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Activity participation among disadvantaged communities and the impact of an aerial cable car: The case of TransMiCable, Bogotá

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ABSTRACT

In Latin America and the Caribbean, topographical difficulties and urban spatial inequity patterns exacerbate transport complexities and challenges among disadvantaged communities. Aerial cable cars (ACC) have emerged as an innovative transit solution to address these disparities. This study measures the effects of an ACC system on activity participation in a disadvantaged community in the Global South. Using cross-sectional data before and after, we compare the impact of TransMiCable ACC in Ciudad Bolívar with that in San Cristóbal, two neighbourhoods with similar sociodemographic and travel behaviour characteristics in Bogotá, Colombia. Activity participation levels of total, mandatory, flexible, and care activities were measured using an ordered logit model controlled by temporal, neighbourhood, individual, and household characteristics. The results indicate that ACC increased activity participation, which was influenced by the rise in flexible and care activities. Interestingly, females are less likely to participate in care activities in 2019, a trend found to be independent of the ACC's influence. Additionally, the built environment exhibited different scale effects considering the type of activity. For instance, mandatory activities, typically conducted outside the neighbourhood, are more influenced by destination accessibility, whereas flexible and care activities, mainly conducted inside, are more influenced by distance to bus stops, population density, and land use mix. These findings suggest that decision-makers should consider the differential effects of sociodemographic and built environment variables on activity participation to maximise the social benefits of new transit infrastructures.

1. Introduction

Mobility is a fundamental right that allows people to enjoy the city's opportunities (Rodas et al., 2022), increasing accessibility and social inclusion (Lucas, 2012). Urban settlements in developing countries, such as Latin America and the Caribbean (LAC), often present an unfair distribution of transport and land use created by their unique topology, urban planning decisions, and autonomous and unplanned processes (Cheng et al., 2013; Oviedo & Dávila, 2016). For instance, low-income people have been pushed to the city's peripheries to access more affordable housing (Oviedo & Dávila, 2016; Posada & García-Suaza, 2022). Those zones are at a higher risk of natural hazards (floods or landslides), usually in hilly terrains, making it difficult to provide public transport and essential services (Brand & Dávila, 2011; Oviedo, 2021). This has led to informal settlements (slums) (Oviedo & Dávila, 2016), with nearly 20.9 % of the LAC population living in slums, and almost 50 % of them lack public transportation access (UN, 2024).

Aerial cable car (ACC) systems have been implemented to supply better public transport in disadvantaged communities established in hilly terrains or cities with steeper topography (Brand & Dávila, 2011; Cardona et al., 2024). This has been an increasingly popular solution among transport planners. Since 2010, 90.9 % of the 33 operative lines have been inaugurated as public transport modes in seven countries in LAC (Cardona et al., 2024). While ACC's systems have been increasingly adopted in disadvantaged communities in hilly terrain (Cardona et al., 2024), there is limited evidence of their impact on travel behaviour and activity participation (Okami et al., 2022). This is more evident in the Global South, where research among disadvantaged communities remains scarce (Luz et al., 2022; Okami et al., 2022), particularly in studies about activity participation (Nayak & Pandit, 2023). This research addresses the above gaps by measuring the impacts of ACC implementation on inhabitants' activity participation, focusing on disadvantaged communities established in steeper topography. We focus on changes in activity participation in the Ciudad Bolivar locality in

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Bogotá before and after the TransMiCable was inaugurated in 2018, using repetitive cross-sectional data collected by the household travel survey (HTS) in 2015 (before) and 2019 (after). This study uses an ordered logit framework to identify how the ACC implementation and the individual, household and built environment characteristics determine the activity participation among disadvantaged communities in hilly terrain.

The paper is composed of five sections. The following section presents the literature review about travel behaviour among disadvantaged communities and the impact of ACC on travel behaviour, accessibility and social inclusion. Then, section 3 presents the materials and methods in conjunction with the case study TransMiCable in Ciudad Bolívar (Bogotá). The fourth section includes the main results of the activity participation models. Finally, the last two sections present the research's conclusions and discussion.

2. Literature review

The literature review is focused on understanding the empirical findings about the travel behaviour of disadvantaged communities, paying special attention to activity participation, how the hilly terrain can exacerbate their social exclusion and how ACC, as a transit mode, impacts travel behaviour among individuals in their area of influence. We understand disadvantaged communities (DC) as characterised by low-income people who often live in the peripheries and/or hillside terrains. In some cases, these communities may also manifest informal development.

2.1. Transport in disadvantaged communities: Challenges and travel behaviour

DC are characterised by several transport issues that limit their enjoyment of the city's opportunities, potentially leading to social exclusion (Lucas, 2012; Luz et al., 2022). Their low income limits the affordability of private and public transport (Guerra et al., 2022; Ureta, 2008). For example, Bogota's low-income people spend more than 20 % of their monthly income on public transport (Oviedo & Dávila, 2016). Furthermore, being in the city's peripheries increases their commuting travel time and distance, reducing their free time to engage in other activities during the day, negatively impacting their accessibility to essential services and quality of life (Brikman, 2021; Cheng et al., 2013, 2019; Oviedo & Dávila, 2016). In many cases, public transport is the only commuting option, as a private vehicle is not affordable (Cheng et al., 2013; Guerra et al., 2022; Oviedo & Dávila, 2016; Pieroni et al., 2021). In addition, their informal development lacks adequate transport planning, and the hilly terrain presents challenges for effective urban planning (Brand & Dávila, 2011; Kamalipour & Dovey, 2019; Okami et al., 2022; Sarmiento et al., 2020). Space to expand sidewalks and roads or to implement transit modes with larger capacities is particularly limited. The first and last-mile connections to mass transport systems are challenging. Inhabitants consequently rely on paratransit services or low- to medium-capacity diesel-powered buses, which share roads with private vehicles, reducing their average speed and road safety and increasing pollution (Oviedo & Dávila, 2016; Villar-Uribe, 2021).

Walking is often observed as the primary mode of transport, e.g., it is used for accessing public transport and reaching maintenance activities such as grocery shopping and visiting friends (Brikman, 2021; Cheng et al., 2013, 2019; Garnica, 2020; Manoj & Verma, 2015; Okami et al., 2022; Oviedo, 2021; Salon & Gulyani, 2010; Ureta, 2008). Empirical evidence from Asia and Africa shows high levels of trips on foot. For example, in Huzhou (China), 73 % of the maintenance trips among low-income people are done walking (Cheng et al., 2013), while in Nairobi (Kenia), 65 % of slum residents walk to work (Salon & Gulyani, 2010). Similar shares were observed in Bangalore (India), where 78 % of non-work trips by low-income households are made walking (Manoj & Verma, 2015). Similarly, investigations from Latin America evidence that the hilly terrain does not seem to prevent walking trips. For instance, inhabitants of hilly neighbourhoods in Colombia (Medellín "Comunas" and Ciudad Bolívar in Bogotá) and Brazil (Complexo do Alemao in Rio de Janeiro) walk on most of their daily trips, especially for intra-neighbourhood trips (Duarte & Soares Gonçalves, 2017; Garnica, 2020; Okami et al., 2022). On the other hand, cycling is less common among disadvantaged communities due to topographical constraints.

The mentioned lack of transport directly impacts travel behaviour, with evidence suggesting that people in DC travel less than other groups (Cheng et al., 2013, 2016, 2019; Okami et al., 2022). For instance, in Medellín, Colombia, DC residents engaged in less than two trips per person per day (Cordoba et al., 2014). These challenges are further exacerbated for specific groups, particularly females. Since there are deep gendered mobility inequalities across several societal groups (de Madariaga, 2013), females in DC often face additional barriers due to their multiple social roles, including income generation, caregiving, household responsibilities, and maintenance of social relationships (de Madariaga, 2013; Montoya et al., 2020; Salon & Gulyani, 2010). As a result, females made more and shorter trips, mainly focused on specific purposes such as maintenance (e.g., buying groceries), social (e.g., visiting friends or family) and caregiving (e.g., escorting children to school), relying heavily on public transport- including paratransit services- and active mobility (Cheng et al., 2019; Duarte & Soares Gonçalves, 2017; Guerra et al., 2022; Montoya et al., 2024; Okami et al., 2022; Ureta, 2008).

2.2. Aerial cable cars to bring transport equity to disadvantaged communities

The ACC has been established as a transit mode to provide accessible and affordable public transport in Latin American and the Caribbean (LAC) cities, being an innovative solution to transport challenges, particularly among DC in hilly terrains (Cardona et al., 2024). The ACC has produced diverse outcomes in mobility, travel behaviour and quality of life, shaped by individual (e.g., income level, gender, occupation, etc.) and the built environment (topography, access to transit systems, local accessibility, etc.) characteristics in the communities it serves. These outcomes reveal the importance of placing the ACC implementations in their context, paying special attention to the role of the ACC in the mobility system.

The ACC system in LAC has been implemented in two main ways. Its most common use is as a first- and last-mile connection to broader public transport systems like metro or BRT systems (as in Medellín, Bogotá, México, etc.). On the other hand, cities with steeper topography, such as La Paz and Manizales, have developed a public transport system around ACC. The ACC have brought transport equity and reduced social exclusion among communities in their area of influence (Cardona et al., 2024). The ACC is an air-based transportation system that moves cabins (with capacities between 8 and 35 people) through a continuous loop using a cable and stopping in stations that allow passengers to access and egress (Cardona et al., 2024). The first ACC as a transit mode was inaugurated in Medellín (Colombia) in 2004, serving a disadvantaged community in hilly terrain and connecting them to the Metro system (Brand & Dávila, 2011). The ACC are usually part of Social Urbanism projects, strategic interventions in the built environment that address social inequalities in DC through upgrading urban space and providing new public facilities. The most successful ACC implementations, such as Medellín's Metrocables and Bogotá's TransMiCable, have comprehensively integrated Social Urbanism principles during the planning, design, and implementation phases (Brand & Dávila, 2013; Cardona et al., 2024).

The ACC potentially impacts accessibility, social inclusion, and activity participation by providing more direct access to the city-wide transit system (Cardona et al., 2024). The inauguration of the ACC reduced the average travel time among commuters in the DC communities by 45 min in Medellín and 22 min in Bogotá, enabling residents to reallocate time to leisure or work activities (Guevara-Aladino et al., 2023; Heinrichs & Bernet, 2014). The fare and physical integration of the ACC with Metro or Bus Rapid Transit (BRT) systems reduced travel costs, raising affordability among commuters (Bocarejo et al., 2014; Guzman et al., 2022; Heinrichs & Bernet, 2014). These benefits were highly perceived among ACC users, particularly males (Guzman et al., 2024). Furthermore, in Medellín, the first Metrocable line increased the probability of finding jobs (Matsuyuki et al., 2020), while employment accessibility doubled (Bocarejo et al., 2014). These outcomes reveal ACC's role as a first- and last-mile connector, expanding access to facilities outside neighbourhoods, especially the labour market, and improving the efficiency of the public transport network.

On the other hand, the ACC improved local accessibility by increasing the facilities in the neighbourhood through Social Urbanism projects (Baldovino et al., 2023; Brand & Dávila, 2013; Guevara-Aladino et al., 2023), impacting intra-neighbourhood trips mostly related to flexible activities like visiting friends or family or buying groceries. For instance, park renovations were implemented in parallel with Bogota's ACC, producing increased physical activity, mainly among boys and males (Baldovino et al., 2023).

In addition, the ACC potentially impact travel behaviour and quality of life. In Medellín, Cordoba et al. (2014) found that ACC potentially reduced the risk of social exclusion by increasing the number of daily trips, while Milan and Creutzig (2017) found an increase in public transport, walking, and biking modal share, especially among low-income and female residents. The perception of the benefits is influenced by ACC use and gender (Guzman et al., 2022). Females perceived fewer benefits in terms of travel time savings, while male users perceived larger benefits in this item. Meanwhile, female users perceive higher in-vehicle security. Crime and security have been a major concern among females, being a relevant predictor of mode choice (Sarmiento et al., 2013). For instance, in Medellín, females prefer traditional buses over ACC for intra-neighbourhood trips because bus stops are closer than ACC stations. Therefore, they are less exposed to crimes when walking to the bus stops (Sarmiento et al., 2013).

This research hypothesises that the ACC inauguration positively impacts activity participation among disadvantaged communities. There is evidence about the positive influence of public transport on activity participation in the Global North (Allen & Farber, 2020) and South (Luz et al., 2022) contexts. Therefore, we will investigate how ACC impacts participation in total, mandatory, flexible, and care activities, and how individual, household, and built environment characteristics influence out-of-home activity levels. We are particularly interested in identifying how gender influences the ACC effect of activity participation, considering that females have different mobility patterns; the new transport facility will consequently impact their travel behaviour differently. Furthermore, the characteristics of the built environment are measured at the residential and destination levels. Improving mobility by directly connecting to the broader public transport system will generate impacts for trips mainly conducted outside the neighbourhood, such as for work or study. On the other hand, local accessibility potentially impacts flexible trips (visiting friends or family, buying groceries) that are shorter and mainly conducted inside the neighbourhood. Those effects will be considered through built environment variables like destination accessibility (city-level), distance to bus stops, population density, land use diversity, and road intersection design (neighbourhood level).

3. Materials and methods

This section describes the case study and data sources in more detail, followed by a description and model of the method specification.

3.1. Case study and data

In this study, we will focus on the case of Ciudad Bolivar's TransMiCable, which was inaugurated in Bogotá (Colombia) in December 2018. Bogotá is the capital city of Colombia, with more than 7 million inhabitants and a population density of 177.55 inhabitants per hectare. This city has been recognised for developing public transportation around the Bus Rapid Transit (BRT) system called TransMilenio (red lines in Fig. 1) (Hidalgo & Huizenga, 2013). TransMilenio has demonstrated an increase in the accessibility and affordability of public transport; nevertheless, the benefits diminished in the peripheries, where most of the low-income population have settled (Bocarejo & Oviedo, 2012; Oviedo & Dávila, 2016). TransMiCable is the first ACC implemented in the city, serving Ciudad Bolívar's locality on the south periphery of the city (yellow line in Fig. 1) and designed as a Social Urbanism project, including investment in complementary projects in the neighbourhood (Sarmiento et al., 2020). Ciudad Bolivar has nearly 850,000 inhabitants, with 85.5 % of the households classified as low-income, and it is characterised by its steep terrain, making it difficult to develop traditional public transport projects (Sarmiento et al., 2020; Villar-Uribe, 2021). The ACC is 3.43 km long and has four stations, being an alternative that is directly connected to the BRT system. It is used by 22,000 passengers daily, reducing travel time (by 22 % on average for commuting) and costs (Cardona et al., 2024; Guevara-Aladino et al., 2023).

We used data from government portals and open sources. Bogota's open data portal (Datos Abiertos Bogotá for its acronym in Spanish) allowed us to download Bogota's Household Travel Survey (HTS), the cadastral data with land use information and employment data (2021) at the block level, and the General Transit Feed Specification from July of 2023 (Datos Abiertos Bogotá, 2023). The HTS collected cross-sectional data every four years and considers inhabitants' travel patterns and sociodemographic variables at the individual (gender, age, education, occupation, etc.), household (income, car ownership, etc.) and Traffic Analysis Zone (TAZ) levels. This research used the HTS of 2015 (collected between March and August) and the HTS of 2019 (collected between February and November). Although the ACC began operations in December 2018, and the HTS 2019 was collected from February, ridership reports from TransMilenio (2025) indicate rapid adoption. For instance, TransMiCable reported an average usage of 19 thousand passengers daily in 2019, similar to the ridership of 21 thousand passengers daily in 2024. Besides, there is empirical evidence about the shock effects of new transit systems in the short term (see Termida et al. (2016) or Ingvardson et al. (2025)), demonstrating that less than one year is enough to observe changes in travel behaviour. On the other hand, the population at the block level was retrieved from the Census of Population and Households 2018 (CNPV, its acronym in Spanish) collected by the National Administrative Department of Statistics (DANE, its acronym in Spanish) (DANE, 2018). Finally, we downloaded road networks from OpenStreetMap in July 2023 (OpenStreetMap contributors, 2017).

3.2. Methods

This research uses a natural experiment following recommendations from previous studies on ACC implementations in the area (see Sarmiento et al., 2020). A natural experiment is used to evaluate the changes in travel behaviour produced by a new transport infrastructure (Sun et al., 2020). It considers an intervention group, where the new transport infrastructure is operating and the control group, where no transport infrastructure was installed. The control group must have similar sociodemographic and built environment characteristics to facilitate comparisons. In the case of our study, the intervention group corresponds to Ciudad Bolívar, where the first ACC operates (see Fig. 1). The control group is represented by the locality of San Cristóbal (see Fig. 1), where the second ACC line has been under construction since 2023, with operations projected to begin in 2026. The natural experiment considered households in the HTS (2015 and 2019) within an 800-m buffer around Ciudad Bolívar's ACC stations and the projected San

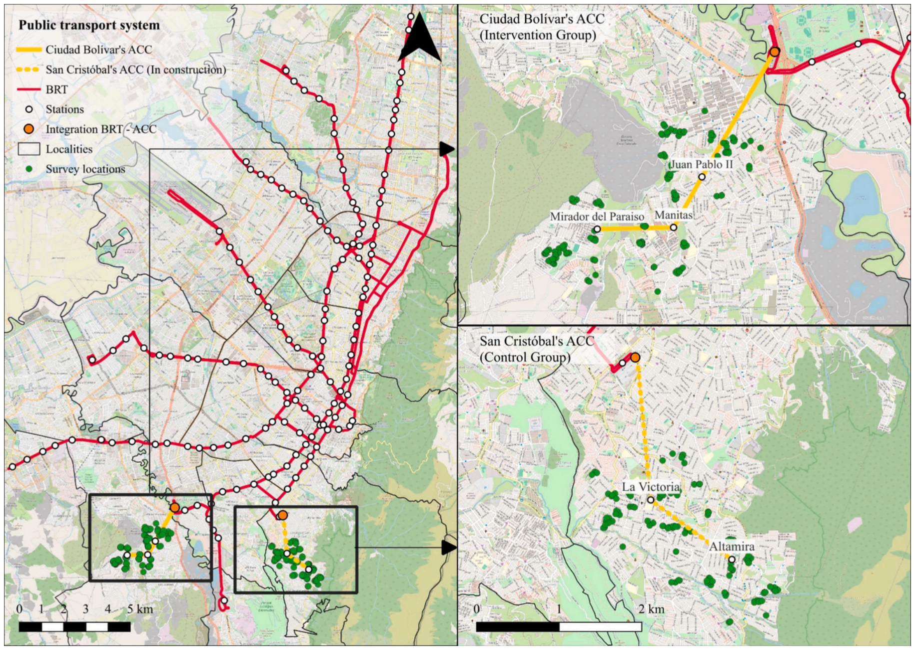

Fig. 1. Study zone. Bogota's public transport system. Ciudad Bolívar (Upper-right), San Cristóbal (Bottom-right). Green dots are households in the zone of influence of ACC stations retrieved from the Household Travel Survey. Source: Own elaboration using Bogotá's Open Data Portal and Open Street Maps data. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Cristóbal's ACC (green dots in Fig. 1), considering only those over 18 years old in the analysis areas.

We estimated an Ordered Logit (OL) model to calculate the probability of an individual conducting a certain number of activities per day. It considers the ordered number of activities based on a latent utility (V_{AP}) (Mahdi & Esztergár-Kiss, 2023; Soza-Parra et al., 2019). Furthermore, sociodemographic (SD) and built environment (BE) characteristics are used as independent variables (see eq. 1). We used the Apollo R package to estimate the OL with a BGW algorithm for maximum likelihood optimisation (Bunch et al., 1993; Hess & Palma, 2019). To account for the causal relationships in the impact of the ACC on activity participation in Ciudad Bolivar (CB), we included variables of interest regarding the HTS periods (β_{2019}), the neighbourhoods (β_{CB}), and the interaction between them ($\beta_{CB-2019}$). Finally, we included a scale factor (λ_{year}) to adjust for the possible heteroscedasticity across HTS samples (i.e. difference in the variances of the cross-sectional samples of two different years) (Soza-Parra et al., 2019). As both scale factors cannot be estimated separately, we fix the one for 2015 to 1.

$$V_{AP} = \lambda_{year}{}^{*}\Big(\beta_{2019}{}^{*}Year_{2019} + \beta_{CB}{}^{*}Neighbourhood_{CB} + \beta_{CB-2019}{}^{*}Year_{2019}{}^{*}Neighbourhood_{CB} + \sum \beta_{SD}{}^{*}SD + \sum \beta_{BE}{}^{*}BE \Big) \tag{1}$$

3.2.1. *Activity participation*

Activity participation (AP) is all the out-of-home activities conducted during a day, e.g., to work, study, visit relatives or go to the gym (Allen & Farber, 2020; Luz et al., 2022). We calculated AP using the travel diaries reported in the HTS, using travel purposes as a proxy (Luz et al., 2022). We categorised travel purposes from the HTS 2015 and 2019 into work, study, leisure, social, care, health, and other by merging the reported by people in each survey, considering the questionnaire options. We must acknowledge that some developments were made in the questionnaire, obtaining a more refined categorisation of the travel purposes in the HTS 2019. Then, the AP was categorised into total activities (TA), mandatory activities (MA), flexible activities (FA) and care activities (CA). Table 1 presents the AP categories, the travel purpose categories, and the original options in the HTS.

Table 1
Categorisation of activity participation.

Activity	Category	Travel Purposes
Total activities (TA)	Work, Study, Leisure, Social, Care, Health, Other	All out-of-home activities
Mandatory activities (MA)	Work and Study Study	Work, Work Issues Study
Flexible activities (FA)	Leisure	Shopping*, Recreation*, Recreation and Culture, Religious activities, Physical activity and sport,
	Social	See someone, pick up/drop off something, pick up/drop off someone who does not need your care*, eating/drinking, errands
Care activities (CA)	Care	Pick up/drop off someone who needs your care*, pick up/drop off someone, care for people

* Only present in HTS 2015.

We considered care activities a separate category because of their imbalanced distribution among gender groups (Gómez-Varo et al., 2023). Females generally performed more care tasks than males, especially in developing countries and disadvantaged communities like the studied neighbourhoods (Guevara-Aladino et al., 2023; Guevara et al., 2024; Montoya et al., 2020; Murillo-Munar et al., 2023; Orjuela & Schwanen, 2023; Rodas et al., 2022). We defined care activities as accompanying someone in the household who needs some level of assistance or care (Gómez-Varo et al., 2023; Orjuela & Schwanen, 2023).

3.2.2. *Sociodemographic variables*

We calculated sociodemographic variables at the individual (1846 observations) and household (773 observations) level. Descriptive statistics of the variables are presented in Tables 2 and 3. The samples are equilibrated for the intervention and control groups at the individual level (see Table 2), except for education levels, where fewer people with primary education were surveyed in 2019. The average family household size is similar for both periods and between the groups (see

Table 2
General statistics at the individual level.

Variables		Ciudad Bolívar 2015 (n = 595)	Ciudad Bolívar 2019 (n = 370)	San Cristóbal 2015 (n = 511)	San Cristóbal 2019 (n = 370)
Gender	Female	53.9 %	47.6 %	53.8 %	47.6 %
	Male	46.1 %	52.4 %	46.2 %	52.4 %
Age	18–30	29.2 %	35.4 %	26.0 %	30.3 %
	30–45	28.9 %	26.5 %	33.1 %	25.4 %
	45–60	21.3 %	19.7 %	21.7 %	20.0 %
	>60	20.5 %	18.4 %	19.2 %	24.3 %
Education level	Primary	71.3 %	49.2 %	65.9 %	35.7 %
	Middle	17.3 %	36.2 %	14.9 %	39.5 %
	Technical	6.9 %	11.4 %	13.9 %	17.8 %
	Higher	4.5 %	3.2 %	5.3 %	7.0 %
Occupation	Worker	58.2 %	51.1 %	58.9 %	57.3 %
	Student	2.5 %	5.9 %	3.3 %	7.6 %
	Household-chores	23.2 %	28.4 %	22.9 %	24.3 %
	Other	16.1 %	14.6 %	14.9 %	14.6 %
Relation with household head	Head	41.7 %	42.2 %	41.9 %	40.3 %
	Partner	26.4 %	27.0 %	29.7 %	21.4 %
	Nuclear Family	28.6 %	25.9 %	26.0 %	31.6 %
	Extended Family	2.5 %	1.9 %	2.2 %	4.1 %
	Other Family	0.8 %	3.0 %	0.2 %	2.7 %

Table 3
General statistics at the household level.

Variables		Ciudad Bolívar 2015 (n = 252)	Ciudad Bolívar 2019 (n = 156)	San Cristóbal 2015 (n = 216)	San Cristóbal 2019 (n = 149)
Family size (average)		3.41	3.43	3.42	3.43
Presence of children (<12 years old)		46.8 %	53.8 %	44.9 %	38.3 %
Presence of cars		7.6 %	10.9 %	14.4 %	15.4 %
Presence of motorcycles		12.3 %	16.7 %	14.8 %	20.1 %
Household Income (USD)*	<252	57.5 %	62.8 %	48.1 %	55.0 %
	252–456	34.1 %	28.2 %	47.2 %	23.5 %
	456–761	6.3 %	7.1 %	4.2 %	14.1 %
	>761	2.0 %	1.9 %	0.5 %	7.4 %

* A value of COP 3289 per USD was used for the calculations, representing the mean value for 2019. Values for 2015 were adapted to 2019 categories.

Table 2). Furthermore, a slight increase in private motorised ownership was observed from 2015 to 2019, especially in Ciudad Bolívar and the category of motorcycles (see Table 3). As we described previously, these neighbourhoods are mainly comprised of disadvantaged communities (household income of less than USD 456 monthly) with low affordability for private vehicles (<30 %). In HTS, household income was self-reported, allowing the participants to skip the question. Some values are, therefore, missing. We imputed the missing monthly household income values (207 in 2015 and 18 in 2019) using a Multinomial Logistic Regression considering socioeconomic strata (SES) as a proxy of the socioeconomic level (Cantillo et al., 2019), the number of household members, neighbourhood (Ciudad Bolivar or San Cristobal), and the number of vehicles as independent variables.

3.2.3. Built environment variables

We measured the built environment considering the five D's categories presented by Ewing and Cervero (2010): density, diversity, design, distance to public transport at the residential level and destination accessibility. We used cross-sectional data to calculate built environment variables (except for destination accessibility, where the availability of the ACC before and after its inauguration was considered).

The density category considered the population per block from the 2018 census (CNPV), and it was aggregated to TAZ in inhabitants per hectare (inhab/ha). We calculated the diversity of land use using the entropy index (E), which considered the cadastral data. Bogota's cadastral data contains 98 land use categories. We reclassified the land use categories into 10 to calculate the entropy index per TAZ: housing, commercial, industrial, institutional, educational, health, security, cultural and recreational. In this case, the airport was considered a separate category due to its size and influence in the city. Eq. 2 presents the formula used to calculate the entropy index, where p_i is the proportion of land use, and n is the number of land use categories. The E is normalised from 0 to 1, with values near one, meaning it is more diverse regarding land use. Furthermore, we calculated the design as the road intersection density per TAZ (int/ha) using the OSM road networks considering walking, cycling, and driving.

$$E = \frac{-\sum_{i=1}^{n} p_i * \ln(p_i)}{\ln(n)} \tag{2}$$

Distance to public transit stops and destination accessibility were calculated at the household level. We used a multimodal network, considering Bogota's GTFS for public transport and the OSM walking network. Calculations were conducted using the *R5R* package of R language (Pereira et al., 2021). The distance to the nearest ACC and BRT station and bus stop was calculated using the household's origin, considering only the walking network. Furthermore, we used the cumulative opportunities accessibility measure. Cumulative opportunities are the percentage of employment opportunities reached by a household in a defined travel time (Wu & Levinson, 2020). Employment data was aggregated at the TAZ level. Travel times were calculated from household locations to TAZ centroids using the multimodal network (walk+transit). We estimated the average travel time in the morning peak hour, considering departure times from 5 to 8 am every 5 min. This allowed us to account for temporal variations (Pereira, 2019). Eq. 2 presents the cumulative opportunities (*Ai*) approach where i are the households in the study zone, j is the TAZ destination, Oj are the employment opportunities in TAZ j and $f(C_{ij})$ is the isochronic impedance function considering the time threshold. We tested accessibility values (Ai) in the OL models, considering travel time thresholds (t) from 15 to 120 min, every 15 min.

$$Ai = \sum_{j=1}^{J} g(O_j) f(C_{ij}) \tag{3}$$

$$f(C_{ij}) = \begin{cases} 1 \; if \; C_{ij} \le t \\ 0 \; otherwise \end{cases}$$

The average of the built environment variables at the TAZ level are presented in Table 4. Both groups have similar population densities but are much higher than the city's density (177.55 inhab/ha). On average, San Cristóbal presents a lower land use diversity. The density of walking road intersections is higher than those for cycling and driving road networks. Values in Ciudad Bolívar are larger among groups. Bus stops are the nearest among transit modes for distance to transit. It is plausible that a lower average distance value to ACC stations in Ciudad Bolívar is

Table 4
General statistics at the TAZ level.

Variable		Ciudad Bolívar (n = 17)	San Cristóbal (n = 18)
Population density (inhab/ha)		296.04	293.43
Land Use Entropy		0.26	0.20
Road intersection density (int/ha)	Walking	4.45	3.58
	Cycling	2.90	2.55
	Driving	2.81	2.38
Distance to transit (km)	ACC stations	0.74	7.43
	BRT stations	3.22	2.81
	Bus stops	0.17	0.14

due to it being the intervention group. Similarly, the average distance to BRT stations is more than 2.8 km in both cases, showing the low supply of mass transport systems in those parts of the city.

Accessibility analysis shows significant differences after the inauguration of the ACC in Ciudad Bolivar. For instance, the percentage of jobs reached by Ciudad Bolivar's inhabitants raised an average of 5.13 % for 75 min and 4.39 % for 90 min. Fig. 2 shows the percentage of cumulative jobs reached in the study zone per time threshold. We observe the same accessibility in the studied periods for San Cristóbal because no changes in public transit supply were considered. Results show that San Cristóbal exhibits better access, i.e., their inhabitants could reach a higher percentage of jobs at the same time as Ciudad Bolívar's inhabitants. This is because San Cristobal is geographically closer to the employment hotspots in the city.

4. Results

Levels of activity participation are similar in both neighbourhoods. The average total number of activities was 0.878 in 2015 and 1.132 in 2019 (see Table 5). Approximately 20 % of the individuals in the intervention and the control group do not report activity participation during the day, i.e., they did not conduct out-of-home activities. In addition, we observe an increase in the average frequency of all activity categories from 2015 to 2019, except for mandatory activities in Ciudad Bolivar, where a slight decrease of 7.9 % is registered. Interestingly, San Cristobal experienced an increase of 41.49 % in the average of Mandatory Activities. On the other hand, flexible and care activities were more impacted in Ciudad Bolívar. For instance, the average flexible activities increased by 87.66 % compared to 45.16 % in San Cristobal. Finally, care activity levels show development in both neighbourhoods, reaching 0.218 in Ciudad Bolivar and 0.148 in San Cristobal.

Table 6 shows the percentage of activities conducted inside and outside the neighbourhoods. Remarkably, there is an increase in the percentage of activities conducted inside the neighbourhood in Ciudad Bolivar by 2019, particularly for total (19.79 %), flexible (24.61 %), and care (10 %) activities. In the case of San Cristobal, there is a reduction in the activities conducted inside the neighbourhood, except for care activities, which increase by 3.29 %.

Table 7 presents the Ordered Logit (OL) results for the activity participation (AP) models divided into total activities (TA), mandatory activities (MA), flexible activities (FA), and care activities (CA). We found strong evidence for the positive effect of the ACC on the likelihood of engaging in more total activities in Ciudad Bolivar in 2019 (estimator = 0.377, *p*-value = 0.021) after the inauguration of TransMiCable. This increase could be influenced by larger numbers of flexible and care activities (see Table 5). Interestingly, the increase in mandatory activity participation in Ciudad Bolívar from 2015 to 2019 is lower than that of San Cristobal (estimator = −0.361, *p*-value = 0.008), despite a general increase in mandatory activities in 2019 (estimator = 0.331, p-value = 0.003) and higher likelihood for Ciudad Bolivar to engage in work and study activities (estimator = 0.412, p-value <0.000) compared to San Cristóbal.

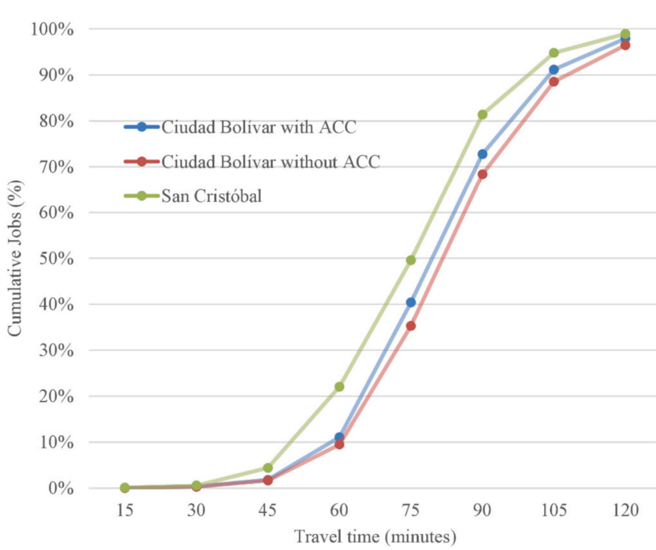

Fig. 2. Cumulative accessibility to jobs (percentage).

Being female increases the probability of performing more out-of-home activities (estimator = 0.169, *p*-value = 0.011). This result is highly influenced by levels of flexible activities (estimate = 0.209, *p*-value = 0.01) and care activities (estimate 0.738, p-value <0.000). On the other hand, being male strengthens the chances of engaging in more mandatory activities, considering a negative estimate for females in this activity category (estimate = −0.193, *p*-value = 0.007). Changes in care activities through the years exhibit that females are less likely to engage in those activities in 2019 (estimate = −0.601, p-value = 0.006), while there are non-significant effects for the rest of the activities. Finally, we isolated the effect of the ACC by gender through the interaction: year-neighbourhood-gender. We do not find significant results; therefore, the changes in activity participation by gender are independent of the ACC, particularly for care activities.

Being occupied in household chores negatively influences the levels of total (estimate = −0,521, *p*-value <0.000) and mandatory activities (estimate = −1388, *p*-value <0.000) but increases the likelihood of engaging in more flexible (estimate 0,411, *p*-value <0.000) and care activities (estimate = 0.303, p-value = 0.01). In addition, the OL models show that being the household head's partner diminishes total activity levels (estimate = −0.184, p-value = 0.007), while being older (>60 years old) reduces the chances of engaging in out-of-home activities (total, mandatory and care activities). In addition, being a young adult (18 to 30 years old) increases the mandatory activity participation levels (estimator = 0,162, *p*-value = 0.036). Interestingly, flexible activity levels are not influenced by age.

The variables at the household level show that the number of household members reduced the probability of conducting out-of-home activities (estimate = −0.054, *p*-value = 0.01). As we expected, the presence of children positively impacted the likelihood of being involved in care activities (estimate = 0.201, *p*-value = 0.016), and car and motorcycle ownership did not affect activity participation levels. However, in the case of total (estimate = 0.106, p-value = 0.087) and care activities (estimate = 0.122, p-value = 0.058), the presence of motorcycles indicates a higher tendency of the activity.

Finally, the distance to transit stops positively influences the likelihood of activity participation: an increase in the distance to bus stops decreases the levels of total (estimate −0.474, *p* = 0.059), flexible (estimate −0.673, *p* = 0.015), and care activities (estimate −0.602, *p* = 0.020). Remarkably, job accessibility has a slightly positive effect on the likelihood of engaging in mandatory activities (estimator = 0.008, *p*-value = 0.093), while land use entropy has the opposite effect (estimate = −0.527, p-value = 0.097). The rest of the built environment variables do not strongly relate to the activity participation models.

5. Discussion

This section is split into four segments. First, the effect of ACC on activity participation levels is discussed, with attention to the descriptive statistics and the model results. This provides hypotheses about the effects that drive these outcomes. Secondly, we discuss the relevance of the gender variable and the particular effect of ACC in shaping their activity participation. Thirdly, the effects of built environment variables are discussed by considering the city and residential level impacts on the different activity participation categories. Finally, general findings of activity participation in disadvantaged communities are discussed by considering their sociodemographics and contrasting them with similar empirical studies.

Table 5
Activity participation in the study zone.

	Total				Ciudad Bolivar				San Cristobal			
	2015		2019		2015		2019		2015		2019	
Total Activities (TA)												
0	225	20.3 %	135	18.2 %	103	17.3 %	63	17.0 %	122	23.9 %	72	19.5 %
1	807	73.0 %	428	57.8 %	457	76.8 %	198	53.5 %	350	68.5 %	230	62.2 %
2	58	5.2 %	133	18.0 %	28	4.7 %	80	21.6 %	30	5.9 %	53	14.3 %
3	16	1.4 %	32	4.3 %	7	1.2 %	20	5.4 %	9	1.8 %	12	3.2 %
4 or more	0	0.0 %	12	1.6 %	0	0.0 %	9	2.4 %	0	0.0 %	3	0.8 %
Average per day	0.878		1.132		0.897		1.227		0.855		1.038	
Mandatory Activities (MA)												
0	641	58.0 %	404	54.6 %	317	53.3 %	220	59.5 %	324	63.4 %	184	49.7 %
1	452	40.9 %	311	42.0 %	270	45.4 %	136	36.8 %	182	35.6 %	175	47.3 %
2 or more	13	1.2 %	25	3.4 %	8	1.3 %	14	3.8 %	5	1.0 %	11	3.0 %
Average per day	0.432		0.488		0.481		0.443		0.376		0.532	
Flexible Activities (FA)												
0	887	80.2 %	521	70.4 %	464	78.0 %	238	64.3 %	423	82.8 %	283	76.5 %
1	203	18.4 %	175	23.6 %	122	20.5 %	101	27.3 %	81	15.9 %	74	20.0 %
2 or more	16	1.4 %	44	5.9 %	9	1.5 %	31	8.4 %	7	1.4 %	13	3.5 %
Average per day	0.212		0.355		0.235		0.441		0.186		0.270	
Care Activities (CA)												
0	1058	95.7 %	639	86.4 %	572	96.1 %	311	84.1 %	486	95.1 %	328	88.6 %
1	36	3.3 %	67	9.1 %	16	2.7 %	38	10.3 %	20	3.9 %	29	7.8 %
2 or more	12	1.1 %	34	4.6 %	7	1.2 %	21	5.7 %	5	1.0 %	13	3.5 %
Average per day	0.054		0.182		0.050		0.216		0.058		0.148	

Table 6
Activities conducted inside and outside the study zone.

Neighbourhood	Activity category	2015		2019	
		Inside	Outside	Inside	Outside
Ciudad Bolivar	TA	15.40 %	84.60 %	35.19 %	64.81 %
	MA	6.30 %	93.70 %	8.82 %	91.18 %
	FA	20.14 %	79.86 %	44.76 %	55.24 %
	CA	62.50 %	37.50 %	72.50 %	27.50 %
San Cristobal	TA	22.43 %	77.57 %	18.69 %	81.31 %
	MA	13.04 %	86.96 %	5.52 %	94.48 %
	FA	30.53 %	69.47 %	25.51 %	74.49 %
	CA	53.57 %	46.43 %	56.86 %	43.14 %

5.1. *The effect of ACC on activity participation*

After our analysis, we can see that the ACC has a relevant impact on increased activity participation in Ciudad Bolívar, driven by the rise in flexible and care activities, but it has no clear effects on mandatory activities. TransMiCable was a social urbanism project that invested in local amenities parallel to the ACC transport project (Sarmiento et al., 2020). We consider complementary projects to play an essential role in increasing total activity participation by increasing people's local accessibility. For instance, analysis of the percentage of trips made inside Ciudad Bolivar shows an increase, particularly for flexible and care activities (see Table 6). The interventions parallel to the ACC include cultural (library, museum, tourism office), institutional (citizen service office, community centres), recreational (sports centres, bike trails, renovation of urban parks), and commercial facilities (local markets), which increased local accessibility and activity participation among ACC users and non-users (Baldovino et al., 2023; Guevara-Aladino et al., 2023). Regular ACC users mostly benefit from the reduction of travel time, allowing the allocation of these savings to other activities during the day (Guzman et al., 2024), while maintaining healthy levels of physical activity by walking to the ACC stations in the access and egress parts of the journey (Baldovino et al., 2023).

The insights from mandatory activities are intriguing. Our analysis suggested a lower likelihood of engaging in work and study activities in Ciudad Bolivar, while an increasing trend is observed in San Cristobal. Explorations of time allocation after the ACC inauguration with longitudinal data suggest that regular ACC users are more likely to engage in work and study activities (Guzman et al., 2024). Consequently, the effect of mandatory activity participation in our study could be driven by economic and social determinants beyond the effect of the transport project.

5.2. *Activity participation among females and the ACC effect*

Our findings evidence substantial gender differences in activity participation. While males have higher levels of mandatory activities (work or study), females are more involved in flexible activities (e.g., shopping, visiting family) and accompanying dependants (e.g., children, seniors) to their activities. This indicates a general gap, when controlling for other individual characteristics like occupation, education, and relations with the household head in the model. Therefore, females are more involved in care activities, even when they are occupied with something else (de Madariaga, 2013; Gómez-Varo et al., 2023; Murillo-Munar et al., 2023). This is aligned with recent findings in the gendered mobility literature in the Global North (Gómez-Varo et al., 2023; Montero et al., 2023; Scheiner & Holz-Rau, 2017) and South (Montoya et al., 2020; Murillo-Munar et al., 2023; Orjuela & Schwanen, 2023).

This trend seems to have been changing over the years, considering that females were less likely to engage in care activities in 2019 in both neighbourhoods; results from other processes beyond the ACC effect. For instance, Bogotá is the first LAC city to implement a Care System policy (Alcaldía Mayor de Bogotá, 2025a), building Care Blocks, which is a hub with free services designed to attend to the necessities of unpaid caregivers and their dependants, including caregiving, education, healthcare and legal assistance, recreation, among others (Alcaldía Mayor de Bogotá, 2025b; Guevara et al., 2024). Care Blocks have been built in several localities, including Ciudad Bolívar (in ACC station Manitas, see Fig. 1) and San Cristóbal.

5.3. *The role of built environment variables in activity participation*

Previous research in activity participation found a significant relationship with built environment variables (Allen & Farber, 2020; Cheng et al., 2019; Fransen et al., 2018; Luz et al., 2022). Furthermore, studies on the ACC's impact on mobility and accessibility have found local and city-level effects. Although our findings do not indicate strong effects for the built environment variables, we could identify some interesting trends. For example, destination job accessibility slightly influences

Table 7
Ordered logit models for activity participation.

	Total Activities		Mandatory Activities		Flexible Activities		Care Activities	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Neighbourhood (reference San Cristóbal)								
Ciudad Bolivar	0.113	0.113	**0.412**	**0.000**	0.104	0.161	−0.169	0.152
Year (reference 2015)								
2019	**0.236**	**0.063**	**0.331**	**0.003**	**0.274**	**0.013**	0.192	0.145
Interaction: Neighbourhood - Year								
Ciudad Bolivar - 2019	**0.377**	**0.021**	**−0.361**	**0.008**	0.241	0.081	0.216	0.116
Gender (reference Male)								
Female	**0.169**	**0.011**	**−0.193**	**0.007**	**0.209**	**0.010**	**0.738**	**0.000**
Interaction: Year - Gender								
Female - 2019	0.093	0.281	0.157	0.139	−0.039	0.402	**−0.601**	**0.006**
Interaction: Year - Neighbourhood - Gender								
Female-Ciudad Bolivar - 2019	−0.140	0.251	−0.184	0.152	−0.125	0.224	0.008	0.471
Age (reference "45–60")								
18–30	0.121	0.086	**0.162**	**0.036**	−0.043	0.320	0.001	0.493
30–45	0.114	0.078	0.092	0.127	−0.072	0.201	**0.130**	**0.049**
>60	**−0.262**	**0.002**	**−0.295**	**0.003**	0.072	0.202	**−0.255**	**0.010**
Household income (reference "<252")								
252–456	−0.037	0.283	**0.117**	**0.039**	0.023	0.372	**−0.174**	**0.025**
456–761	0.122	0.129	0.090	0.202	0.012	0.455	0.093	0.117
>761	**−0.312**	**0.040**	0.022	0.445	**−0.390**	**0.034**	−0.019	0.440
Education level (reference "Primary")								
Middle	−0.053	0.228	−0.004	0.480	−0.099	0.094	−0.007	0.454
Technical	0.057	0.277	0.053	0.284	**0.178**	**0.034**	**−0.164**	**0.043**
Higher	**0.200**	**0.064**	**0.264**	**0.022**	0.199	0.075	**−0.290**	**0.036**
Occupation (reference "Work")								
Household-chores	**−0.521**	**0.000**	**−1.388**	**0.000**	**0.411**	**0.000**	**0.303**	**0.002**
Study	0.013	0.466	−0.108	0.207	−0.027	0.434	0.170	0.111
Other	**−0.533**	**0.000**	**−1.369**	**0.000**	**0.351**	**0.000**	**0.259**	**0.019**
Relation with the household head (reference Head)								
Partner	**−0.184**	**0.007**	−0.087	0.140	**−0.201**	**0.007**	0.002	0.487
Other	**−0.292**	**0.000**	0.085	0.152	**−0.247**	**0.003**	**−0.170**	**0.041**
Total of household members	**−0.054**	**0.009**	0.005	0.412	−0.045	0.059	0.004	0.406
Presence of children (dummy)	0.014	0.416	−0.015	0.412	−0.085	0.107	**0.201**	**0.016**
Presence of cars (dummy)	−0.060	0.243	−0.016	0.428	−0.023	0.400	−0.005	0.475
Presence of motorcycles (dummy)	0.106	0.087	0.029	0.355	−0.028	0.364	0.122	0.058
Built environment								
Population density	0.174	0.355	−0.387	0.219	0.368	0.224	0.763	0.066
Land Use entropy	−0.414	0.143	−0.527	0.097	0.202	0.308	0.179	0.313
Road intersection density (walking)	0.020	0.233	0.020	0.245	−0.006	0.421	−0.024	0.207
Distance to bus stops	−0.474	0.059	0.126	0.346	**−0.673**	**0.015**	**−0.602**	**0.020**
Accessibility to jobs (60 min)	−0.002	0.360	0.008	0.093	−0.008	0.094	−0.001	0.411
Scale factor - year (reference 2015)								
2019	**0.569**	**0.014**	**1.066**	**0.000**	**1.129**	**0.016**	**3.068**	**0.019**
tau_activity_1	−2.124	0.000	0.096	0.407	1.257	0.002	4.395	0.000
tau_activity_2	1.549	0.000	4.298	0.000	3.617	0.000	5.799	0.000
tau_activity_3	3.148	0.000						
tau_activity_4	4.793	0.000						
Goodness-of-fit measures	LL	−1627.7	LL	−1039.56	LL	−1098.64	LL	−506.69
	R^2	0.4521	R^2	0.4874	R^2	0.4583	R^2	0.7502
	AIC	3323.4	AIC	2143.13	AIC	2261.28	AIC	1077.38
	BIC	3511.1	BIC	2319.79	BIC	2437.94	BIC	1254.05

mandatory activity levels, while land use diversity has the opposite effect. Interestingly, mandatory activities, which usually have fixed locations, are not influenced by the distance to the transit stops in the neighbourhood. This evidence shows that the built environment influences mandatory activities at the destination rather than in the residential area. For instance, most individuals in the study zone must travel long distances outside the neighbourhood to reach the employment hot spots in the city centre, despite the travel time reductions due to TransMiCable (Guzman et al., 2024). Consequently, policy interventions must consider the effects of increasing the opportunities for flexible and care activities among commuters near their fixed activity location to positively impact their activity participation levels.

On the other hand, built environment variables in the residential area positively affect flexible and care activities, considering that most of their trips are inside the neighbourhood. An increase in the distance to bus stops negatively influences activity participation. In this area of Bogotá, where the TransMilenio has no nearby stations (>2.8 km away), the buses are frequently used for inter and intra-neighbourhood travel (Guevara et al., 2024; Villar-Uribe, 2021). Furthermore, traditional buses continue as the primary transit mode after the inauguration of ACC projects, which is evidence of their importance in those areas (Cardona et al., 2024). Interestingly, population density slightly increases care activities, evidence that high-density areas need more attention regarding care policy. This result is opposite to those found in Barcelona, where the population density is associated with a decrease in the number of trips for daily shopping and accompanying others (Gómez-Varo et al., 2023).

5.4. *The effects of socioeconomic characteristics on activity participation among disadvantaged communities*

Activity participation levels increase for both neighbourhoods in the studied period, reducing the risk of social exclusion (Cordoba et al., 2014). However, sociodemographic characteristics can reveal hidden inequalities among different groups. For instance, people who are highly educated have a higher probability of engaging in more activities, particularly mandatory and flexible activities, when their participation in care activities diminishes. Similarly, occupation exacerbated activity participation differences, e.g., people involved in household chores engaged in more flexible and care activities, but fewer mandatory activities, a pattern consistent with findings in LAC (Luz et al., 2022; Murillo-Munar et al., 2023) and Europe (Gómez-Varo et al., 2023). The relationship between the household head and participation levels is interesting. The partners participate less, but this effect is insignificant in the care activity category. For example, a recent study in Ciudad Bolivar's care block program found that most unpaid caregivers are female heads of households (Guevara et al., 2024).

While previous studies in LAC found a positive relationship between age and activity participation (Luz et al., 2022), our findings suggest a non-linear relationship, which has also been evidenced in studies in the Global North (Allen & Farber, 2020; Fransen et al., 2018). People over the age of 60 conducted fewer activities compared to people aged between 45 and 60 years. Furthermore, being young (age 18 to 30) increases the possibility of participating in mandatory activities. Finally, age is not a significant predictor of flexible activities. This is an interesting result, considering that being an older adult does not hinder their flexible activity levels, as it negatively influences other activity categories; therefore, public policy efforts should focus on preserving this equity across age groups.

We also found that an increase in the number of household members reduces the probability of participating in out-of-home activities at the individual level, which is aligned with the literature among low-income residents (Cheng et al., 2019). Besides, the presence of children increases the likelihood of engaging in care activities, similar to other case studies about care mobility (Gómez-Varo et al., 2023). In addition, car ownership is low in both neighbourhoods and, therefore, does not influence activity participation, which aligns with previous research conducted in the area (Guzman et al., 2024). On the other hand, motorcycle ownership positively impacts care activities. Diverging from the Global North, where car ownership is a high predictor of activity participation and a driver of social exclusion (Allen & Farber, 2020; Fransen et al., 2018), motorcycles in LAC are more affordable and accessible, particularly among low-income households (Chiu et al., 2023; Hagen et al., 2016), making them an option for many travel purposes, including care-related trips.

6. Conclusions

This research outlines the impact of an ACC on activity participation by examining the effects of Ciudad Bolivar's TransMiCable. Furthermore, it provides empirical evidence about the role of individual, household and built environment variables in shaping activity participation among disadvantaged communities in LAC, something underexplored in the Global South context. By using repetitive cross-sectional data, the research demonstrates its potential to make ex-post evaluations of transport projects. However, the time gap between the household travel surveys constrains the control over unplanned processes and public policies implemented independently from the ACC project. In addition, changes in the questionnaire and travel purposes options, particularly for flexible and care activities, can influence our results. These limitations were mitigated by employing a natural experiment and the model specification by incorporating controls for temporal and neighbourhood changes and respondents' individual and household characteristics. Finally, there are three primary conclusions.

First, we found that the ACC increased activity participation, which was mainly influenced by the rise in flexible and care activities. Results presented in this article provide empirical evidence of how ACC projects positively affect travel behaviour by decreasing commuting travel time and costs and increasing activity participation for travel purposes that are principally conducted at the residential level. This highlights the impact of complementary projects that came with the intervention of social urbanism. These findings reinforce recommendations that decision-makers should prioritise complementary projects as key strategies to magnify the impact of ACC transit projects in disadvantaged communities. The impacts of ACC are also highly context-dependent and influenced by its role in the transit network. The transferability of these outcomes to other ACC projects must, therefore, be carefully analysed. More empirical evidence must also be collected among case studies where ACC plays an essential role in the public transport network. In addition, there is a potential to explore the impact of the ACC on transport poverty by considering its linkages with activity participation (e.g. Allen & Farber, 2020; Luz et al., 2022; Tiznado-Aitken et al., 2024), something that could be developed in future investigations.

The second primary conclusion deals with the associations of gender on activity participation and the particular effect of the ACC. The outcomes reveal a lower likelihood of females conducting care activities in 2019; nevertheless, we find the results to be independent of the ACC project. This could be related to public policies like the District Care System and Care Blocks Program, which were implemented throughout the city. This is the first study exploring the effects of an ACC in care activities as a separate category through an activity participation-based model. Future research should focus on the impact of public policies and transport projects on the just distribution of care activities and gender roles in society. Besides, efforts should be made to refine care-related activity categories, especially for shopping and errand activities related to family care.

The third key finding is related to the scale effects of the built environment on activity participation, which is relevant for decision-makers. Mandatory activity participation is more influenced by the land use in the destination, e.g., job accessibility, while variables at the residential level, such as bus stop proximity and population density, influence more flexible and care activity levels. This is relevant in policymaking because transport projects and facility provisions should be designed to focus on the main impacts of specific activity participation categories. In addition, the lack of significant effects of bus proximity in mandatory activities suggests that commuters among disadvantaged communities are constrained by their fixed activity location, trip distance, and the high competitiveness of accessing the labour market. Future research should investigate this effect by providing evidence by considering job accessibility, trip distance and the labour market competitiveness at the individual level while controlling for the effects of the process at the city level. This can be potentially addressed in future investigations by including person-based accessibility and spatial availability measures in the models.

CRediT authorship contribution statement

Santiago Cardona-Urrea: Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Jaime Soza-Parra:** Writing – review & editing, Validation, Supervision, Software, Methodology, Investigation. **Dick Ettema:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation, Conceptualization.

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Declaration of competing interest

No potential conflict of interest was reported by the author(s).

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Data availability

Open data from government portals were used. The links to search the data were provided.

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