

Critical review

Understanding the barriers affecting women's mobility in the first- and last-mile stretches in low- and middle-income countries: A systematic review

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ABSTRACT

Globally, women encounter physical and social barriers that challenge their mobility. This review explores the barriers affecting women's mobility, in the first- and last-mile stretches, in low- and middle-income countries and their consequences on accessibility, availability, affordability, and acceptability of public transport. This review includes 42 studies on mobility, accessibility, safety, travel patterns, and gendered transport, employing mixed, quantitative, and qualitative methods. The barriers observed in these studies are primarily related to 1) public transport, 2) non-motorized transport, 3) safety, 4) gendered norms, 5) urban form, and 6) policies. The most common concerns for women are the lack of adequate, reliable, inclusive, safe, and integrated public transport, poor pedestrian infrastructure, and unsafe environments. These, coupled with gendered norms, restrict mobility and access to essential services and opportunities for women, especially if traveling with children and luggage, as well as for older adults and persons with disabilities. This is one of the first reviews focusing on barriers affecting women's mobility. It advocates for more contextualized evidence-based studies on first- and last-mile connectivity from more geographic locations, integrated feeder and main transport lines, and operationalizing and monitoring policies and regulations.

1. Introduction

The first and last miles, the beginning and end of a transit trip, are crucial segments of a trip that can restrict or facilitate access to public transport, influencing access to basic services and economic and social opportunities. The first and last miles connect the origin and destination of a trip to the main transit line (Borker, 2022; Kanuri et al., 2019; Kumar and Khani, 2021). Yet, the first and last miles are often most neglected, resulting in commuters encountering and negotiating several barriers while accessing public transport, particularly in low- and middle-income countries (LMICs) (Chant, 2013; CiSTUP, 2017; SPACE10, 2018).

The problem of the first and last miles in LMICs differs from that in developed countries due to their rapid urbanization and high density of development (Borker, 2022; Jedwab et al., 2021; Thondoo et al.,

2020b). Rapid urbanization has been overwhelming the infrastructure, including transport, making the transport system inefficient and unsafe in LMICs (GTZ, 2010). Meeting the mobility needs of a growing population is more challenging in LMICs as they are socioeconomically more diverse, thus increasing contextual complexities and the importance of intermediate public transport (IPT) (Thondoo et al., 2020a). Non-motorized transport (NMT) and IPTs dominate urban mobility in LMICs due to the lack of adequate and appropriate public transport infrastructure and facilities (Falchetta et al., 2021; Mogaji and Nguyen, 2021; UN-Habitat, 2013). While developed countries have a higher share of formal public transport, LMICs rely heavily on informal transport or IPTs. Often, IPTs are the only transport service available or the only service that can negotiate the narrow streets in the densely built areas of LMICs. Besides, intermodal facilities are almost non-existent in LMICs, which makes first- and last-mile connectivity weaker

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(UN-Habitat, 2013). Public transport in LMICs is poorly integrated with other modes of transport, which, coupled with the lack of a systematic feeder system and appropriate pedestrian and bicycling infrastructure, makes the first and last-mile connectivity problem more acute and has time and cost implications besides decreasing transit ridership (Hussin et al., 2021; Kanuri et al., 2019; Rahman et al., 2022; Zuo et al., 2020).

Across contexts, women prefer integrated service to avoid waiting during transfers and longer travel times particularly when undertaking care trips (Allen, 2018; Borker, 2022; Dominguez Gonzalez et al., 2020; Hussin et al., 2021). Time-consuming trips are arduous as women have multiple time-bound tasks to complete (Jobses et al., 2017; Shaheen et al., 2017). Shah and Raman (2019) find in their study of 11 selected cities in India that even though more than 80 % of women lived within a 15-min walk from a public transport stop, a distance that can be traversed by walking or cycling, only 47 % walk or cycle. Inadequate first- and last-mile connectivity increases vulnerability, especially for older adults and low-income people, so much so that the latter prefer to save up for a taxi in Chile (Herrmann-Lunecke et al., 2020). In a study of six Sub-Saharan African cities, Olvera et al. find that most still walk to complete their first- and last-mile stretches despite transit stops being 2–3 km away, and negotiating such hostile environments makes their walking trips long, arduous, and sometimes dangerous (Olvera et al., 2013). Women constitute the largest share of public transport users in LMICs, yet numerous barriers: lack of safety, poor access to transit stops, and unreliable last-mile connectivity, to name a few, limit their mobility (Adlakha and Parra, 2020).

Existing literature acknowledges that equitable mobility is necessary to ensure economic and social inclusion and create inclusive communities and cities (Kett et al., 2020; Ng and Acker, 2018; Ollier, 2018). However, current approaches and interventions focus more on the efficiency of urban transport than on equitable mobility. Current literature reviews, too, focus primarily on new mobility services (Golbabaei et al., 2020; Kamargianni et al., 2016; Oeschger et al., 2020; Silva et al., 2016; Utriainen and Pöllänen, 2018), sustainable public transport systems (Javaid et al., 2020; Lopez-Arboleda et al., 2019; Nikulina et al., 2019; Rathour et al., 2018; Wittstock and Teuteberg, 2018), active transport (Aldred et al., 2017; Chillón et al., 2011; Larouche et al., 2014; Mueller et al., 2015; Scheepers et al., 2014), mobility devices (Unsworth et al., 2019), gender differences in walking practices (Pollard and Wagnild, 2017), older adults' mobility (Haustein and Siren, 2015), not specifically on women's mobility barriers, particularly in the first- and last-mile stretches in low- and middle-income countries (LMICs). Kett et al. (2020) note the need for research in LMICs and the paucity of current research in this area. There is a gap and a need to review the existing literature concerning women's mobility and barriers faced, particularly those in the crucial first- and last-mile stretches. This review, therefore, explores the barriers that affect women's mobility, particularly in the first- and last-mile stretches in LMICs. The key research question is 'What are the barriers affecting women's mobility, particularly in the first- and last-mile stretches, in LMICs?'

2. Methods

Following Van Wee and Banister (2016), we identified the research gap as noted in Section 1 and conducted the search as mentioned in the following subsections where the search strategy, criteria, and process are explicitly mentioned. We also included a table of the studies included in this study with details on their publication, study focus, study location, study methods, and barriers discussed in their articles, books, or reports. A descriptive analysis of the included studies was also done. For content analysis, we followed Carruthers et al. (2005) framework as they highlight the significance of users' perspectives on the availability, accessibility, affordability, and acceptability of public transport for understanding mobility. In this framework, "availability" refers to route possibilities, timings, and frequency; "accessibility" refers to the ease with which one can use public transport; "affordability"

refers to the ability to undertake transport movements without significantly inhibiting other important activities and "acceptability" refers to if the transport is acceptable either because of the transport quality or the benchmark of the commuter. Furthermore, following De Vos and El-Geneidy (2022), we developed a conceptual framework that depicts the linkages between the barriers and the direct and long-term consequences, as seen in Fig. 2. We also summarized the key empirical insights, critical research gaps, and recommendations in section 4 and section 5.

2.1. Search strategy

The literature search was conducted in April and June 2021 in six electronic databases, namely Scopus, SpringerLink, ScienceDirect, Web of Science, IEEE Xplore, and Transport Research International Documentation (TRID), to ensure the capturing of relevant literature. The literature search was also conducted on other sources, namely Google, Google Scholar, Research Gate, UITP (The International Association of Public Transport), ITDP (Institute for Transportation & Development Policy), and WRI (World Resources Institute). As the number of hits was very high on Google, the search was limited to the first 500 hits. Publications between 1991 and 2021 were searched. The following search terms were used for the PEO (Population – Exposure – Outcome) framework:

(Women OR older women OR differently-abled women OR working women OR poor women OR gender) AND (Urban transport OR transportation OR transport infrastructure OR road OR street OR street connectivity OR first-mile OR last-mile OR intermodal OR multimodal OR transport mode OR modal choice OR public transport OR rapid transit OR light rail OR bus OR metro OR tram OR non-motorized transport OR active transport OR cycle OR bicycle OR walk OR intermediate public transport OR paratransit OR shared transport OR shared mobility OR ola OR uber OR tuk-tuk OR rickshaw OR auto-rickshaw OR cycle-rickshaw OR walking OR cycling OR commuting OR transit stop OR bus stop OR bus terminus OR transit station OR metro station OR sidewalk OR footpath OR walkway OR footbridge OR over bridge OR overpass OR underpass OR subway OR walkability OR street lighting OR lighting OR CCTV) AND (Equitable mobility OR transport mobility OR women's mobility OR mobility barriers OR safety) AND (low-income countries OR middle-income countries OR LMICs).

IPTs or paratransit, unlike public transport, do not have fixed routes and schedules, are comparatively more flexible, and can provide door-to-door services. They serve as dominant modes in smaller cities and feeder modes in larger cities to supplement or complement public transport services (Kar et al., 2022; Kunhikrishnan and Srinivasan, 2018; Vuchic, 2007). Also, it is important to note at this point the use of both 'women' and 'gender' as search terms, which implies the inclusion of studies that focus on sex-disaggregated data (sex defined as fixed, biological, and universal male/female difference), as well as on gender (the social construction of dynamic differences) where the latter is context-specific and allows for a more in-depth gendered analysis of gender and everyday mobility (Hanson, 2010).

2.2. Search criteria

The inclusion criteria used during the screening of literature are as follows:

1. Women, 18 years and above, abled and differently-abled, from across socioeconomic groups in LMICs (Population)
2. Barriers to availability, accessibility, affordability, and acceptability of public transport (Exposure)
3. Women's mobility (Outcome)
4. All types of study design in an urban context

5. Documents only in English
6. Publications where the studies are not aligned with the research question are excluded from the review.

2.3. Selection process

The PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) flow chart shown in Fig. 1 summarizes the screening process. First, the search was conducted using the search strategy. Next, duplicate studies were eliminated, following which the titles and abstracts of the documents were screened for relevance based on the inclusion and exclusion criteria. Rayyan software was used to identify duplicates and to screen titles and abstracts. The full texts were, after that, reviewed for screening. At both stages, studies meeting the selection criteria were noted as ‘included’, and studies not meeting the selection criteria were noted as ‘excluded.’ The reason/s for exclusion were recorded. Following two rounds of review, a total of 42 studies were included. Two reviewers reviewed the screening to ensure consistency.

2.4. Data extraction and synthesis

During the full-text review, key data extracted were title, author/s, year of publication, country/location of study, study domain, study objectives, study design, methods, and results related to the research question. The extracted data were entered in a data extraction sheet. If any of these data was unavailable, it was noted as ‘not available’ in the data extraction sheet. A pilot was conducted for ten randomly selected studies, and the data extraction sheet was updated accordingly. The results were textually and numerically summarized in a table based on the search criteria outlined for this study (deductive) and based on the terms extracted from the searches relevant to this study (inductive). Wherever applicable, the results were examined in terms of ‘who’ ‘what’, ‘how’, ‘whom’, and ‘when’.

3. Results

3.1. Descriptive analysis

As we see in Table 1, the studies included in this review are from more than 20 LMICs in Asia, Africa, South America, and North America. The studies are primarily from Pakistan (n = 7) and India (n = 4), followed by Chile (n = 3), Colombia (n = 3), and Mexico (n = 3). Studies from other LMICs are limited. As we see in Annexure, the studies range between 2013 and 2024, mostly from 2020 (n = 16) and 2019 (n = 10), and the remaining spread over other years. The studies are from 20 journals and 11 books and reports. The journals are from geography, planning and development; engineering; cultural; health; psychology; demography; law; and sociology and political science. Journal of Transport & Health, and Journal of Transport Geography contributed the most, with five articles each. The included studies focus on mobility, accessibility, safety, travel patterns, and gendered transport. Thirteen studies employed mixed methods, 11 quantitative methods, and 10 qualitative methods. Quantitative methods include questionnaires (on-street and online surveys), secondary data, and audits. Qualitative methods include semi-structured interviews, in-depth interviews, face-to-face interviews, telephone interviews, focus-group discussions, ethnographic methods, photo voice, collaborative workshops, participatory observation, field observation, mapping, community mapping, and go-along.

Of the studies included in this review, nine articles and reports mention first- and last-mile connectivity. Though the remaining articles and reports do not specifically mention the terms first- and last-miles, they discuss women’s mobility, such as walking and availing of buses and IPTs to reach public transport stops in the first- and last-mile stretches. They discuss the barriers women including older women and those with disabilities, encounter due to the lack of public transport infrastructure, intermodal facilities, and pedestrian infrastructure, requiring them to either walk long distances to access public transport while negotiating poor and unsafe walking conditions or increase reliability on IPTs and NMTs. The studies also capture the gendered norms, user experiences, and corporeal and emotional consequences while accessing, boarding, and alighting, or using public transport. Thus, these discussions add to understanding women’s mobility barriers in the first- and last-mile stretches. Including studies that only explicitly mention first- and last-mile would have excluded pertinent studies concerning

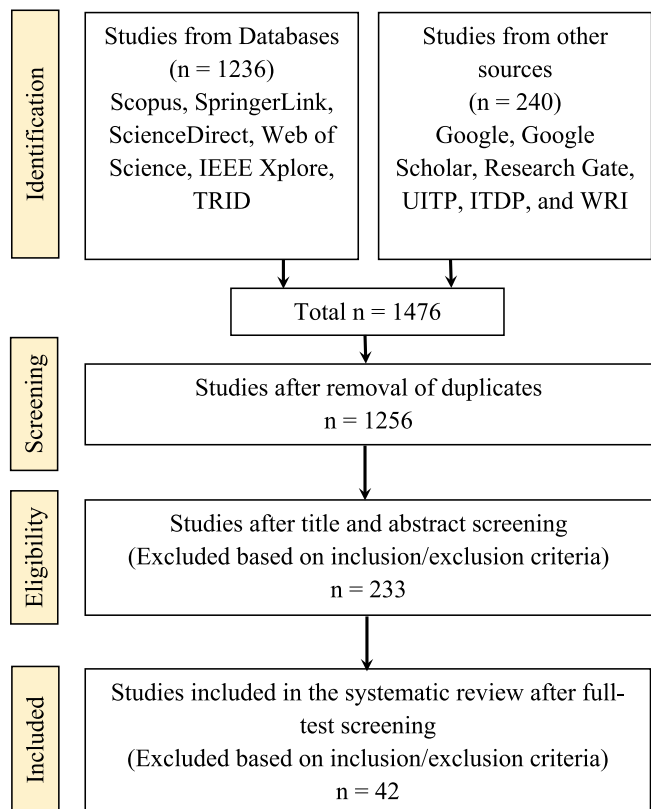


Fig. 1. PRISMA flow chart.

Table 1
Included studies by geographical location.

Continent (studies included)	Country (studies included)
Asia (18)	Pakistan (7) India (4) Bangladesh (2) Indonesia (1) Iran (1) Israel (1) Malaysia (1) Sri Lanka (1)
South America (10)	Chile (3) Colombia (3) Argentina (1) Brazil (1) Paraguay (1) Peru (1)
Africa (6)	Kenya (2) Ghana (1) Morocco (1) Nigeria (1) South Africa (1)
North America (3) LMICs (3) Developed + developing countries (2)	Mexico (3) More than one country (3) More than one country (2)

Source: Authors.

the research question and limited the findings of this review.

3.2. Content analysis

From content analysis, women’s barriers to mobility in LMICs – particularly in the first- and last-mile stretches – were inductively found to be primarily associated with public transport, NMTs, safety, gendered norms, urban form, and policies. Most studies note public transport and safety as the major barriers followed by NMTs (mostly walking) and gendered norms. Fewer studies touch upon urban forms and policies influencing women’s mobility. As we see in Fig. 2, these barriers have both direct and long-term consequences that influence women’s mobility and well-being as well.

In this section, following Carruthers et al. (2005), this review elaborates on the consequences of these barriers from users’ perspectives on the availability, accessibility, affordability, and acceptability of public transport. In the next section, following De Vos and El-Geneidy (2022), this review provides key empirical insights and gaps, as summarized in Table 2, and areas for further research. It also highlights a few key policy recommendations put forth by the studies.

3.2.1. Public transport

This review finds that the lack of adequate and reliable public transport services, coverage, connectivity, intermodal facilities, and response to gendered needs pose serious barriers to women’s mobility in the first- and last-mile stretches in LMICs. They limit modal choice, increase travel time and costs, impact travel behavior, cause discomfort and inconvenience, restrict accessibility and mobility, result in exclusion, and debilitate self-confidence and efficiency.

Studies in many LMICs find that buses are perceived as a slow mode

lacking frequency, adequate services, bus stops, transfers, and comfort besides being overcrowded, unsafe, and inconvenient. In Sub-Saharan Africa, public transport services only on the major paved roads result in walking or paying up to 20 % of the household income. While most residents, especially those further from the major paved roads, depend on walking, the dependence is higher among women, children, and the young (Olvera et al., 2013). Women, pregnant women, and persons with disabilities (PWDs) often decide to quit jobs or change workplaces, as studies in Bangladesh and Latin America show, because of the lack of coverage, low bus frequency, poor or absent pedestrian infrastructure, and unsafe conditions both near work and home (Dominguez Gonzalez et al., 2020; Munira and San Santoso, 2017). In Israel and Morocco, public transport has a short operating time, and trams and taxis are unavailable at night. In Morocco, although taxis are preferred to save time and have a certain level of comfort and safety, the taxis do not follow the rules, pick up multiple passengers, and even refuse to go (Kerzhner et al., 2018; Saadaoui, 2019). Metro stations in India lack parking spaces and feeder bus services that hinder first- and last-mile connectivity. Women prefer shared auto services but lack service in certain parts of the city. Some rely on private motorized vehicles or taxis to reach the nearest transit station (B.PAC, 2020).

In Iran and Pakistan, most women avoid public transport due to overcrowding, harassment, lack of route coverage, and cleanliness, and prefer to pay up to five times more for door-to-door services (Iqbal et al., 2020; Lak et al., 2020). In Kenya, women in the workforce use overloaded matatus (privately owned public transport minibuses) even at the expense of safety and convenience, as they must stay in the workforce to contribute to their household income. Matatu drivers have abysmal safety records. If the women travel with children or luggage, even if they walk to the nearest transit stop negotiating unsafe conditions, they must

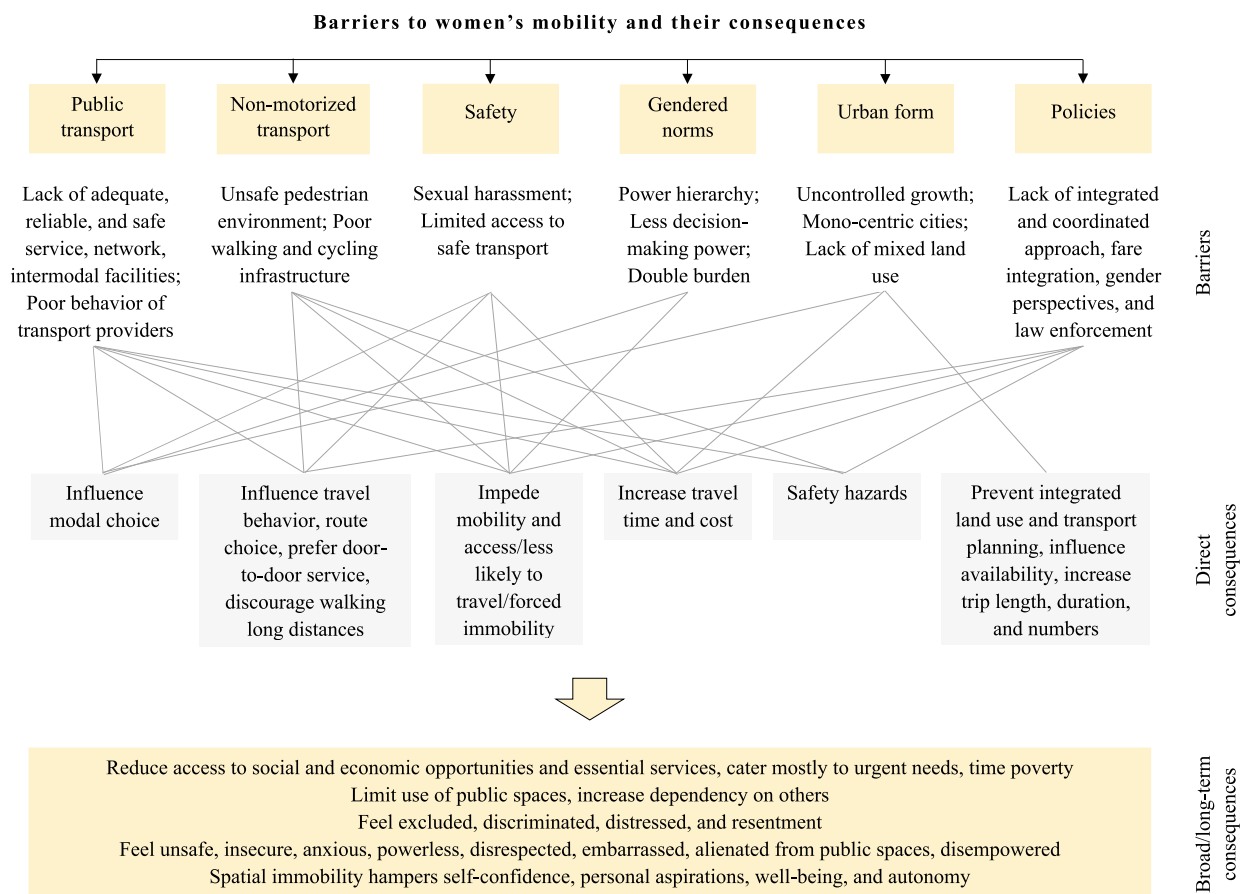


Fig. 2. Barriers to women’s mobility particularly in the first- and last-mile stretches and their consequences.

Table 2

A summary showing key empirical insights.

Factors	Barriers	Consequences for women's mobility			
		Availability	Accessibility	Affordability	Acceptability
Public transport, Intermediate public transport	Lack of adequate, reliable, inclusive, safe transport infrastructure and facilities Lack of intermodal connectivity Lack of inclusive vehicles Lack of road safety High transport cost Abusive behavior of service provider	Avoid public transport Limits modal choice and access to essential services Increase travel time Compelled to use door-to-door services to save time	Impede mobility and access to essential services Increase travel time Risk of injury	Make trips expensive Affect employment opportunities	Cause discomfort, inconvenience, insecurity, powerlessness, and distress Increase dependency on others Restricts participation in society Feel unsafe, fear of accidents
Non-motorized transport	Lack of adequate, inclusive, safe pedestrian infrastructure, environment	Option for overcrowded public transport	Restrict mobility and access Lack of road safety		Reduce comfort and safety. Limit the use of public spaces
Safety	Sexual harassment, abuse, violence, unsafety	Deterred from walking Influence modal choice. Increase car dependency	Hamper access to essential services; fulfill only urgent needs Seek a company Influence route choice	Make trips expensive	Feel insecure, anxious, distressed Take measures to counter harassment Internalize harassment
Gendered norms	Deep-rooted socio-cultural norms Double burden	Influence modal choice Discourage cycling	Forced immobility, avoid long trips	Make trips expensive	Influence reputation and respect Less decision-making power, exclusion Frustration, stress Time poverty
Urban form	Unplanned growth, fragmentation Lack of mixed land uses	Influence availability Influence modal choice	Influence accessibility Increase trip length and duration Poor access to opportunities	Influence affordability Make trips expensive Forced to buy a car to reduce travel time	
Policies	Lack of gender perspective and policies Lack of integrated land use and housing policies Lack of coordination and fare integration Violation of traffic rules, lack of law enforcement	Choose modes with affordable fares	Limits mobility, access, participation	High transport costs. Prioritize mobility needs	Discrimination Feel embarrassed, exhausted, insecure, and powerless Fear of injury Increasing gap between population groups

Source: Authors.

wait for a matatu that *accepts* them. Boda-bodas (motorcycle taxis) are an option, but they are limited in specific routes and inconvenient while traveling with children and luggage. Despite significant challenges, matatus and boda-bodas are the most workable options for women in Kenya (Kishiue et al., 2020; Salon and Gulyani, 2010). Poor behavior of auto-rickshaws in India (Munshi et al., 2018), qingqis (six-seater motorcycle-type three-wheelers), and minibuses in Pakistan (Ahmad et al., 2019) are also reported as significant barriers to women's mobility.

Articles that focus on the mobility of PWDs observe that people consider PWDs as a stigma, are disrespectful towards them, and are less inclined to accommodate their needs causing PWDs to feel insecure, powerless, and anxious. The lack of dignity and understanding instills in them a sense of losing their place on the streets, causing psychological barriers and resentment towards society (Bombom and Abdullahi, 2016; Tennakoon et al., 2020). In Bangladesh, PWDs are perceived as 'others' and are prevented from using taxis and auto-rickshaws due to their disability. Despite the unwillingness of the auto-rickshaws to provide PWDs with services, they do not have an option but to avail of them as buses mostly deny them access, restricting their mobility and forcing them to be at home more often than not. Some even prefer to 'walk' than use public transport (Nahar, 2019). In Ghana, PWDs are even compelled to crawl or be carried inside buses and trotros (minibuses) which are not designed for the dignified mobility of the PWDs (Naami, 2019). The culture of exclusion and isolation of the PWDs is evident in Nigeria as well. There is reluctance, even deliberate withholding of help (Bombom and Abdullahi, 2016). Such barriers prompt PWDs in Chile, India, Palestine, and Sri Lanka to choose private motorized vehicles and taxi services, which push transport costs up (Kerzhner et al., 2018; Munshi et al., 2018; Tennakoon et al., 2020; Tiznado-Aitken et al., 2020).

3.2.2. Non-motorized transport

Studies in this review that focus on walking suggest that unsafe pedestrian environments, poor walking and cycling infrastructure, lack of accessible, continuous, unobstructed, shaded, safe, and comfortable sidewalks and cycling tracks, lighting, covered drains, universal design, proper intersections, and pedestrian crossings, and high-speed vehicles are significant barriers in the first- and last-mile stretches, particularly for the older adults and the PWDs. They decrease walkability which in turn discourages walking longer distances, restricts mobility, limits the use of public spaces, increases preference for door-to-door services, makes trips expensive, and influences route choice.

A study on Palestinian women's mobility finds that the nearest bus stops are at a considerable distance for many. While for older women negotiating unpaved, unlit, and steep sidewalks is a challenge, for younger women, it is the perception of unsafety and familial and social unacceptance of women's mobility especially at night. These conditions are aggravated at the checkpoints in the city, where after hours of waiting, they are often forced to walk to their destinations causing a sense of alienation from public spaces (Kerzhner et al., 2018). In West and Central African cities, sometimes the nearest transit stop from home is 2–3 km away, requiring long walking distances (Olvera et al., 2013). Even in the City of Recife in Brazil, women in low-income communities walk at least a kilometer to access education and healthcare negotiating poor walking infrastructure and conditions (Maia et al., 2016). A study on older women's mobility in Iran elaborates on how distant and isolated locations of transit stops on hilltops without pedestrian infrastructure entail the ability to climb up and are physically demanding, especially for women with limited physical movement, resulting in using public transport less (Lak et al., 2020). Walking long distances to access public transport in Morocco is challenging for women, mainly because of

safety issues (Saadaoui, 2019).

In Dhaka, Bangladesh, and Latin American cities, obstructed sidewalks prompt women and PWDs to walk on the streets, making walking unsafe and creating traffic congestion (Nahar, 2019; Dominguez Gonzalez et al., 2020). Studies in Bangladesh and Ghana note that inaccessible sidewalks and bus stops result in falls and keep PWDs either away from the streets or make them dependent on others for accessing essential services (Naami, 2019; Nahar, 2019). For older adults, fear of falling and helplessness while walking and crossing roads, coupled with fatigue from travel, reduce their participation in society studies in Iran and Ghana note (Lak et al., 2020; Naami, 2019). The degree of walkability in low-income communities is lower than in other communities in Chile (Herrmann-Lunecke et al., 2020). The lack of shaded, continuous, and dedicated cycling tracks, coupled with street harassment, makes cycling an undesirable mode in Indian cities (Shah and Raman, 2019).

3.2.3. Safety

What strongly emerges from this review is that lack of safety is one of the critical barriers to women's mobility in the first- and last-mile stretches that have adverse direct and long-term consequences on women's mobility inflicting corporeal and emotional distress.

Women encounter sexual harassment while walking, waiting at bus stops, and traveling in buses and rickshaws, particularly during peak hours when overcrowded and at night whether from co-commuters or transport providers in Chile, Colombia, Kenya, Latin American cities, Morocco, Pakistan, and South Africa (Ahmad et al., 2019; Dominguez Gonzalez et al., 2020; Faiz et al., 2018; Iqbal et al., 2020; Jaitman, 2020; Jirón et al., 2020; Kishiue et al., 2020; Malik et al., 2020; Orozco-Fontalvo et al., 2019; Quinones, 2020; Saadaoui, 2019; Tiznado-Aitken et al., 2020; Vanderschuren et al., 2019). Studies in Chile, Malaysia, and Mexico also note how deserted and poorly lit streets add to the difficulty for women (Harumain et al., 2017; Herrmann-Lunecke et al., 2020; Jirón et al., 2020; Mejía-Dorantes, 2018). In the Latin American cities of Buenos Aires, Santiago, and Quito, safety is the key concern that determines women's travel behavior and mobility patterns, restricting their mobility spatially and temporally, especially for care trips, at times prompting them not to use the public transport unless accompanied by another adult (Allen et al., 2017). Limited access to safe transport prevents access to essential services and opportunities, thus affecting social and personal well-being. Studies in Colombia, Mexico, Pakistan, and Sri Lanka find that it puts women at risk and causes psychological, physical, and emotional distress, fear, exhaustion, insecurity, powerlessness, disrespect, embarrassment, and undesirable feeling while using public transport (Faiz et al., 2018; Hoor-Ul-Ain, 2020; Mejía-Dorantes and Villagrán, 2020; Montoya-Robledo et al., 2020; Orozco-Fontalvo et al., 2019; Tennakoon et al., 2020). In the case of Buenos Aires, Santiago, and Quito, fear of theft and robbery adds to women's concerns with unsafe public transport (Allen et al., 2017).

Women encounter verbal abuse, physical assault, including tearing of hijab, and disregard from co-commuters in Palestine (Kerzhner et al., 2018). In Pakistan, as well, women are unable to commute to their workplaces and back home in a respectful manner. They lack acceptability if not clad in traditional attire or veils. Moreover, male-dominated and overcrowded buses trigger the social exclusion of women (Iqbal et al., 2020; Hoor-Ul-Ain, 2020). The risk of harassment and stalking in Pakistan and Latin American cities triggers a sense of unsafety discouraging walking to transit stops and modifying travel patterns and behavior (Ahmad et al., 2019; Dominguez Gonzalez et al., 2020). In Mexico, the fear of harassment makes women feel that leaving their homes for work is putting their lives in danger (Picard, 2019). In Mexico City, pirata taxis (fake taxis or cars with false plates) are difficult to distinguish, causing insecurity and a sense of unsafety (Mejía-Dorantes, 2018).

Studies in Argentina, Chile, Colombia, India, Israel, Morocco, Pakistan, and Sub-Saharan Africa find that for women, unsafe streets are

battlegrounds throughout the day. They perceive cities to be hostile. They do not consider leaving home at night, steer clear of men on the streets, prefer to be in groups, avoid certain areas, and blend in to be as invisible as possible. The fear prompts them to avoid late or early hours, avoid modes, avoid traveling alone, avoid overcrowded spaces, change schedule routes and clothing, choose safer bus stops, and stay alert (Adlakha and Parra, 2020; Iqbal et al., 2020; Jirón et al., 2020; Kerzhner et al., 2018; Mark and Heinrichs, 2019; Masood, 2017; Olvera et al., 2013; Orozco-Fontalvo et al., 2019; Saadaoui, 2019; Shah and Raman, 2019; Quinones, 2020). Women in Israel, particularly at night, resort to taxis and private motorized vehicles to shield themselves from the hostile public transport environment (Kerzhner et al., 2018). In Lima and Asuncion in Latin America, to feel safe, most women avoid public transport and avail of microbus or remis (taxis or car services) even at a higher cost (Jaitman, 2020). Even low-income women in Chile prefer to save up for a taxi to avoid harassment (Herrmann-Lunecke et al., 2020). In Chile, women are often forced to use private motorized vehicles or Uber to reach metro stations or travel at night; in Karachi, Pakistan, women prefer Careem (similar to Uber) for safer journeys. Also, knowing that women are willing to pay more to avoid harassment associated with using buses, rickshaw drivers charge women up to five times more (Iqbal et al., 2020; Lak et al., 2020; Tiznado-Aitken et al., 2020). A literature review on gender and transport from developed and developing countries also notes that lack of safety costs women opportunities besides money and time (Sagaris et al., 2024).

3.2.4. Gendered norms

This review finds that gendered norms in male-dominated cultures pose significant barriers to women's mobility including the first- and last-mile stretches, curtailing freedom of movement, and imposing spatial, temporal, and monetary constraints. They influence modal choice and reduce mobility options, making women less likely to travel, resulting in exclusion.

Studies in Morocco and Pakistan find that power hierarchy and gendered norms are so deep-rooted that they restrict women's access to social and economic opportunities. The social and cultural contexts render women private and secluded whose mobility is controlled. Women following gendered norms are perceived as 'virtuous' or 'respectful.' Covering themselves from head to toe wearing traditional dresses or veils and not mingling with men when on public transport, lowering their gaze to avoid contact with men, dressing in a certain way, coming home early, and taking accompanied or approved trips are few gendered norms women must follow to be 'respectable' (Adeel et al., 2017; Iqbal et al., 2020; Saadaoui, 2019). Families even deny women the right to travel in Pakistan as the literature review on gender and transport suggests (Sagaris et al., 2024). In Palestine, women are advised by their families to avoid public transport due to safety concerns (Kerzhner et al., 2018). Families in Indonesia, too, restrict women's mobility at night (Song et al., 2019). In Colombia, nights are perceived as a time when women should not go alone (Quinones, 2020).

In Pakistan, women are excluded from cheaper modes of transport such as motorbikes and bicycles and are more likely to stay at home or make few trips of short duration. Women are discouraged from riding motorcycles as it is deemed socially unacceptable. Buses in Pakistan have separate areas for women with separate entrances and a separating wall. However, these areas are small, most likely indicative of the assumption that few women need to travel. In Pakistan, reputation and family honor are also questioned when women stay outside their homes for extended periods; working women, too, get trapped in the cycle of blame and restrictions (Adeel et al., 2017; Faiz et al., 2018; Iqbal et al., 2020; Masood, 2017). In Kyrgyzstan, the double burden compels women to use marshrutkas (minibuses) disproportionately as they are faster than buses and less expensive than taxis. However, women opt out of certain activities to avoid the hassle, discomfort, and risks associated with marshrutka trips, further restricting their access to social infrastructure and employment opportunities (Turdaljeva and Edling, 2017).

3.2.5. Urban form

Some studies in this review note that urban form, largely shaped by land use and transport policies and interventions at a macro level, shapes urban infrastructure development directions that affect women's mobility.

Studies find that unplanned, uncontrolled, and imbalanced spatial growth prevents integrated land use and transport planning and results in the fragmentation of cities and sporadic implementation of transport measures, thus adversely affecting the availability and affordability of public transport (Herrmann-Lunecke et al., 2020; Mark and Heinrichs, 2019; Mejia-Dorantes, 2018; Olvera et al., 2013). For example, Chile has highly centralized land-use planning, and its transport system is car-oriented and lacks pedestrian infrastructure, particularly in low-income neighborhoods. Therefore, walking remains the primary mode for the low- and middle-income population, particularly for care trips undertaken mainly by women (Herrmann-Lunecke et al., 2020). This is significant as studies in Chile suggest revisiting land use planning to accommodate non-work and care trips. It further notes the disproportionately high number of walking trips that women account for, particularly in low-income areas, which, though environmentally sustainable, may come at a social cost due to the absence of appropriate land use planning (Sagaris and Tiznado-Aitken, 2020). In Santiago, Chile, care trips form the largest category of daily trips on weekends and weekdays and are primarily undertaken by women (Sagaris and Tiznado-Aitken, 2023). De Madariaga and Zucchini (2019) in their work in Madrid, Spain, note the significance of care trips, and the number of care trips is close to the number of work trips. It further notes that 40 % of women's trips are care-related while 9 % of men's trips are care-related, calling for mainstreaming care trips into transport agendas.

A study in Sub-Saharan Africa notes that poor public transport systems restrict the spatial extent of mobility, and women and children in particular, mostly walk to carry out their daily activities. Moreover, transport costs weigh heavily on the poor in peri-urban areas as they are compelled to choose affordable modes of transport: they walk part of their long trips, negotiate fares during off-peak hours, and sometimes forgo certain activities (Olvera et al., 2013). In Buenos Aires, Argentina, balancing productive and reproductive works becomes challenging as the land use and transport system do not support routes and schedules suitable for low-income women, forcing women to cater primarily to urgent needs, which are usually reproductive and sometimes productive (Mark and Heinrichs, 2019). A study on working women in Mexico City finds that many people live on the outskirts due to lower housing costs, which results in increased travel time to the city center. To reduce travel time, some working women are compelled to buy private motorized vehicles, which make trips expensive. Despite serious concerns, women presume them to be part of their daily lives and modify their transport patterns accordingly (Mejia-Dorantes, 2018). In Palestine, for women, land-use segregation forms the first layer of exclusion and policing, and the atmosphere of public spaces forms the other layer (Kerzhner et al., 2018).

3.2.6. Policies

Though few studies in this review deliberate on policies, they note the significance of policies and the potential adverse consequences the lack of policies inflicts on women's mobility.

This review finds that lack of gendered and coordinated approach (Montoya-Robledo et al., 2020), under-representation of women in the transport sector (Tennakoon et al., 2020), lack of fare integration (Mejia-Dorantes, 2018; UN-Habitat, 2013), differences in fares between private and public operators (Olvera et al., 2013; UN-Habitat, 2013), and absence of public subsidies (Olvera et al., 2013) increases transport costs, especially for the poor, and compels one to prioritize mobility needs. Walking and shorter trips related to household work are not included in transport surveys in Kenya, as they are not considered relevant for transport planning (Kishiue et al., 2020). In Latin America, lower fares are in place for some, including older women, but the

microvan and minivan drivers discriminate against people paying lower fares. Lack of policies limits mobility and accessibility, particularly to care services and jobs in Latin American cities (Montoya-Robledo et al., 2020; Dominguez Gonzalez et al., 2020).

Besides, studies in Colombia and Sri Lanka report the lack of law enforcement, violation of traffic rules, and risk of accidents due to overtaking, overloading, speeding, and aggressive driving, adversely affecting the pedestrian environment and walkability (Montoya-Robledo et al., 2020; Tennakoon et al., 2020).

4. Key insights

The studies in this review employ a wide range of qualitative and quantitative methods and discuss the barriers women face while accessing and using public transport – particularly in the first- and last-mile stretches - and their influences on women's mobility. This review notes that though the environment within which mobility takes place is highly context-specific, the similarities safely allow the authors to classify the barriers broadly. As summarized in Table 2, following Caruthers et al. (2005) framework, the lack of adequate, reliable, inclusive, safe, and integrated public transport, IPTs, poor pedestrian infrastructure, and unsafe environments are the most common concerns for women in the LMICs. These, coupled with gendered norms, are found to restrict mobility and access to essential services and opportunities for women, especially if traveling with children and luggage, as well as for older adults and the PWDs, requiring them to rely even more on door-to-door service. Gendered norms and (un)safety strongly influence women's mobility, causing them to be less likely to travel, thus alienating them from public spaces. These result in exclusion, limit freedom of movement, and change travel patterns and behavior, among other negotiations. These compel women to undertake journeys at the expense of their safety, convenience, and affordability, and sometimes only to fulfill urgent needs. The issue of 'respectability' and lack of empathy adds to the emotional distress of women, which, coupled with the misbehavior of the transport providers, causes physical and psychological barriers and resentment towards society. As a result, women perceive the city as hostile, and there is a sense of powerlessness and acceptance. The barriers pose serious challenges for women regarding accessibility and acceptability of public transport.

These barriers have direct and indirect impacts on women's mobility in the first- and last-mile stretches and, without exception, instill in women a sense of powerlessness, distress, anxiety, and frustration. For example, a lack of intermodal facilities would decrease modal choice, increase waiting time, increase the risk of sexual harassment, and increase the probability of availing of more expensive transport, not to mention the fear of unsafety and anxiety this series of events may cause. Fortunately, evidence suggests that IPTs when integrated with the main transit lines, can bridge the mobility gap in the first- and last-miles (Kanuri et al., 2019).

5. Key research gaps and recommendations

The geographic distribution of the studies is limited only to some LMICs. Hence, this review suggests the need for undertaking more contextualized evidence-based studies on first- and last-mile connectivity in more geographic locations. As Hanson notes in her work, understanding the nexus between gender and mobility requires in-depth, contextualized studies, quantitative or qualitative (Hanson, 2010). Gender, which is socially constructed, is context-specific; hence, a holistic understanding of gendered mobility requires contextualized studies that pay attention to power and inequality, going way beyond using sex-disaggregated data (Hanson, 2010).

The studies included in this review focus more on barriers associated with walking and public transport. They also discuss gendered norms and safety in various urban contexts. Understanding the range and degree of their influences on women's accessibility, affordability, and

acceptability of public transport would help formulate context-specific guidelines and interventions. The influences of barriers on acceptability need to be particularly delved into and assessed as most barriers discussed in this review impact women's well-being.

Understanding the barriers women face when traveling with children or luggage, undertaking care trips, and accessing social infrastructure in more geographic locations would provide more significant insights into barriers to women's mobility. Further studies on cycling and integration of feeder systems with main transport lines are also required.

It is acknowledged that land use and transport set the stage for equitable access in cities. However, studies on understanding the influences of the same on women's mobility are limited. Further studies on land use and transport can aid in formulating more relevant perspective plans for cities. More studies on policies and mechanisms for operationalizing and monitoring policies, particularly concerning first- and last-mile connectivity, can help effectively implement transport interventions. Studies included in this review highlight the need for meaningful participation of the stakeholders, and societal awareness and engagement.

Studies included in this review have recommended a few key policies and interventions to enhance first- and last-mile connectivity in LMICs: first, assessment of mobility needs and gaps of women, older adults, and PWDs and accessibility analysis for women; second, ensuring gender-disaggregated data, gender-sensitive planning process, gender-inclusive policies and programs, and gender-responsive budgeting; third, integrated urban transport and social planning, inter-sectoral public policies integrating transport with land use, housing, and urban systems through a participatory process to ensure integrated, inter-modal, inclusive, and safe public transport, fare structure, and pedestrian infrastructure; and finally, training transport sector personnel and awareness programs about mobility needs and rights for users and transport providers. Context-specific gendered data is important to understand women's mobility needs and travel characteristics and undertake strategic urban transport planning policies and interventions. Focusing only on work trips during peak hours or providing only closed-circuit television cameras and streetlights to enhance perceived and actual safety will no longer suffice.

6. Conclusions

Considering the diversity and expanse of debates and research in the domain of transport and mobility, literature on women's mobility, particularly in the first- and last-mile stretches, is found to be limited despite being one of the most crucial stretches in a journey and having the ability to limit or enable one's mobility. For each LMIC, we must understand the development context, the transport system, and the barriers women face even before they step out of their homes to access public transport.

An urban transport system sensitive to women's needs plays a huge role in building equitable cities and realizing the sustainable development goals laid down by the United Nations. Availability, accessibility, affordability, and acceptability of public transport are critical, a lack of which results in exclusion and has far-reaching consequences. A comprehensive address of mobility barriers and further studies on the research gaps highlighted in this paper may facilitate women's access to public spaces by choice. Women are a travel-disadvantaged group, which is long recognized; what is important is to take stock of the barriers that hinder women's mobility to have effective policies in place and revitalize the first- and last-mile connectivity.

CRedit authorship contribution statement

Sanghamitra Roy: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ajay Bailey:** Writing – review & editing, Validation, Supervision, Software,

Resources, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Femke van Noorloos:** Writing – review & editing, Validation, Supervision, Software, Resources, Methodology, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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Appendix A. Supplementary data

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