Cities under lockdown: Mobility and access inequalities stemming from COVID-19 in urban Colombia

Daniel Oviedo[1], Luis A. Guzman[2], Julian Arellana[3], Orlando Sabogal-Cardona[1], Carlos Moncada[4], Lynn Scholl[5]

[1]University College London

[2]Universidad de Los Andes

[3]Universidad del Norte

[4]Universidad Nacional de Colombia

[5]Interamerican Development Bank

Daniel Oviedo

Dr Daniel Oviedo is Assistant Professor at the Bartlett Development Planning Unit of University College London. An engineer and development planner by training, Daniel has over ten years of experience in the analysis of social and spatial inequalities of urban mobility, and the role of formal and informal transport on social inclusion and well-being in cities of Latin America and Africa.

Luis A. Guzman

Luis A. Guzman is an Associated Professor at the School of Engineering at Universidad de los Andes (Bogotá, Colombia). Dr. Guzman research interests include urban mobility, transport and land-use interaction and social, economic and spatial analysis of inequalities related to urban transport and policy evaluation in Latin America. He is also a consultant and adviser in different urban transport projects in Colombia. Author of several articles published in international journals related to the evaluation of transport policies, poverty, equity and urban structure.

Julian Arellana

Julian is Dean of the College of Engineering at Universidad del Norte in Barranquilla, Colombia. He holds a Civil Engineer degree from Universidad del Norte, MSc and PhD degrees in Engineering Sciences from the Pontificia Universidad Católica de Chile. He is a member of the Academic Network of Mobility in Colombia, the Pan-American Society for Transport Research, and the International Network for Transport and Accessibility in Low-Income Communities for Latin America. He has co-authored more than 45 articles in scientific journals. His areas of interest are transport modelling, transport planning, transport economics, active mobility, and the novel application of choice experiments.

Orlando Sabogal-Cardona

Orlando is a PhD student at The Bartlett Development Planning Unit DPU in University College London. He is an engineer with expertise in studying urban and transportation issues. As part of his previous jobs he has developed skills in programming (R user) to conduct data analysis, statistical models, geographic computation tasks, visualization, map-

making, and in general, to make sense of data. His work has two distinguishing features: a theoretical driven approach to analyse data (understand what he is statically modelling) and a strong geographical component. Advocate of R, open data, and reproducible research.

Carlos Moncada

Civil Engineer, PhD in Engineering-Transport, MSc in Transport Engineering, MSc in Infrastructure Planning – 21 years of experience in transport and infrastructure projects as director, consultant, advisor and engineer in public and private sector of developing countries – Associate Professor in transport planning and transport policy – Transport Modeller - Head of Department of Civil and Agricultural Engineering at Universidad Nacional de Colombia (2018-2022).

Lynn Scholl

She is a senior transport specialist at the Interamerican Development Bank IDB where she leads research projects on inclusive sustainable transport in the Latin American and the Caribbean LAC region. She holds a PhD on public policy from the School of Public Policy at UC Berkeley. More recently, she has been working in the intersection of machine learning and videos to assess traffic calming interventions intended to improve well-being of vulnerable users. Since three years ago she has been pushing a research agenda on how app-based mobility can be used to produce positive social outcomes.

Abstract

The effects of the COVID-19 pandemic on cities have transformed the lives of urban societies across the globe. One of such effects has been the redefinition of access and urban mobility patterns, exposing divides and inequalities along the lines of class, gender and social positions. In Latin America, long-term lockdowns and widespread containment-oriented restrictions have deepened already acute conditions of poverty and deprivation. Low-income and socially vulnerable households and individuals in countries such as Colombia find themselves unable, or in a disadvantaged position, to work from home, access goods and services securely, and avoid transport modes that increase exposure to contagion. This chapter examines inequalities in urban mobility and access to essential opportunities in urban settings in Colombia, through data collected from 3,900 respondents to a web survey organized during the national lockdown in the country in April 2020. The chapter presents a Latent Class Analysis model exploring how intersecting differences of class, gender, ethnicity, age, and other relevant socioeconomic characteristics, influence the degree of adaptability and capacity to adapt to the challenging conditions posed by COVID-19 for physical travel and carrying out everyday activities. Building on three distinct classes of mobility and access-related conditions, the chapter reflects on structural inequalities associated with Colombian cities' urban form, functional and productive structures, and its wide social gaps. The paper builds on empirical findings to reflect on urban policy and discuss avenues for addressing social and spatial inequalities worsened by the pandemic.

Keywords: COVID-19; urban mobility; urban access; inequality; Colombia.

1. Introduction

According to a Lancet report on COVID-19 in Latin America and the Caribbean (LAC) (Burki, 2020), the Coronavirus disease arrived late in the region compared to other parts of the world. Only weeks after the first case was reported in Brazil on February 25, 2020, many countries enforced isolation measures that involved the suspension of international travel, border closures, and widespread lockdowns.

In addition to the significant loss of human lives and strain on unprepared and insufficient hospitals and medical facilities (Burki, 2020), economic shutdowns and lockdown measures taken in response to the pandemic have also led to impacts such as rising unemployment, increases in economic vulnerability and extreme poverty, hunger and social tensions (Shammi et al., 2020). Moreover, LAC countries have some of the highest rates of inequality, which are positively correlated with the number of COVID-related deaths (Bolaño-Ortiz et al., 2020). Such conditions challenge recovery and future development in the region, raising questions on the scale of the negative social impacts of the pandemic and how to enable those who need it the most to access essential opportunities, goods, and services that can mitigate the pandemic's negative consequences.

It is in such a context that this chapter provides a snapshot of the effects of lockdowns and other policy responses to COVID-19 concerning urban mobility and access to opportunities in Colombian cities. Building on a web-based survey with over 3,900 respondents across the country, which does not aim to be representative of the general population, the research interrogates COVID-related mobility and activity behaviors among urban populations, reflecting on the structural inequalities associated with the urban form, transport supply, and functional configurations of cities in Colombia. The research adopts perspectives of mobility

and access to opportunities as analytical lenses given the strong emphasis of policy measures across LAC on emergency shutdowns and restrictions of physical movement, which limit the availability of opportunities and increase dependency on digital connectivity and delivery of goods and services.

COVID-19 raises important questions about how to reduce health risks while ensuring equitable access to critical urban activities for populations often in peripheral locations enduring long daily commutes. The majority of the poor in large cities of LAC work in activities with variable or centralized locations, which makes them heavily dependent on public transport (Boisjoly et al., 2017; Guzman et al., 2021a). The economic activities of low-income populations are commonly informal and are largely dependent on low-skilled labour. Jobs in the informal economy commonly share a lack of security, access to social protection and fair wages (Günther and Launov, 2012). Citizens working in such activities are frequently unable to work from home, due to either the nature of their jobs and/or to a lack of access to critical resources (such as computers and internet connection), or to access social support in compensation for their lack of income. Social distancing and measures to control local outbreaks forced millions already dealing with acute poverty, lack of basic connectivity, and limited access to formal livelihoods, social security, and safety nets (Renahy et al., 2018; Roelfs et al., 2011) to engage in physical travel and exposure to contagion to maintain their livelihoods and access essential goods and services.

This research addresses the relevance of digital connectivity and types of employment for accessibility, particularly under conditions that challenge urban forms built around physical travel as a precondition for access. We provide a statistical and quantitative analysis of physical and social mechanisms through which communities travel and secure local and

city-level accessibility. We also use a Latent Class Analysis (LCA) model to examine how intersecting differences of class, gender, ethnicity, age, and other relevant socioeconomic characteristics influence the degree of adaptability to the challenging conditions posed by COVID-19 for physical travel and carrying out everyday activities. Finally, we provide reflections for research and practice around mobility and access inequalities associated with the pandemic and considerations for future recovery in Colombia and LAC.

2. Literature review

2.1. Structural urban inequalities in Latin America and Colombia preceding the pandemic

The built environment of LAC cities is complex and influences social and environmental determinants of health (Sarmiento et al., 2021). Also, the rapid increase in the urban population (CEPAL, 2017) in recent decades has implications for social exclusion, vulnerability, and disorganized urban growth (Rodríguez-Vignoli and Rowe, 2018). This translates into considerable challenges for the provision of accessibility to local services, urban amenities, and work opportunities, as well as in limited empowerment of urban and peri-urban citizens to overcome increasing distances and physical challenges for interacting with the city (Keeling, 2008). Such conditions have now been further compounded by a long series of strict lockdowns that lasted nearly four months (March to August, 2020) and were progressively relaxed, although widespread restrictions to access and mobility associated with COVID-19 remained for most of 2020.

Urban expansion in the region led to an increase in socioeconomic segregation as well as growing spatial segregation between wealthier and poorer households. Jobs and services

in most cities tend to be physically concentrated close to or in central business districts (Andreano et al., 2021; Inostroza et al., 2013). Economic disparities lead to the marginality of specific social groups that, in turn, result in a lack of public amenities, security, and dependency on motorized transport (Coatsworth, 2008; Smets and Salman, 2016). In Colombia, cities are also characterized by deficits in urban infrastructure and public services that confront citizens with increasing levels of insecurity, road-related hazards, and decreasing quality of the environment due to noise and air pollution.

Thibert and Osorio (2014) argue that most cities in the region have strong tendencies toward spatial segregation, defined as the concentration of social groups (determined by income, ethnicity, and status, among others) in specific areas of a city. Such segregation is heightened, on the one hand, by the development of both gated communities and suburban settlements of high value and connectivity by the elites, who seek larger spaces, security and a reduced social mix by living farther from the city center in more segregated and homogeneous neighborhoods in terms of both land use and socioeconomic strata. On the other hand, by the development and consolidation of both formal and informal settlements of low-cost housing for the poor in areas where land is still affordable, which tends to be in the periphery or less attractive suburban areas (Thibert and Osorio, 2014).

2.2. COVID-19 and urban mobility

Research about the distributional and urban effects of the pandemic has grown considerably since April 2021 with a larger share of recent scholarship focusing on the Global North and contexts where the virus hit earlier (Cash and Patel, 2020; Sohrabi et al., 2020). A significant area of focus in the literature has been the changes in lifestyle behaviors as a consequence of the pandemic and the array of measures taken in response to it (Balanzá–Martínez et al.,

2020). Some authors argue that behavioral and social sciences will play a significant role in addressing such changes to inform decisions in the short and medium-term (van Bavel et al., 2020). Food insecurity and unemployment have been identified as significant concerns, particularly for the poor facing restricted mobility and an incapacity to adapt to remote working (Guzman et al., 2021a; Power et al., 2020; Roelfs et al., 2011).

The effects of the pandemic on urban transport and mobility are diverse and have not been sufficiently covered in the literature. How safe will it be to return to public transport remains an open question, with research alluding to public transport as a significant vector of contagion for general airborne transmitted diseases (Troko et al., 2011). In particular, overcrowding conditions in public transport systems have been suggested as a risk factor in the spreading of COVID-19 (Sohrabi et al., 2020; Yang et al., 2020), with many public transport authorities resorting to suspend or restrict services.

Beyond debates on public transport and mobility behavior, significant concerns in the current agenda around urban transport in a COVID and post-COVID world are the rapid advance of climate change and changing risk of contagion. Such concerns have made evident the need to (i) modify mobility habits in cities (Bashir et al., 2020; Nordbakke and Olsen, 2019; van Wee et al., 2019), and (ii) to devise strategies for long-term transformations in the distribution of urban land and infrastructure (Carter, 2018). Most literature acknowledges the likelihood of a marginal modal shift to private motorized vehicles in the context of the pandemic (Gutiérrez et al., 2020; Muley et al., 2020).

Such changes in behavior can not only widen gaps in access and mobility across urban populations but would negatively impact sustainability goals. Scholarship in the context of COVID-19 and before the pandemic suggests the transition to non-motorized alternatives

such as walking and cycling as a desirable direction for future urban mobility (Arellana et al., 2020) and public health (Brooks et al., 2021) in LAC. Such debates call into question the long-term implications of the pandemic on transport and urban planning and decision-making (Megahed and Ghoneim, 2020), needing further research that examines individual and collective perceptions and preferences about risk, mobility (Muley et al., 2020), activity patterns and needs and capacity to make use of different forms of transport.

3. Methodology

3.1 Data collection

Data for this research was collected through a web-based survey issued between April 2, 2020, and May 27 2020. The survey was part of a collective initiative led by researchers and universities in Colombia to understand the effects of COVID-19 on urban mobility and daily life activities. Data collection started two weeks after the national government announced a complete lockdown in Colombia and, as a consequence, the results are a picture of the impacts and perceptions in the early days of the lockdown. The lockdown included the closure of schools, universities, shops, and any commercial businesses, and constraints to mobility. For everybody but essential workers and delivery services, it was mandatory to stay at home.

The survey included three sections. The first section included demographic information about the individual and the household, such as age, gender, household composition, vehicle ownership, household socioeconomic strata (SES), education level, occupation, and household location. In Colombia, SES classifies households into six categories and is considered a proxy variable for household income (Cantillo-García et al., 2019). The SES

one and two are linked with low-income, three and four with medium-income groups, while five and six with wealthy households. Second, information about travel decisions and time expenditure for different activities (i.e., work, study, shopping, sports, leisure, health, and time with family) were asked in a week before the COVID-19 and during the lockdown. The survey inquired about people's ability to perform activities from home and travel information such as modes of transport, trip costs and travel time. Third, we collected perception information about social, economic, technological, and personal impacts derived from the measures adopted by governments in response to the pandemic. In this section, respondents were asked to express their level of agreement with several statements about the impacts of the pandemic, using a Likert scale ranging from 1 (strong disagreement) to 5 (strong agreement).

We performed a preliminary data cleaning process to remove respondents with short (i.e., least than 5 minutes) and high (i.e., more than 2 hours) response times. We also removed surveys with more than 70% of unanswered questions. After the cleaning process, we reached above 3,900 respondents distributed throughout Colombia.

3.2 Data Analysis

The data was analyzed using two complementary approaches. First, we used exploratory data analysis and descriptive statistics to understand the main activity and mobility patterns. Second, we used a Latent Class Analysis (LCA) to identify sub-population groups that allow disentangling heterogeneity in activity and mobility patterns during the pandemic. Based on the formulation of the LCA, we seek to test the hypothesis that mobility patterns and times spent on different activities during the lockdown are not homogeneous across the population.

LCA is a statistical technique (Denson and Ing, 2014; Porcu and Giambona, 2017) that is commonly used in the social sciences for classifying individuals into unobserved classes or clusters with similar characteristics or behavioral patterns. LCA identifies clusters in such a way that they are as different among them as possible, but as homogenous within them as possible. The LCA is based on the idea of a latent variable, which exists but is not directly measured. Instead, a latent variable causes the scores and correlations observed in the measured variables (also known as indicators). Then, indicators can be used to identify and measure the original latent variable. Latent variables represent perceptions, attitudes, and personal traits. Nonetheless, a peculiarity in LCA is that the indicators are categorical and the latent variable itself generates a categorical response. Widely used in psychology and other social sciences, LCA has proved to be useful in studying transport and urban topics (Lee et al., 2020). LCA is most useful when researchers do not know the number of clusters in the data and therefore, involves running several models for a different number of categories in search of the model with the best fit, and that enables more interpretability. The Akaike information criterion AKI and the Bayesian information criterion BIC are the two measures used in LCA to assess goodness of fit, a model with lower values than others is preferred.

Conceptually, the LCA model has two components (**Figure 1**). The first one refers to a class membership component predicting the probability of an individual belonging to a particular class. The second component is the measurement model, which includes the manifest variables that, in this case, allow observing different activity and mobility patterns.

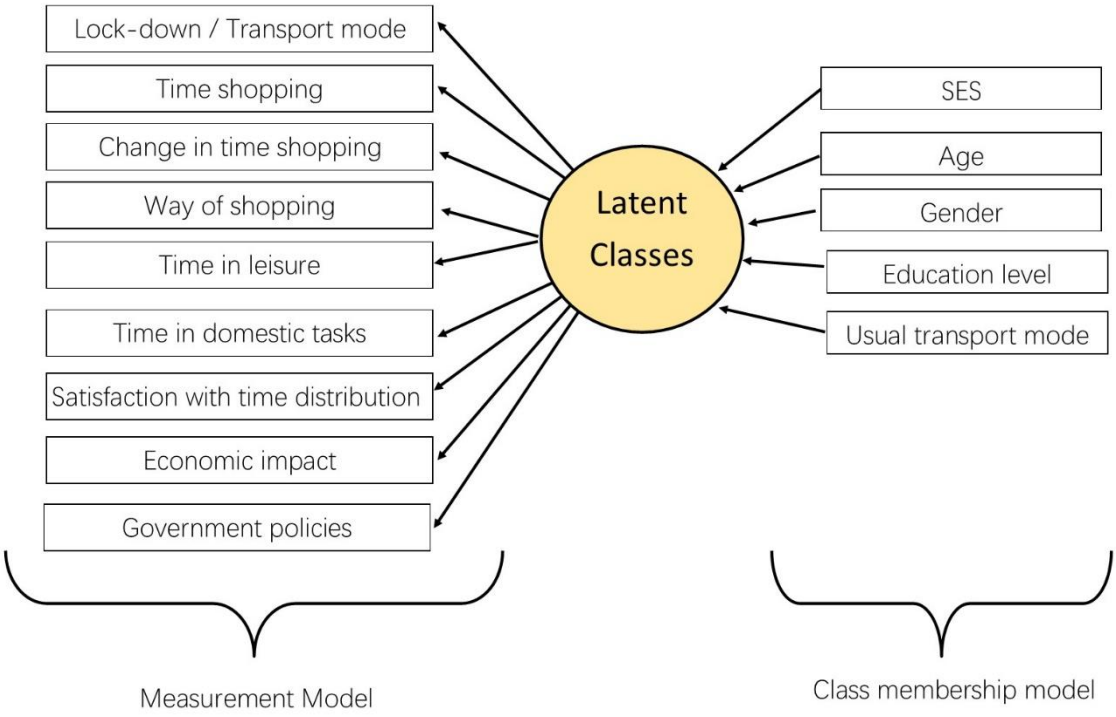

Figure 1. LCA model components

The class membership component in this study consists of a multinomial model considering SES, age, gender, education level, and usual transport mode. These variables are individual characteristics that were not caused or affected by the COVID-19 outbreak. Instead, in the context of the pandemic and the lockdown, these variables become predictors of the capacity to stay at home, reallocate activity times, and the perceptions of the potential pandemic impacts.

Indicators in our model include responses to perception questions such as satisfaction with the time distribution, the economic impact, and the agreement with government policies adopted during the pandemic. Other indicators refer to travel decisions and the time spent participating in different activities during the lockdown. Unfortunately, given high rates of incomplete surveys, the subsample used for the LCA was reduced to 628 respondents. While the reduction in the sample was considerable, most missing values were very relevant for the analysis presented and corresponded to attitudinal questions for which it was not possible to input values. All data processing and plots were performed in the R programming language (Wickham et al., 2019), and the LCA was run with the poLCA package (Kennedy, 2013).

4. Results: Access and mobility inequalities during the pandemic

4.1 Exploratory data analysis

To understand access and mobility inequalities during the pandemic, we aggregated results by three income groups: low, middle, and high-income. Table 1 shows descriptive statistics of the indicative sample, that were used to analyze mobility and activity patterns, and the subsample used to develop the LCA modeling.

Table 1. Descriptive statistics

	Total sample		Subsample (for LCA)	
	People in survey	Percentage	People in survey	Percentage
Income group				
High (SES 5 and 6)	590	15.71%	105	16.72%
Medium (SES 3 and 4)	2063	54.93%	159	25.32%
Low (SES 1 and 2)	1103	29.37%	364	57.96%
Gender				
Male	1889	50.13%	321	51.11%
Female	1862	49.42%	307	48.89%
Prefer not to say	17	0.45%	0	0.00%
Household size				
1	263	7.00%	60	9.55%
2	758	20.16%	156	24.84%
3	996	26.50%	156	24.84%
4	946	25.17%	140	22.29%
5	443	11.79%	57	9.08%
6	167	4.44%	34	5.41%
> 7	186	4.95%	25	3.98%
Age				
0 - 15	17	0.45%	3	0.48%
15 -20	224	5.93%	26	4.14%
20 - 30	1,309	34.67%	205	32.64%
30 - 40	1,089	28.84%	180	28.66%
40 - 50	646	17.11%	131	20.86%
50 - 60	373	9.88%	65	10.35%
More than 60	118	3.13%	18	2.87%
Education level				
Low	697	18.47%	91	14.49%
Medium	643	17.04%	94	14.97%
High	1,150	30.47%	185	29.46%
Very high	1,284	34.02%	258	41.08%
Transport mode				
Public transport	1,700	56.84%	350	55.73%
Cycling/Walking	416	13.91%	84	13.38%
Motorcycle	115	3.84%	32	5.10%
Car	592	19.79%	125	19.90%

Taxi	112	3.74%	25	3.98%
Other	56	1.87%	12	1.91%

As shown in Table 1, over half of the respondents in the full sample are in the low-income group. Respondents in the high-income group are much less than in the medium-income group. The latter (i.e., SES three and four), is the larger income group in the country, which suggests a potential bias in the sample. The gender distribution is balanced, with 50.1% of males in the total sample and 49.4% of females. Households are between 2 and 4 members, with only 7% of the sample living alone. Furthermore, 4.4% of respondents declared to live in households with six members and 5.0% in households with seven or more members. Finally, the modal share shows that public transport was (before the pandemic) the main mobility alternative for 56.8% of surveyed people, followed by car (19.8%) and cycling or walking (13.9%). Regarding the subsample for the LCA, despite containing a higher concentration of low-SES respondents (57.9%), the percentages reported for all other variables in Table 1 are very similar to the total sample.

Our examination of access and mobility inequalities associated with pandemic-related lockdowns compared results in specific dimensions across the three income groups presented in Table 1. We first analyzed the ability of respondents in different income groups to work from home. The low-income group shows the smallest proportion of respondents teleworking during lockdown (35%). By contrast, the share of the sample in the middle- and high-SES groups able to telework were 70% and 87%, respectively (Figure 2 above). Such findings can be related to a higher proportion of informal and unskilled labor in the low-SES group. In LAC, 53% of the employed population works in the informal economy. In Colombia, this figure is over 45% of the economically active urban population (Guzman et al., 2021a).

Underemployment, a proxy of the underutilization of the productive capacity of the employed population, affects 37% of the poorest urban youth, 24% for those in medium and 28% in high-income groups.

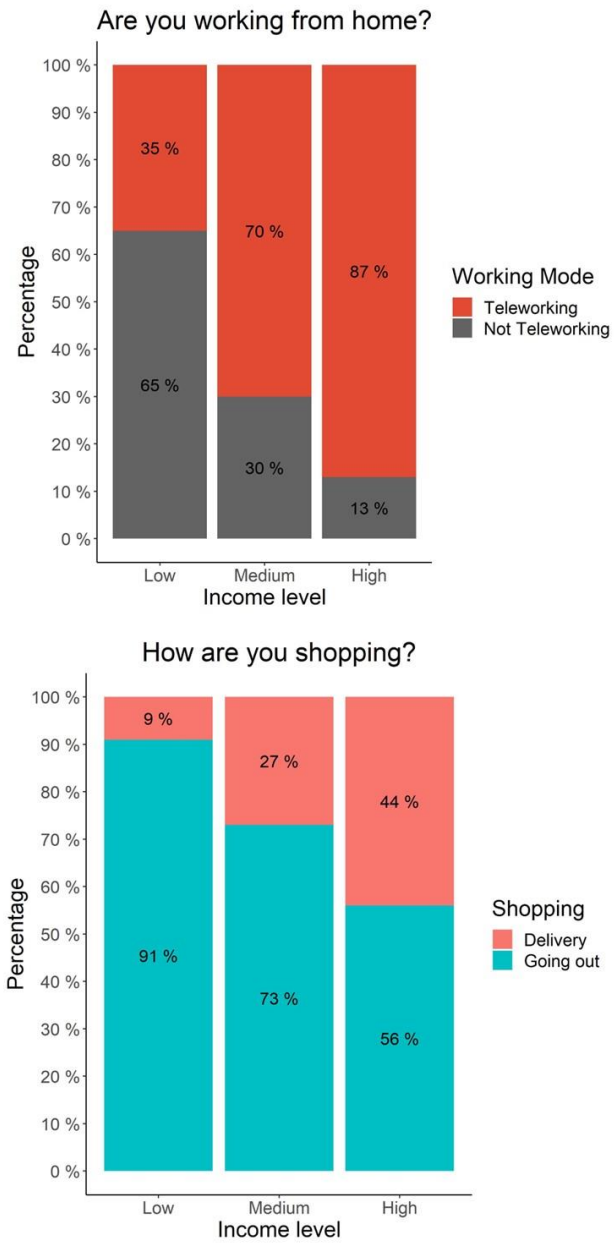

Figure 2. Share of respondents teleworking by income group (above) and shopping by income groups during the lockdown (below)

Results in Figure 2 (above) serve as entry points for discussing access to digital connectivity and transport as drivers of inequalities associated with the pandemic. On the one hand, according to CEPAL (2017), data internet coverage in Colombia is close to 60%, and the internet speed of those who have access is four times slower than in OECD countries. Furthermore, internet connectivity is only about 21% in the low-income group, while in the high-income group, it is 98%. This suggests the intersection of different forms of disadvantage, worsening the conditions for those already in precarious employment as a consequence of the wide digital divide in the country.

On the other hand, despite evidence supporting the links between crowding in public transport systems and the spread of COVID-19, Colombian national authorities issued a decree on April 15, 2020, limiting public transport supply by reducing operating fleets and capping occupation of public transport vehicles at 35%. From September 2020, the limit rose to 50%. This decision negatively affects mostly the low-income segment of the population by lengthening their travel times due to the decrease in frequencies while increasing congestion and social tensions in and around bus stops across the country. A large share of the low-income urban population in the sample is not able to work from home (Figure 2-above). Restrictions on public transport can lead to perverse incentives that encourage the use of private transport. Such incentives are larger among those social groups who are already in an advantageous position to reduce exposure, while negatively affecting the travel conditions of the low-income group. Moreover, Colombian cities show a progressive uptake of private motorcycles among low and middle-low SES households, which previous research has found to be positively correlated with decreases in public transport quality and availability in some country areas (Kopp, 2011). This suggests that some of the unintended effects of the intersection between the inability to telework, strict lockdowns, and reduction

in public transport, may lead to a rapid increase in motorcycles and their negative externalities, especially among low-income groups over time.

Second, we analyzed patterns of access to goods as reflected by shopping activities in each income group. Figure 2 (below) suggests that the majority of people in the low-income group remain dependent on in-store shopping during the lockdown. Cash flow and access to banking and electronic payment are correlated with employment status, the formality of work and income, which excludes a majority in the low-income group from the digital economy. Moreover, subsistence economies, predominant among low-income households force people to address their needs daily. By contrast, groups with more stable income and access to banking and electronic payment systems such as medium- and high-income groups can afford weekly, and monthly shopping of groceries and other essentials, as well as are more prone to shop retail. Online shopping and deliveries have increased considerably during the pandemic, primarily due to fear of contagion. However, there is a relevant cost added to the value of online shopping which is unaffordable for some income groups. Despite a relatively low penetration of online shopping in Colombia, Figure 2 (below) reflects that delivery use is considerably higher in the high-income group.

Levels of satisfaction with the measures adopted by local administrations and the national government also vary by income group. The policy response prioritized preventing COVID-19 transmission in urban centers by closing stadiums, theatres, cinemas, and public spaces. **Figure 3** (above) suggests that the highest level of disagreement (19%) is found in the low-income group, who has been the most affected. About 17% of the middle- and 10% of the high-income respondents reported disagreement with policies implemented during the pandemic. Agreement with such measures is higher in the wealthiest group (i.e., 87%).

Despite such visible differences, although Colombia's lockdown is the most prolonged in the LAC region (four months), the approval rate in all income groups was higher than 70%.

Results of approval of policy responses to the pandemic stand in stark contrast with the perceived economic impact of lockdowns. **Figure 3** (below) shows that about 75% of the respondents from the lowest income group perceive that the effect of the pandemic on their economic situation has been high (i.e., score of 4 or more on a scale of 1 to 5). In contrast, this percentage is 46% and 59%, for the high- and middle-income groups, respectively. Only about 8% in the low-income group reported being unaffected economically, while this percentage was 18% and 25% in the middle- and high-income groups, respectively.

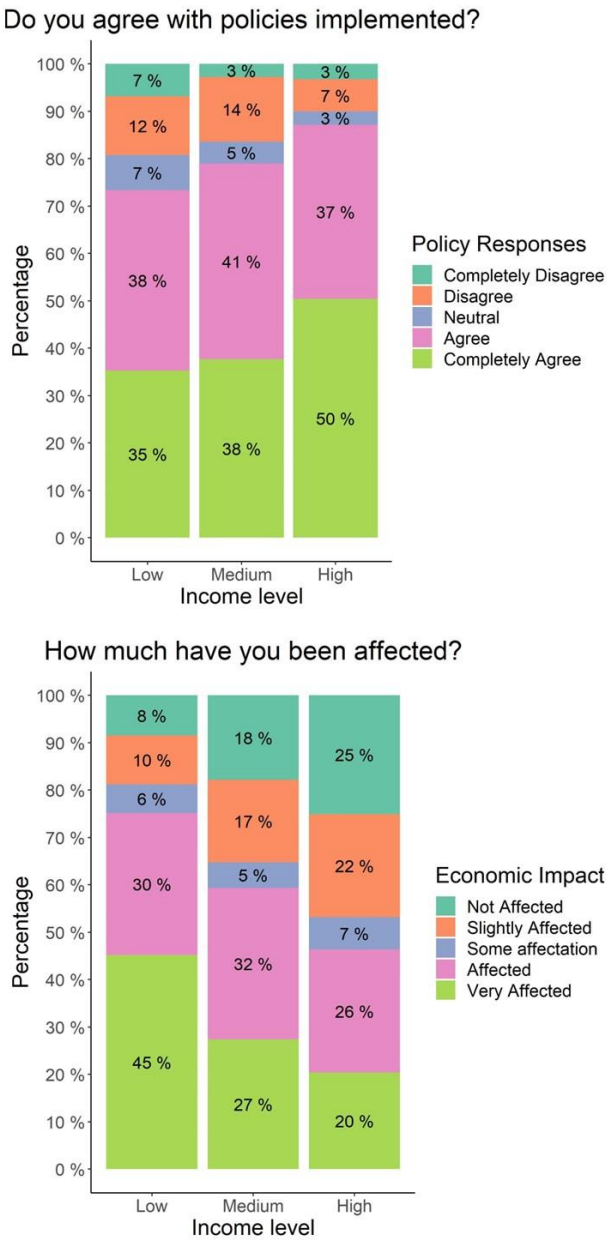

Figure 3. Agreement with policies implemented by income groups (above) and economic impact by income group (below)

4.2 Latent Class Analysis results

We ran eight LCA model versions considering two to ten clusters to identify the best number of clusters. The model with three clusters reported the lowest AIC and BIC values and defines the most understandable and easy to differentiate classes within the sample. The distribution of the main characteristics of each latent class is summarised in Table 2 below.

Table 2. Description of the three latent classes

	Total Proportions		
	Class 1 (Not Working from Home (WFH) + public transport)	**Class 2 (WFH + car)**	**Class 3 (WFH + multimodal)**
Share	34.08%	37.10%	28.82%
Transport mode during pandemic for the main trip purpose			
Walking and Cycling	2.39%	2.23%	0.00%
Car	0.48%	5.10%	0.00%
Motorcycle	0.00%	0.00%	0.80%
Other	0.64%	0.16%	0.16%
Taxi	1.11%	1.43%	0.00%
Public transport	18.63%	0.48%	0.00%
Currently teleworking	10.83%	27.71%	27.87%
Time shopping			
< 2 hours	24.52%	21.82%	26.75%
Between 2 and 5 hours	8.76%	14.65%	2.07%
> 5 hours	0.80%	0.64%	0.00%
Change in time shopping			
No changed	8.60%	7.01%	7.32%
Increased	12.90%	12.90%	5.25%
Decreased	12.58%	17.20%	16.24%
Way of shopping			
Delivery	2.39%	11.94%	9.87%
Going out	31.69%	25.16%	18.95%
Time in leisure			

< 2 hours	20.70%	20.54%	6.37%
between 2 and 5 hours	8.92%	7.64%	9.55%
> 5 hours	4.46%	8.92%	12.90%
Time in domestic tasks			
< 2 hours	13.06%	6.53%	5.73%
between 2 and 5 hours	7.80%	7.80%	9.55%
> hours	13.22%	22.77%	13.54%
Satisfaction with time distribution			
Unsatisfied	14.33%	18.47%	9.87%
Neutral	3.18%	1.43%	1.11%
Satisfied	16.56%	17.20%	17.83%
Economic impact			
Not affected	5.41%	12.42%	16.56%
Slightly affected	1.43%	1.43%	3.03%
Affected	27.23%	23.25%	9.24%
Government policies			
Disagree	8.92%	3.98%	4.14%
Neutral	1.43%	1.91%	0.16%
Agree	23.73%	31.21%	24.52%
Variables in the class membership model			
SES			
Low	0.80%	5.89%	10.03%
Medium	19.59%	1.91%	3.82%
High	13.69%	29.30%	14.97%
Age			
(0,10]	0.00%	0.32%	0.16%
(15,20]	2.39%	0.64%	1.11%
(20,30]	11.46%	7.32%	13.85%
(30,40]	10.67%	8.12%	9.87%
(40,50]	6.37%	11.78%	2.71%
(50,60]	2.87%	6.53%	0.96%
>60	0.32%	2.39%	0.16%
Gender			
Female	17.20%	17.20%	14.49%
Male	16.88%	19.90%	14.33%
Education level			
Low	9.87%	3.98%	0.64%
Medium	13.85%	0.48%	0.64%

High	8.92%	9.55%	10.99%
Very high	1.43%	23.09%	16.56%
Transport mode (before COVID-19)			
Walking and Cycling	2.23%	3.82%	7.32%
Car	0.64%	17.99%	1.11%
Motorcycle	0.00%	1.43%	3.66%
Other	0.16%	0.96%	0.96%
Taxi	0.00%	2.07%	1.91%
Public transport	31.05%	10.83%	13.85%

The three clusters identified are:

Class 1 – Not Working from Home (WFH) + public transport: This group mainly encompasses regular public transport users in low and mid-SES. The mean age in this latent class is 34.7 years, and this sub-sample has lower education than other classes. Fewer people in this group stayed at home during the lockdown period. Most people continued traveling by public transport, while some shifted to walking and cycling. Moreover, this is the most affected group both economically and concerning access, mobility, and risk of contagion. Not only they did not stay safe at home. They were also unable to enjoy time in leisure activities as much as other groups. Moreover, this group reported an increase in the time spent on domestic tasks.

Class 2 - WFH + car: The second group is composed mainly of car users and some public transport users in middle-SES. They are the oldest group, with a mean age of 42 years. It is the only group without people under 20 years. They are highly educated, and the majority were traveling by car during the lockdown. However, they are mostly feeling economically affected (but not as the first group) and are also investing less time in leisure activities.

Class 3 - WFH + multimodal: The last group was multimodal. People in this latent class use public transport, walking, and the bicycle. People in this cluster are highly educated and are mainly from middle and high SES. They are the youngest group, with a mean age of 31.5 years. Most of the people in this cluster were working from home, but do not report perceived negative impacts. This group shows an increase in time spent on leisure activities and domestic tasks.

Findings from the LCA model support debates around the intersection between different forms of advantage and disadvantage related to socioeconomic characteristics, availability of transport choices, and access to assets and resources to adapt to the changes imposed by the lockdown. Widespread lockdowns across cities in Colombia have caused changes in urban mobility patterns (**Figure 4**). 53% of those surveyed who declared traveling to carry out their main activity despite the mandatory isolation measure, changed their transport modes. People in Class 1 showed a lower rate of change in transport modes with the public transport share decreasing from 90% to almost 50%. This can be associated with a lower number of available alternatives. As shown in **Figure 4** (below), teleworking in Classes 2 and 3 is considered substituted mobility for a large share of respondents in these classes. Public transport and cars were replaced by walking and cycling, especially in Class 3. This can be related to local responses in terms of infrastructure. In Bogotá, the local government implemented an additional 84 km of cycle paths, reducing available space for the circulation of motorized vehicles (Guzman et al., 2021b).

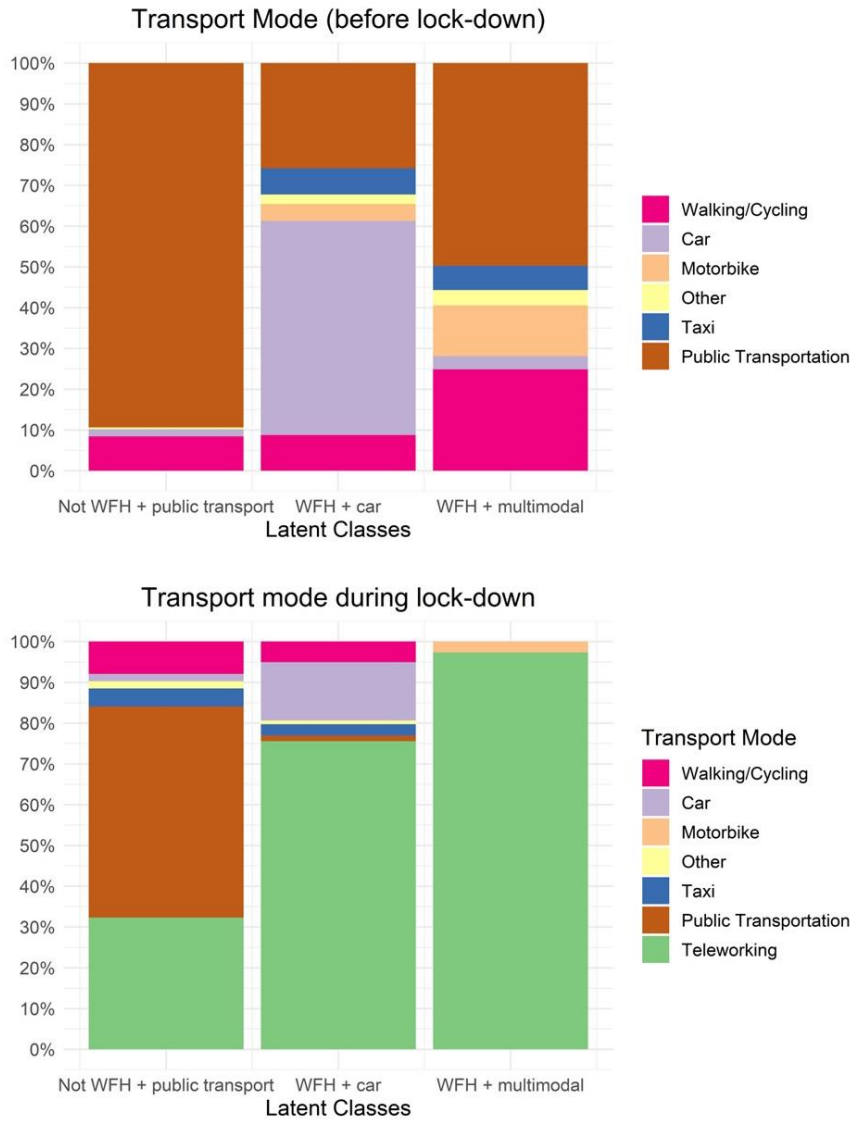

Figure 4. Transport modes before (above) and during (below) the lockdown by clusters identified in the LCA model

Findings related to the distribution of time during lockdown show relevant differences between latent classes (**Figure 5**). 71% of respondents in Class 1, 57% in Class 2, and 71% in Class 3 reported spending less than two hours shopping in a week. This result shows that people in the higher SES, who are more educated and managed to stay at home and telework, faced the least barriers for buying and accessing goods. Such was not the case for respondents in the first two latent classes. Respondents in these groups continued carrying out their shopping more face-to-face and were spending a long time in this activity. The latter can be partly explained by constraints introduced by businesses to comply with government regulations, which often involved long queues and time-consuming protocols.

Most respondents in Classes 1 and 2 reported 2 hours per week dedicated to leisure (61.5% and 53.0% respectively), which suggests potential implications for mental health and well-being. Class 3 reported a higher number of hours dedicated to leisure, with between 2 and 5 hours per week in leisure activities reported by 33% of this group's sample, and a remarkable 42.7% was investing more than five hours. Regarding domestic tasks, Class 2 reported a higher percentage of respondents spending more than 5 hours dedicated to such activities (63%), while in Class 3 this percentage was 47% and in Class 1 it was 38.5%.

The satisfaction of respondents with their time distribution during lockdown suggests inequalities in the perceived effect of the pandemic on the use of time across classes. Respondents in Class 3 show the highest level of satisfaction with their current time distribution (60%). The highest percentage of respondents dissatisfied with the distribution of their time during lockdown are Class 2 (47.9%). The lowest level of dissatisfaction with the use of lockdown time is observed in Class 1 (44.2%). Other results in **Figure 5** suggest that people in Class 3 feel more comfortable with their time distribution during lockdown

because they maintained access and available time for leisure activities than the other classes and have convenience for shopping online and investing shorter times in accessing goods.

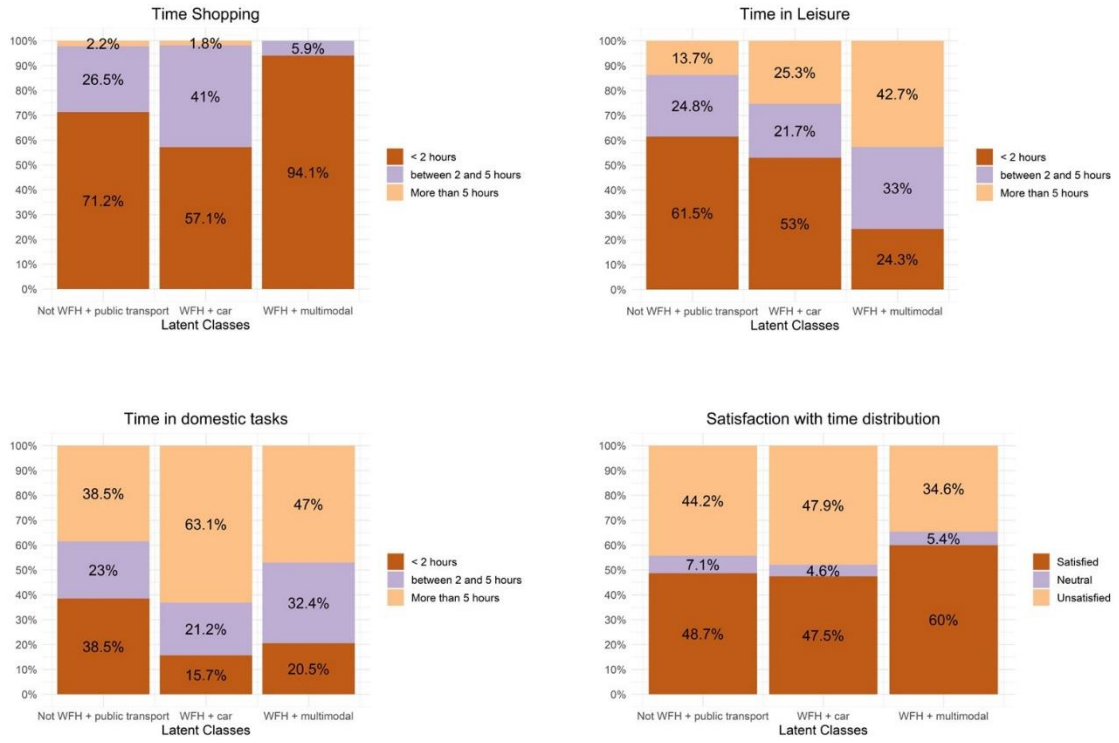

Figure 5. Distribution of time for shopping (a), leisure (b) and domestic tasks (c), and satisfaction with overall distribution (d)

5. Conclusions

The mandatory stay-at-home policy adopted in Colombia due to the pandemic has caused changes in the mobility and activity patterns in cities. Such changes have not been distributed uniformly among the different social groups, affecting differently households and

individuals marked by differences in income, class, gender, employment status, education, and position within the household. Overall, lower-income urban Colombians have been the most affected by measures adopted to reduce the spread of COVID-19 in the country.

Despite the inability to collect a representative sample for the urban population in Colombia, the research builds on one of the largest primary datasets available for the local context during the enforcement of lockdown policies. The findings in this chapter are an indicative testimony to the role of digital tools and social networks in data collection and the production of reliable and rigorous evidence for research and practice.

Structural inequalities underpinning urban forms and mobility in most Colombian cities can be linked with the emerging evidence around mobility and activity behavior associated with lockdowns enforced in response to the pandemic. Our findings align with many of the concerns in the literature regarding which segments of society are more affected by emergency measures. However, despite marked differences in the experience of lockdowns, a large share of citizens in urban Colombia supported the decisions made in the name of public health. This suggests that despite clear perceived impacts to their personal and household economy, there is an overall positive response to health-centered policies and restrictions.

Our findings illustrate the relevance of digital connectivity and non-precarious employment as drivers of more equitable accessibility. COVID-19 has challenged urban structures that assume physical travel as a precondition for access. It becomes clear from our survey that changes in patterns to adapt to such urban structures under restrictions to travel involved differentiated economic, social, and health consequences for communities. The analysis of the use of the time allowed us to identify inequalities in the ability to carry out productive,

social and leisure activities, which have implications beyond the urban and transport fields, as they affect the physical and mental well-being of citizens.

Findings from the LCA suggest that health emergencies can create new divides along the lines of the ability to adapt to the lockdown or accentuate existing inequalities across groups with different conditions of disadvantage. Latent classes are configured more along with the type of engagement with the urban and mobility system and its effects on times and activities, than through distinctions of specific socioeconomic characteristics. Changes in modal choices and time spent in several activities during lockdown show that groups not commonly identified as vulnerable may be facing high economic, mental and social stresses while reinforcing the need to prioritize responses to alleviate the burdens the poor are carrying during the health emergency.

Further research can build on the latent classes identified in this paper to explore other relevant patterns and impacts associated both with lockdown measures and relevant health and social outcomes. In particular, patterns of activity of different classes concerning leisure and social activities are of interest for research exploring the effects of lockdowns on social capital and cohesion. Moreover, the methods for data collection and analysis tested in this research are reproducible. They can be extended to similar contexts, particularly across Latin America. Further research can provide valuable insights for policy and practice during the recovery stages of the current emergency, giving governments and other relevant stakeholders a baseline for prioritizing actions to support those in greater need both because of pre-existing disadvantages or because of conditions created by the pandemic.

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