	0.03
Encroachment	41	0.42	0.73	0.02
Overcrowding	41	0.23	0.81	0.07
Lighting	41	0.55	0.84	0.02

We asked respondents regarding their frequency of walking per week as well as a preferred time of the day to walk on the streets; and observed a differential opinion of elderly pedestrians who used the walkways for morning/evening walks compared to others who used for other short trips during the day. We observed, as seen in Table 2, that for morning and evening walkers, encroachment on streets and overcrowding on the streets were the most important accessibility factors that affected pedestrian evaluation.

Table 3 shows the association between the selected parameters and the distance traveled by the respondents in a day. We found that respondents who used to walk more than 5 kilometers in a day were affected more by factors such as walkway width, encroachment on streets, and overcrowding. In totality, from Tables 3 & 4, it can be inferred that respondents who walk more frequently and longer distances identified encroachments and overcrowding as significant factors that affect their walkability on the streets.

Table 3, Conditions evaluated by pedestrians during morning and evening time.

Frequency of Walking and Equation	Observation (N = 41)	RMSE	Coefficient	P
Walkways Width	41	0.38	0.68	0.04
Guided Intersections	41	0.23	0.71	0.07
At Grade Walkways in Place	41	0.71	0.49	0.1
Encroachment	41	0.22	0.91	0.01
Overcrowding	41	0.43	0.78	0.02
Lighting	41	0.51	0.52	0.02

Table 4, Pedestrians evaluated walkways based on distance traveling a day.

Distance Walking and Equation	Observation (N = 41)	RMSE	Coefficient	P
Walkways Width	41	0.21	0.92	0.04
Guided Intersections	41	0.22	0.62	0.17
At Grade Walkways in Place	41	0.38	0.41	0.03
Encroachment	41	0.41	0.85	0.03
Overcrowding	41	0.17	0.88	0.01
Lighting	41	0.61	0.74	0.01

Table 5 shows the overall rating of each of the six criteria, which likely affected responses in the survey. We made three key observations. Firstly, we observed that there was not a lot of variation in risk perception within subgroups of the elderly. But, our analysis suggested that aged respondents (above 70 years) gave poorer ratings compared to respondents between age 60 and 70 years. Secondly, female respondents gave poorer ratings for most parameters compared to their male counterparts in both cities. Finally, most respondents' preferred time of walking was in the daytime, which suggested the likelihood of higher pedestrian risks in the evenings. This is often exacerbated by other factors such as obstructions on the walkways by encroachments that could be difficult to identify in the evening time.

Table 5, Overall summary of pedestrians' evaluation of walkways in the study area.

Equation Overall Rating	Coefficient	T Value	P-Value
Age	0.12	2.26	0.01
Gender	0.35	0.64	0.02
Frequency of Walking	0.11	0.34	0.07
Purpose of Walking	1.05	0.35	0.03
Distance Travelled	0.16	0.2	0.02
Preferred Time of Walking	0.04	-1.15	0.01

The overall accessibility scores (based on our sample and seven assessment criteria) are plotted in Figure 5. It is observed that respondents in Khulna city rated higher accessibility scores in their city compared to their counterparts in Rourkela city broadly. Also, the responses we received in Khulna city had less variation in comparison to Rourkela. This aspect was probed further with our interviews as well, in which respondents from Rourkela city expressed disapproval of the development works by the Rourkela Municipal Corporation.

8. Discussion And Recommendations

In this section, we briefly discuss four key issues based on our observations and findings. *Firstly*, our study indicates that research on elderly accessibility in South Asian cities is presently inadequate, putting elderly people, especially women, at high risk as pedestrians. Respondents in our survey expressed disappointment with the local municipal corporations in Rourkela and Khulna, with regards to their services in providing road design and pedestrian infrastructures. We suggest that the municipal authorities need to be more proactive in matters related to vulnerable sections of the city such as the elderly. Novel methods such as employing ‘tactical urbanism’ events (such as creating pilot projects on small sections of pedestrian pathways) as well as multiple design charrettes are low-cost but highly effective ways to engage the elderly in cities. This will ensure the participation of the elderly and increase public awareness regarding pedestrian behavior.

Secondly, our study indicates that encroachments and overcrowding on streets significantly affect the accessibility and overall experience of the elderly. Due to reduced distance of travel as well as the frequency of walking, these encroachments are posing potential health risks for the elderly. During our visual survey and multiple interviews, most of the issues discussed were regarding insensitive parking on the roadside as well as on walkways that obstructed smooth pedestrian movement even when walkways existed in decent condition. Another frequently observed issue was unauthorized shops (mostly kiosks and tea stalls) that came up on roadsides attract people, yet block the path of other pedestrians, forcing them to walk on the driveways. Better local enforcement mechanisms as well as creating zones for local street vendors and parking could help create free movement in the walkways with appropriate design guidelines.

Thirdly, we found that elderly women expressed more concerns regarding accessibility. There may be socio-cultural factors such as gendered public spaces as well as local practices and norms (such as perceived societal roles of different gender, and lack of independence of females) that are linked to these findings. It also suggests that street walkways are more suitable for males compared to females. This makes the elderly female pedestrians at a higher risk from public safety and health in South Asian cities, as suggested in similar studies by Flora, (2011). Consequently, poor evaluations by elderly female pedestrians also suggest lower participation in public activities, which is a major cause for concern from an urban planning standpoint.

Fourthly, our findings suggest that microscale urban design elements related to pedestrian infrastructure, street design, and aesthetics were identified as having mixed importance for elderly accessibility. Past research in other contexts suggests that the existence of sidewalks improves the physical activity of the elderly (Cunningham and Michael 2004). We build on this further by suggesting that the existence of sidewalks without encroachment can improve the accessibility of elderly pedestrians in streets. Similar studies by Parida & Cherian, (2017) and Patil & Raj, (2013) also support the view that access to public transit and microscale urban design elements such as walkway width and kerb height can affect the overall risk and safety perception of the elderly.

9. Concluding Remarks

In this study, we attempted to create an aging-specific conceptual framework on the relationship between the built environment and elderly pedestrian accessibility, based on a socio-ecological theoretical approach supported by evidence. Our literature review identified certain limitations of current research on the elderly in South Asian cities, particularly the absence of validated models and consistent measures of specific features of concepts of built environment and accessibility of vulnerable groups. We identified that large cities in South Asia did not get enough attention from researchers while studying the effects of changes in the built environment and pedestrian mobility. Moreover, people in South Asian cities are social and like to walk and talk with friends and relatives. As a result, walking for elderly people is considered at some places as recreational to stay healthy and being social.

Based on our limited work in the field due to time and budgetary constraints, we contend that there is an urgent need for large-scale and sophisticated inquiry on planning for elderly issues in general in South Asian cities. Future research is required with a long-term and larger sample size, to understand specific environmental factors and their relationship with pedestrian accessibility and affordability of groups within the elderly (based on local socio-cultural and economic factors). From a methodological standpoint, a mixed-methods approach using a participatory research framework will be suitable to get elderly voices during the research process, as well as provide solid baseline data for further advancement of knowledge in this regard.

Declarations

Funding

No funding was acquired for the study.

Conflict of Interest

The authors declared no conflict of interests in publishing this article.

Availability of data

The data used in the study is mostly drawn from survey results. Further information regarding the survey instruments and analysis can be provided if requested.

Ethics and consent

All participants in the study provided their consent (verbal or written) to participate in the survey, follow up discussions and debriefing, as well as their responses and words to be used in this article in quotes. All ethical guidelines were followed in line with the University of Alberta's ethics requirements. Some follow up interviews were carried out through phone calls in 2020 during the Covid-19 pandemic, with the same participants.

References

- Alsnih, R., & David, A. H. (2003). "The Mobility and Accessibility Expectations of Seniors in an Aging Population." *Transportation Research Part A* 37 (2003): 903–916. doi:10.1016/S0965-8564(03)00073-9.
- Arokiasamy, P., Bloom, D., Lee, J., & Feeney, K. Marija Ozolins(2012). "Longitudinal Aging Study in India: Vision, Design, Implementation, and Preliminary Findings." In *Aging in Asia: Findings from New and Emerging Data Initiatives*.
- Badami, M. G. (2009). Urban Transport Policy as If People and the Environment Mattered: Pedestrian Accessibility the First Step. *Economic & Political Weekly*, 44(33), 43–51
- Banjare, P., Dwivedi, R., & Pradhan, J. (2015). Factors Associated with the Life Satisfaction amongst the Rural Elderly in Odisha, India." Health and Quality of Life Outcomes. *Health and Quality of Life Outcomes*, 1–13. doi:10.1186/s12955-015-0398-y.
- Barker, R. G. (1968). *Ecological Psychology: Concepts and Methods for Studying the Environment of Human Behavior*. Stanford, California: Stanford University Press
- Bhadra, Sourav, A. K. M., Tanbir Sazid, & Esraz-Ul-Zannat, M. (2015). "An Objective Assessment of Walkability in Khulna City: A GIS-Based Approach." In *3rd International Conference on Green Energy and Technology (ICGET)*. Dhaka.

- Bhan, G. (2019). Notes on a Southern Urban Practice. *Environment and Urbanization*, 1(2), 639–654. doi:10.1177/0956247818815792.
- Bharucha, J. (2017). An Investigation into the Walkability Problem in Indian Cities. *Safer Communities*, 16(2), 77–86. doi:10.1108/SC-02-2017-0010.
- Cauwenberg, J., Van, P., Clarys, I. D., Bourdeaudhuij, V., Van Holle, D., Verté, N. ... Dury Benedicte Deforche(2012). "Physical Environmental Factors Related to Walking and Cycling in Older Adults: The Belgian Aging Studies." *BMC Public Health* 12 (1). BioMed Central Ltd: 142. doi:10.1186/1471-2458-12-142.
- Cauwenberg, J., Van, V. V., Holle, D., Simons, R., Deridder, P., Clarys, L. ... De Bourdeaudhuij Benedicte Deforche(2012). "Environmental Factors Influencing Older Adults ' Walking for Transportation: A Study Using Walk-along Interviews,"1–11.
- Cervero, R. Samuel Seskin(1995). *An Evaluation of the Relationships between Transit and Urban Form*.
- Clarke, P. J., Ting, Y., & Keusch, F., Nancy Ambrose Gallagher. (2015). The Impact of Weather on Mobility and Participation in Older US Adults. *American Journal of Public Health*, 105(7), 1489–1494. doi:10.2105/AJPH.2015.302582.
- Cunningham, G. O., & Yvonne, L. M. (2004). "Literature Review: Health Promoting Community Design Concepts Guiding the Study of the Impact of the Built Environment on Physical Activity for Older Adults. *A Review of the Literature*", 18(6), 435–444
- Dhar, H. L. (2005). Emerging Geriatric Challenge. *Journal of Association of Physicians of India*, 53, 867–872
- Feng, J. (2016). "The Influence of Built Environment on Travel Behavior of the Elderly in Urban China. " *Transportation Research Part D*. Elsevier Ltd. doi:10.1016/j.trd.2016.11.003.
- Flora, M. S. (2011). Ageing: A Growing Challenge. *Bangladesh Medical Journal*, 40(3), 48–51
- Frye, A. (2013). *Disabled and Older Persons and Sustainable Urban Mobility, Thematic Study Prepared for Global Report on Human Settlements*.
- Government of India. *Census of India*.
- Govt. of India. *THE SMART CITY CHALLENGE SMART CITY PROPOSAL: ROURKELA*.
- Govt. of India. *Road Accidents in India – 2018*.
- Handy, S. L., & Niemeier, D. A. (1997). Measuring Accessibility: An Exploration of Issues and Alternatives. *Environment and Planning A*, 29, 1175–1194

- Handy, S. L., & Kelly, J. C. (2001). Local Shopping as a Strategy for Reducing Automobile Travel. *Transportation*, 28, 317–346
- Iwarsson, S., & Ståhl, A. (2003). Design – Positioning and Definition of Concepts Describing Person-Environment Relationships Accessibility, Usability, and Universal Design. *Disability and Rehabilitation*, 25(2), 57–66. doi:10.1080/dre.25.2.57.66.
- James, K. S. (1994). Indian Elderly: Asset or Liability. *Economic & Political Weekly*, 29(36), 2335–2339
- Khulna, C. C. (2020). "About Khulna:Khulna City Corporation Website."
- Koenig, J. G. (1980). Indicators of Urban Accessibility. *Transportation*, 9, 145–172
- Koppen, G., Tveit, M. S., & Sang, O. Åsa, and Wenche Dramstad(2014). "The Challenge of Enhancing Accessibility to Recreational Landscapes." *Norwegian Journal of Geography* 68 (3): 145–154. doi:10.1080/00291951.2014.904399.
- Lavery, I., Davey, S., & Woodside, A. Ken Ewart(1990). "The Vital Role of Street Design and Management in Reducing Barriers to Older Peoples ' Mobility" 2046 (96).
- Lawton, M. P., Windley, P. G., & Byerts, T. O. (1982). *Aging and the Environment: Theoretical Approaches*. New York: NY: Springer
- Lawton, M. P. (1977). An Ecological Theory of Aging Applied to Elderly Housing. *Journal of Architectural Education*. doi:10.1080/10464883.1977.11102585.
- Leather, J., Fabian, H., Gota, S., & Mejia, A. (2011). *Walkability and Pedestrian Facilities in Asian Cities State and Issues Walkability and Pedestrian Facilities in Asian Cities*.
- Li, Y., & Hsu, J. A., Geoff Fernie. (2012). Aging and the Use of Pedestrian Facilities in Winter – The Need for Improved Design and Better Technology. *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 90(4), 602–617. doi:10.1007/s11524-012-9779-2.
- Mollenkopf, H., Marcellini, F., Ruoppila, I., Szeman, Z., & Tacken, M., Hans-Werner Wahl. (2004). Social and Behavioural Science Perspectives on Out-of-Home Mobility in Later Life: Findings from the European Project MOBILATE. *European Journal of Ageing*, 1, 45–53. doi:10.1007/s10433-004-0004-3.
- Nordbakke, S., Schwanen, T., Nordbakke, S., & Schwanen, T. I. M. (2014). "Well-Being and Mobility: A Theoretical Framework and Literature Review Focusing on Older People Well-Being and Mobility : A Theoretical Framework and Literature Review Focusing on Older People" 0101. doi:10.1080/17450101.2013.784542.

- Owen, N., Leslie, E., Salmon, J., & Fotheringham, M. J. (2000). "Environmental Determinants of Physical Activity and Sedentary Behavior." *Exercises and Sport Sciences Reviews*.
- Pal, R., Ghosh, A., Kumar, R., Galwankar, S., Paul, S. K., Pal, S., Sinha, D., et al. (2019). "AFPI Position Paper on Road Safety and Public Health Public Health Crisis of Road Traffic Accidents in India: Risk Factor Assessment and Recommendations on Prevention on the Behalf of the Academy of Family Physicians of India." doi:10.4103/jfmpc.jfmpc.
- Parida, D. (2014). "Planning for Integrated Development of Rourkela Town." Master of Urban and Rural Planning, Indian Institute of Technology Roorkee (Unpublished Thesis).
- Parida, D. Renjin Cherian(2017). "Mobility for the Elderly: A Qualitative Assessment of a Commercial Precinct in Bangalore." In *Challenges and Opportunities for Indian Cities*.
- Patil, D. R., & Mamatha, P. R. (2013). "Accessibility to Bus-Stops for Senior Citizens in Urban Neighbourhoods; An Overview of Best Practices." In *Urban Mobility India Conference & Expo 2013*.
- Prakash, I. J. (2003). Aging, Disability, and Disabled Older People in India. *Journal of Aging and Social Policy*, 15(2-3), 85-108. doi:10.1300/J031v15n02.
- Priya, G., & Lakshmi (2008). Condition of Disabled Elderly in India. *Helpage India-Research & Development Journal*, 14(2), 27-33
- Rahaman, K. R., Ahmed, S. J., & Islam, M. S. (2009). Measuring Space-Time Accessibility to Urban Opportunities: A Study on Demand for and Supply of Activities Performed by University Teachers and Students of Khulna City. *International Journal of Sustainable Development and Planning*, 4(1), doi:10.2495/SDP-V4-N1-70-83.
- Rahaman, K. R., Dhar, T. K., Maruf Hossain, M. S., & Khan, S. (2009). "A Comprehensive Approach to Model Pedestrians Safety in Dhaka City, Bangladesh." *European Journal of Social Sciences* 12 (2).
- Rahaman, K., Rubayet, J. Ã. M., Lourenço, & José Manuel, V. (2012). "Perceptions of Pedestrians and Shopkeepers in European Medium-Sized Cities: Study of Guimarães, Portugal" 138 (March):26-34. doi:10.1061/(ASCE)UP.1943-5444.0000094.
- Rahman, M., Ali, S. A., & Quazi Sazzad Hossain (2015). "Analysis of Travel Behavior in Khulna Metropolitan City, Bangladesh." *Civil and Environmental Research* 7 (2).
- Rahman, M., Nobuaki Ohmori. (2014). Barrier-Free Design and Introducing Accessible Environment in Pedestrian and Public Transportation for Dhaka City, Bangladesh. *Journal of Modern Science and Technology*, 2(2), 19-35
- Rath, P. (2016). "Profile of Elderly Population in India: Evidences from. *Indian Censuses*", 3(1), 13-19

- Rosso, A. L., Wisdom, J. P., Horner-Johnson, W., & McGee, M. G., Yvonne L. Michael. (2011). Aging with a Disability: A Systematic Review of Cardiovascular Disease and Osteoporosis among Women Aging with a Physical Disability. *Maturitas*, 68(1), 65–72. doi:10.1016/j.maturitas.2010.10.004.
- Rosso, A. L., Wisdom, J. P., Horner-johnson, W., Mcgee, M. G., & Yvonne, L. M. (2016). "HHS Public Access", 68(1), 65–72. doi:10.1016/j.maturitas.2010.10.004.Aging.
- Roy, S. (2007). "Urban Space, National Time and Post Colonial Difference: The Steel Towns of India." In *Urban Imageries: Locating the Modern City*, edited by Alev T. Çınar and Bender. Minneapolis: University of Minnesota Press.
- Sallis, J. F., Melbourne, F., Hovell, C. R., Hofstetter, P., Faucher, J. P., Elder, J. ... Christenson, G. M. (1989). A Multivariate Study of Determinants of Vigorous Exercise in a Community Sample. *Preventive Medicine*, 18, 20–34
- Shaheen, M., & Puri, S., Nikhil Tandon. (2016). Physical Activity Measurement in Elderly: The Indian Scenario Physical. *Journal of Physical Activity Research*, 1(1), 9–14. doi:10.12691/jpar-1-1-3.
- Sharmeen, J., Abontika Sara Israt. (2013). MOBILITY AND ACCESSIBILITY PROBLEMS AROUND SCHOOLS IN DHAKA (BANGLADESH): A CASE STUDY. *International Journal of Civil Engineering*, 2(2), 1–8
- Siddiqua, F., Mania Tahsina Taher. (2017). Assessing Walkability of Planned and Historical Streetscape of Urban Dhaka. *AIUB Journal of Science and Engineering*, 16(1), 19–28
- Smith, G. C., & Gina, M. S. (2001). Determinants of the Travel Behavior of the Suburban Elderly. *Growth and Change*, 32, 395–412
- Smith, J. P. Malay Majmundar(2012). *Aging in Asia*.
- Southworth, M. (2005). "Designing the Walkable City" 131 (December): 246–257. doi:10.1061/(ASCE)0733-9488(2005)131.
- Stahl, A. (1987). "Changing Mobility Patterns and the Aging Population in Sweden,"37–41.
- Stahl, A., Carlsson, G., & Hovbrandt, P., Susanne Iwarsson. (2008). "" Let " s Go for a Walk !": Identification and Prioritisation of Accessibility and Safety Measures Involving Elderly People in a Residential Area. *European Journal of Ageing*, 5, 265–273. doi:10.1007/s10433-008-0091-7.
- Stoker, P., Garfinkel-castro, A., Khayesi, M., Odero, W., Mwangi, M. N., & Peden, M., Reid Ewing. (2015). Pedestrian Safety and the Built Environment: A Review of the Risk Factors. *Journal of Planning Literature*, 30(4), 377–392. doi:10.1177/0885412215595438.

Strohmeier, F. (2016). "Barriers and Their Influence on the Mobility Behavior of Elder Pedestrians in Urban Areas: Challenges and Best Practice for Walkability in the City of Vienna." In *6th Transport Research Arena April 18–21, 2016*, 14:1134–1143. Elsevier B.V. doi:10.1016/j.trpro.2016.05.184.

Sugiyama, T., Catharine Ward Thompson. (2007). Outdoor Environments, Activity and the Well-Being of Older People. *Conceptualising Environmental Support*, 39, 1943–1961. doi:10.1068/a38226.

Tight, M. R., Kelly, C., Hodgson, F. C., & Page, M. (2004). "Improving Pedestrian Accessibility and Quality of Life." In *10th World Conference on Transport Research, Istanbul, 4th-8th July 2004*.

UNFPA. *The Status of Elderly in Odisha, 2011*.

Wang, Y., Chau, C. K., Ng, W. Y., & Leung, T. M. (2016). A Review on the Effects of Physical Built Environment Attributes on Enhancing Walking and Cycling Activity Levels within Residential Neighborhoods. *Cities*, 50, 1–15. doi:10.1016/j.cities.2015.08.004.

Watson, V. (2009). "Seeing from the South: Refocusing Urban Planning on the Globe 's Central Urban Issues" 46 (October):2259–2275. doi:10.1177/0042098009342598.

Wee, B., Karst Geurs. (2011). Discussing Equity and Social Exclusion in Accessibility Evaluations. *Journal of Emerging Technologies and Innovative Research*, 4(11), 350–367

Wennberg, H. (2009). "Walking in Old Age: A Year-Round Perspective on Accessibility in the Outdoor Environment and Effects of Measures Taken." Lund University

Figures

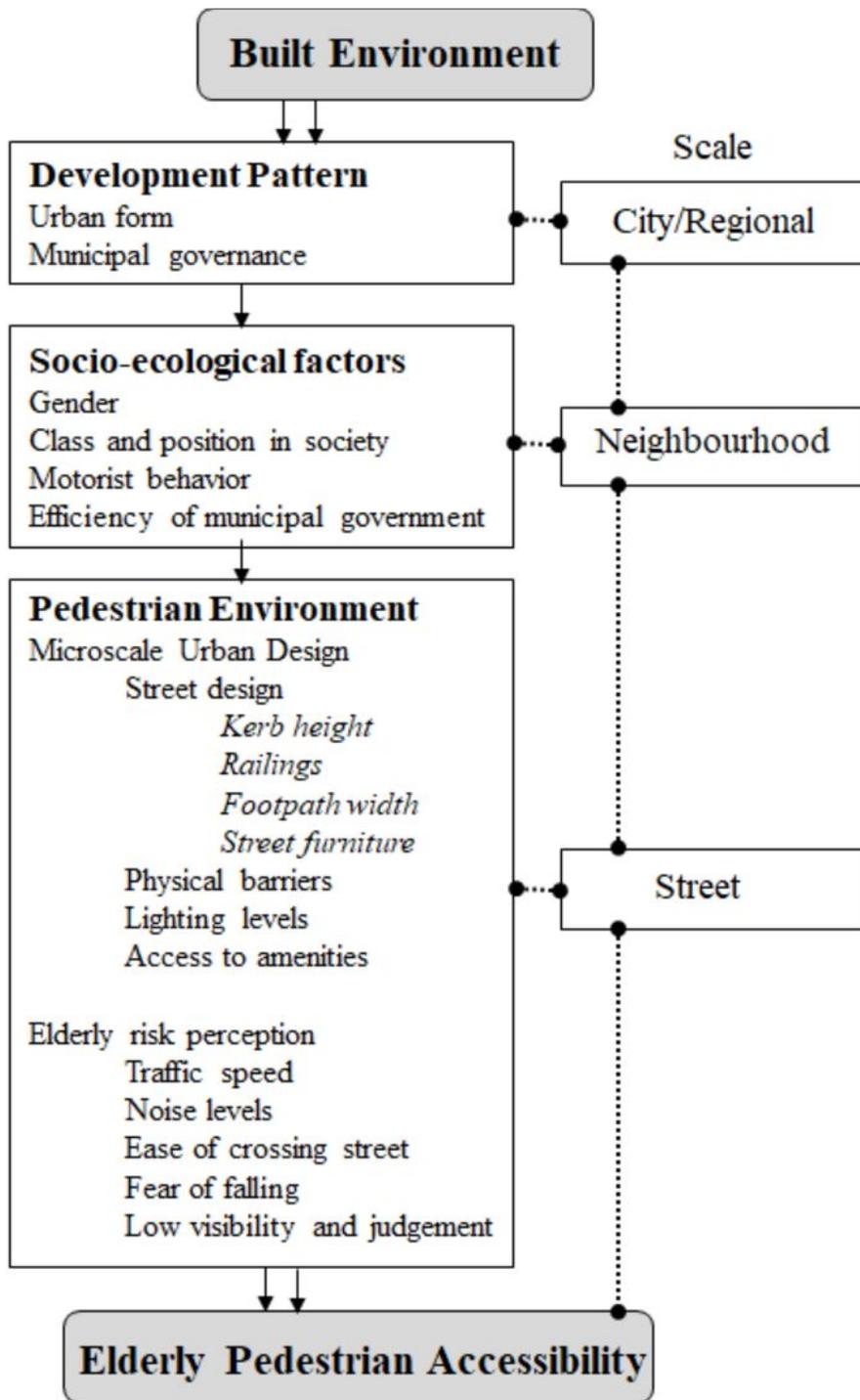


Figure 1 Explaining the concept of elderly pedestrian accessibility need in the built environment at different scales.

Figure 1

Explaining the concept of elderly pedestrian accessibility need in the built environment at different scales.

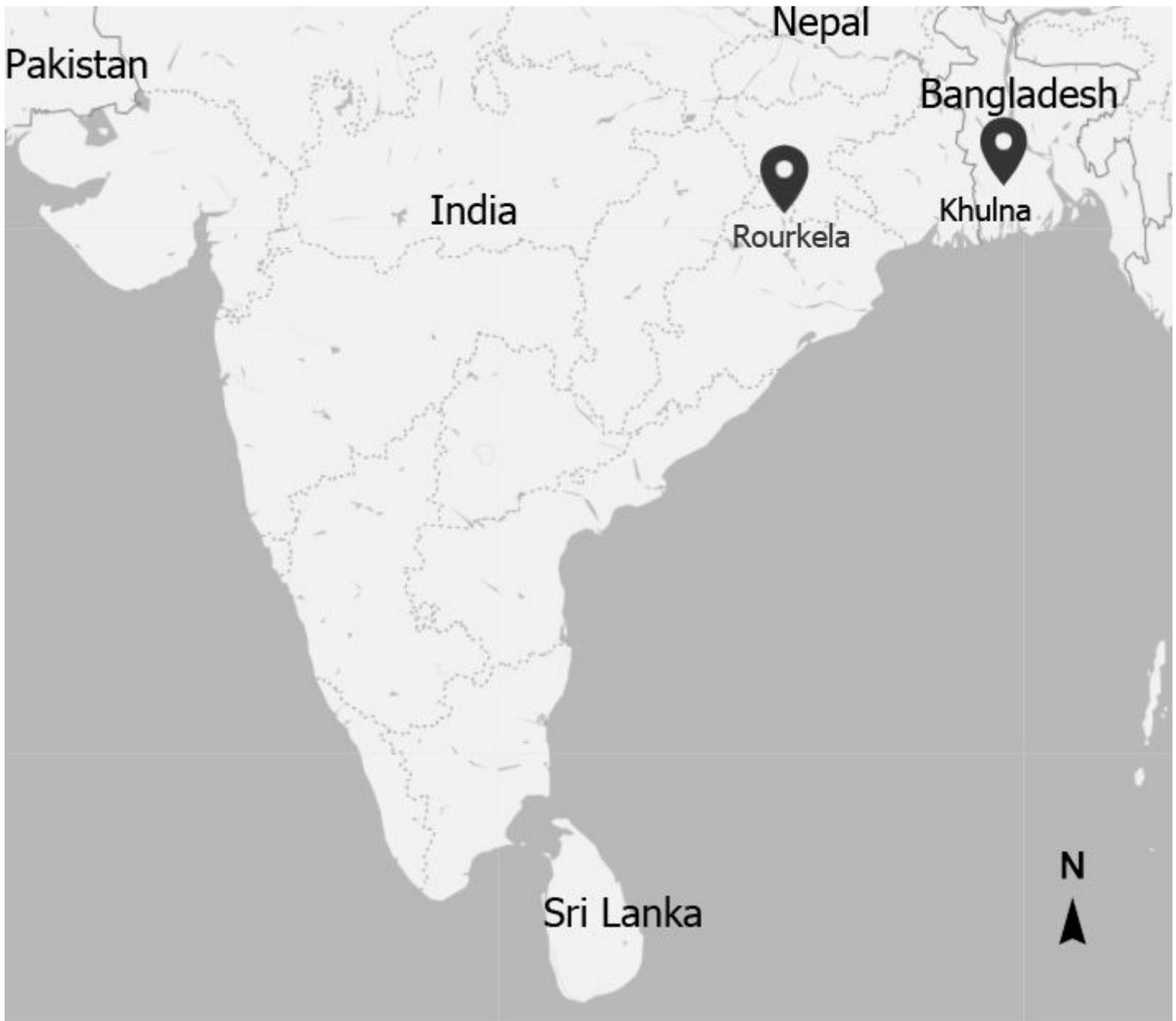


Figure 2

Locations of the study areas.

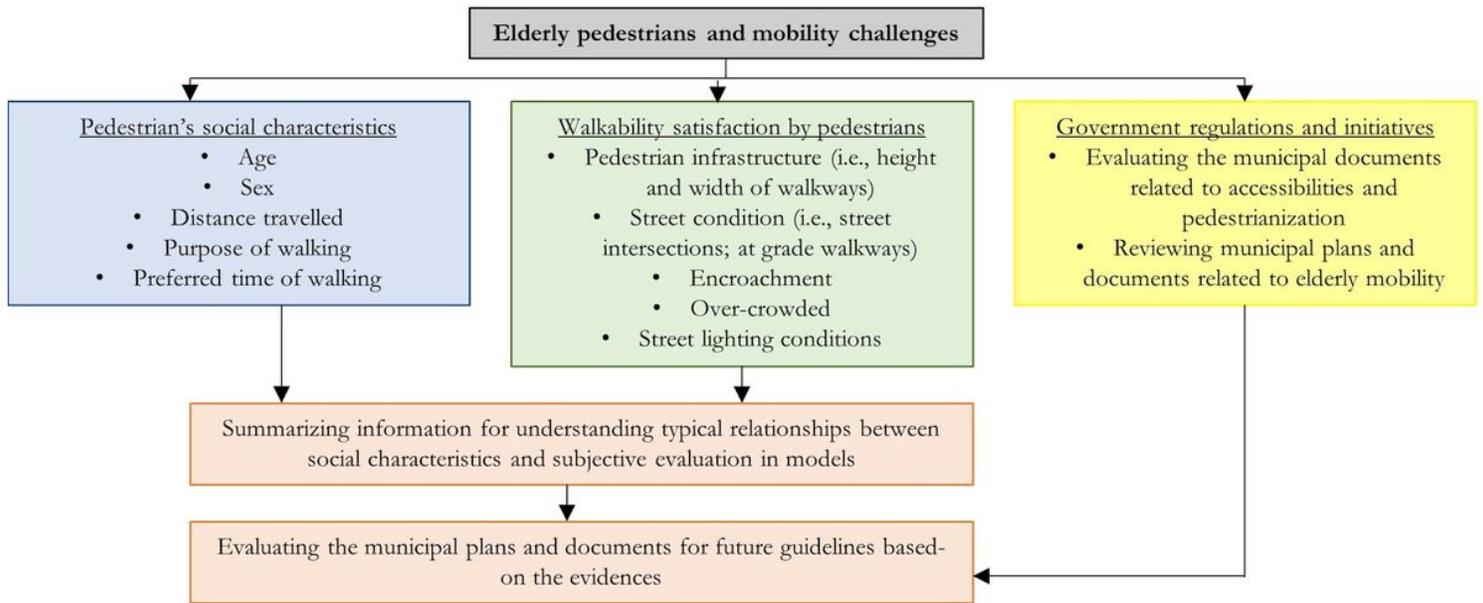


Figure 3

Brief schematic diagram of the methods adopted in this study.

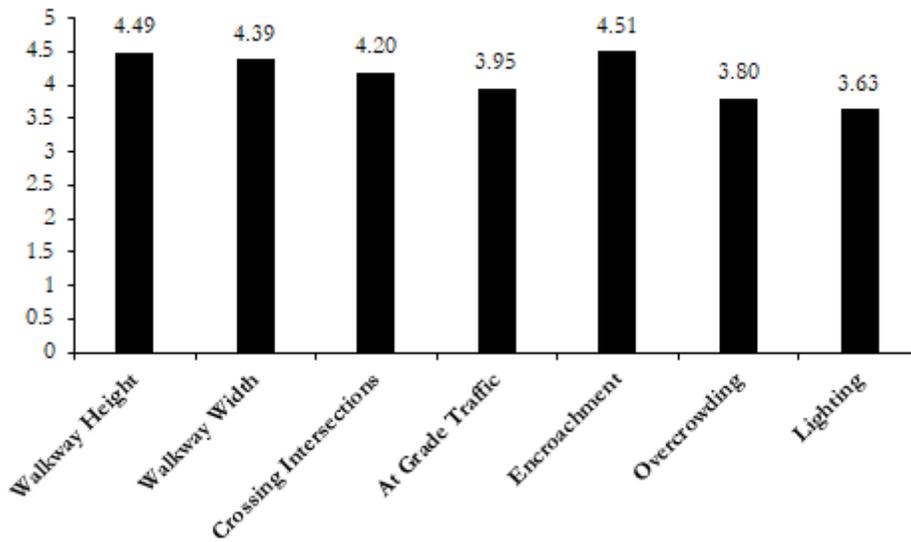


Figure 4

Overall subjective evaluation of different criteria assessed in the study areas.

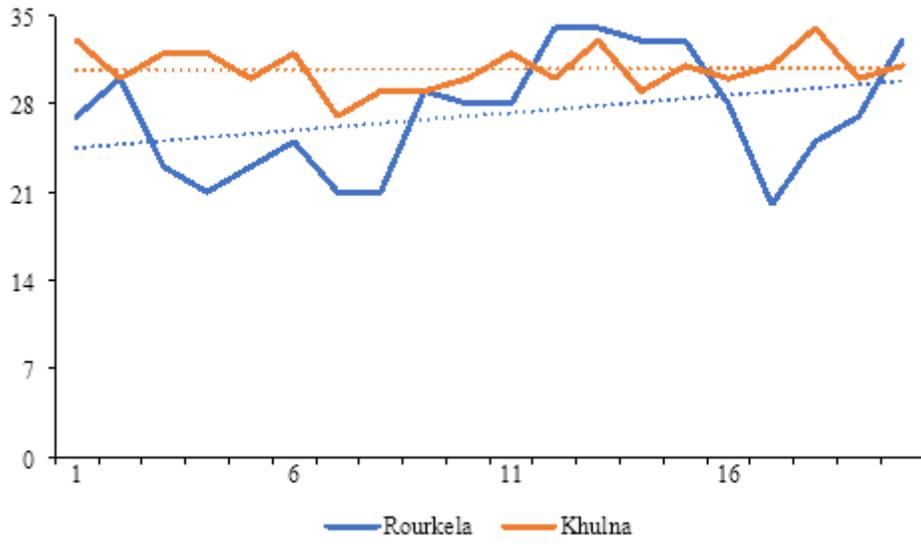


Figure 5

Overall accessibility rating of pedestrian facilities in Rourkela and Khulna city.