



Of cooks, crooks and slum-dwellers: Exploring the lived experience of energy and mobility poverty in Mexico's informal settlements



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ABSTRACT

So-called "slum-dwellers" living in informal settlements in Mexico City Metropolitan Area (MCMA) often confront poor health outcomes, face chronic accommodation insecurity and are frequent victims of social intolerance, discrimination and racism. In addition, they usually reside in living environments with precariously hazardous conditions that often lead to their well-being endangerment. Based on extensive original research with slum-dwellers from the MCMA including focus groups (N = 18 participants), household interviews (N = 51 participants), and site visits (N = 5), this study investigates their energy and housing needs, transport and mobility patterns and challenges to their overall quality of life and health. The MCMA is one of the largest metropolitan regions globally, and most of its inhabitants experience a "double energy vulnerability," circumstances whereby people are at an intensified risk of energy and transport poverty simultaneously. Our investigation circles around three key themes. In exploring the subject of extreme poverty and vulnerability, we show not only the problems they confront but also illegal practices such as electricity thefts and coping strategies. In investigating the subject of perpetual peripheralization, we show troubling patterns of discrimination, racism and social intolerance. In exploring the subject of spatial justice, we suggest a set of policies that ought to help achieve it.

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1. Introduction

The Organization for Economic Co-operation and Development (OECD) reports that in the last 15 years, the population within major metropolitan areas have grown faster than in other semi-urban or rural areas worldwide. In tandem with soaring motorization, this rapid urbanisation has resulted in urban sprawls, increasing traffic congestion and longer commuting distances (OECD, 2018). These effects are not limited to negative impacts on mobility but also growing metropolitan areas have contributed to increased urban poverty, promoted the migration from rural to urban centres, and indirectly, these regions have enabled the establishment of informal settlements (Aguilar, 2008; Glaeser, Kahn, & Rappaport, 2008).

An exemplary case of uncontrolled metropolitan growth is Mexico City Metropolitan Area (MCMA); with one in six Mexicans

living in this region, it is the third-most populous metropolitan area within the OECD countries and the largest outside Asia (INEGI, 2018). The MCMA transitioned from having 14 million inhabitants in 1980 to more than 21 million in 2017. That represents a population growth rate of 1.1%, far above the world average and notably above rates in Europe and the United States. Simultaneously, the urban growth rate was significantly higher at 3.3%, shifting from 61,820.37 ha in 1980 to 235,267,873 ha in 2017 (ONU-Habitat, 2018). Most of this growth entails informal settlements and peripherally-located commercial housing, where slum-dwellers have quickly transformed housing units into shops and local businesses (Guerra, Caudillo, Monkkonen, & Montejano, 2018). Although rapid urbanization has precipitated in the last decades, the MCMA has one of the longest histories of large-scale urbanization in the Americas (Monkkonen, Giottonini, & Comandon, 2021).

Historically, urban poverty has a long and complex history, but in Mexico City it began due to topography and colonial land use. Low-income groups invaded steep hillsides, dried-up lake beds,

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and flood-prone areas, leading to the creation of informal settlements, commonly known as slums (UN-HABITAT, 2003). Currently, in Mexico, 25 % of the urban population live in informal settlements, from which 60 % are considered poor or moderately poor and exhibit varying degrees of deprivation and social heterogeneity (Roy, Bernal, & Lees, 2019). Although informal settlements contribute to the upward mobility of the inhabitants, in Mexico city's case, the majority still lack access to basic services, with Roy and colleagues qualifying this urban growth as '*highly unproductive, [one that] deepens inequality [and] raises pollution levels'* (Roy et al., 2019). In order to prevent the expansion of informal settlements, authorities have implemented policies that range from relocation to resettlement colonies and in situ development slums to forced evictions.

Moreover, the MCMA is one of the largest metropolitan regions globally, and most of its inhabitants experience a 'double energy vulnerability' --circumstances whereby people are at an intensified risk of energy and transport poverty simultaneously (Simcock et al., 2021), there is little research addressing these dynamics. Our study addresses this gap directly by delving into the housing, mobility, health and wellbeing of slum-dwellers in the MCMA. Based on an intensive and original mixed methods design involving extensive site visits to slums in MCMA's locations, 51 household interviews and two focus groups with slum-dwellers ($N = 18$), this study analyses slum-dwellers transport and mobility patterns, housing and energy needs, and quality of life. Our discussion focuses on three different areas of relevance to this journal: perpetual peripheralization (including cultural antagonism and intolerance), spatial justice (including instruments to enhance the quality of life and mobility and energy outcomes for marginalized groups living in this region) and extreme poverty and vulnerability (including notions resilience and coping).

2. Background: Contextualizing the Mexico City metropolitan area (MCMA)

Before presenting our research design and conceptual approach, we considered it useful to offer context and general background to the MCMA.

2.1. MCMA's general characteristics

The inland basin of MCMA is at an altitude of 2 240 Mean Sea Level with a diameter of about 50 km with little room for expansion. It has a high population density of 6,000 people living per square kilometre and significant industrial and commercial activities. The MCMA represents about 20 % of Mexico's entire population and emits 9 % of its greenhouse gas (GHG) emissions, surpassing 60 million tonnes of CO₂e yearly (L. T. Molina, de Foy, Martínez, & Figueroa, 2009). The MCMA comprises Mexico City itself and 60 adjacent municipalities of the State of Mexico and Hidalgo (see Fig. 1). Although most of the economic activities and services are provided by Mexico City, their dwellers do not live in Mexico City; instead, the majority live in the fringe of the Metropolitan area, mostly in the Estado de Mexico (Mejía-Dorantes & Villagrán, 2020).

The MCMA is perhaps the most attractive migration pole within Mexico; people from all over the country migrate to this region seeking economic opportunities, improved medical services and education. The MCMA is also characterized by an active segregation process, where medium to high-income households live together in certain districts or suburbs. In contrast, low-income people locate in several fringe areas. This problem delivers extreme differences in access to public services, amenities and opportunities each area has (Vargas & Magaña, 2020). Indeed, like many other big Latin American cities, the MCMA has three key characteristically elements. First, low-income households cluster in low-density peripheral areas, often with limited or no urban services. Second, high-income households concentrate in specific city areas, often near the historic centre and move outward in one direction. Third, there is a greater socioeconomic homogeneity in low-income neighbourhoods (Monkkonen et al., 2021). Some of the most relevant issues affecting the MCMA are pollution, urban congestion, excessive commuting time, unsafe and inefficient public transport, and lack of and insufficient public space (INEGI, 2014). Such circumstances notably affect low-income people including, children, the elderly, women, and other groups at risk of exclusion.

Due to the haphazard nature of urban development of the MCMA, there are countless informal settlements in poor condi-

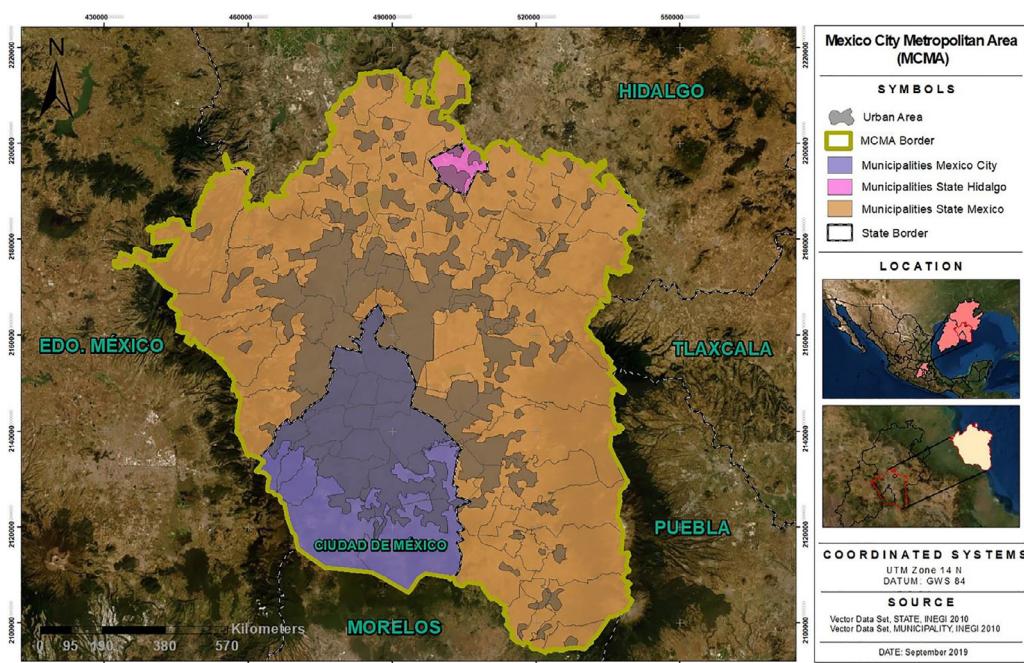


Fig. 1. Mexico City Metropolitan Area. Source (Nacional, 2017).

tions; these are mainly located in the eastern and northeaster parts of the urban areas and the western slopes of the mountains. Another issue emerges from the centralization of jobs. In this sense, Mexico City is the main source of employment in the region, accounting for 68%, while the State of Mexico constitutes the remaining 32% (ITDP, 2015). The MCMA also owns the highest proportion of workers in the country's informal sector at 54%, it has the most affluent households in the country, houses the main federal government offices, and possess the nation's most prominent cultural institutions. In turn, Mexico City contributes to 23% of the national Gross Domestic Product (Pojani & Stead, 2017). The centralization of jobs and the vital economic activities created in Mexico City also generates traffic congestion, long commuting times, and dependency on vehicles (Guerra et al., 2018), all of which affect the population's quality of life in low connectivity areas. One study estimates that due to the rising levels of congestion, lack of mass rapid transit (MRT)—particularly in the peripheral neighbourhoods of Mexico City—and the spurred ownership of cars, urban mobility causes a loss of 3.3 million person-hours per day (IMCO, 2019). Another study reports that the rising congestion levels in the MCMA have dropped the average speed to 3.6% for public transport and 9% for private transport between 1994 and 2007 (OECD, 2015a).

2.2. Household energy use and consumption within the MCMA

Since 1938, the Mexican State has controlled the energy markets through Petróleos Mexicanos (PEMEX) and the Federal Electricity Commission (CFE). Nevertheless, due to emerging conditions such as increasing energy consumption, growing environmental concerns, shortfalls of public funds for investment in existing and new energy projects, and low efficiencies, the Mexican government passed a constitutional amendment to open the energy markets for competition (EIA, 2020). In Mexico, subsidies in electricity and gasoline are among the highest globally (Rosas-Flores, Bakhat, Rosas-Flores, & Zayas, 2017), representing an extremely high expenditure of fiscal resources. For instance, the cumulative spending for energy subsidies from 2005 to 2010 represented 1150 billion pesos. This was equivalent to 10% of the annual average gross domestic product (Rosas-Flores, 2017). The trend is that energy subsidies will persist. For example, in real terms, energy subsidies from 2019 to 2020 increased by 31%, ascending from 52,000 million to 70,000 million pesos (Solís, 2019).

The negative impacts of high subsidies are many. For instance, Villanueva indicates that due to high subsidies, energy users are not aware of how much they should pay for their energy services in real life (Villanueva, 2021). Therefore, there are no price signals. Another impact of high energy subsidies is that these may lead to increased energy consumption, having adverse outcomes on social spending, productivity, the environment and income distribution (Coady, Parry, Sears, & Shang, 2017; Moshiri & Santillan, 2018). Subsidies in gasoline have also promoted increased personal car use instead of expanding public transportation systems in large cities, contributing to increasing greenhouse gas emissions, congestion, and health problems (Granado et al., 2012). Other studies have revealed that energy subsidies deliver greater benefits to the rich because they use more energy, and energy subsidies take away economic resources from social programs, which mostly benefit low-income groups. For example, in 2012, the gasoline consumption subsidy in Mexico was greater than the expenditure on health and the cornerstone program to combat poverty reduction named Oportunidades (Parker & Petra E. Todd, 2017). The subsidies in electricity at a national level also provide greater benefits to the rich since they spend about three times more on electricity than low-income groups (Moshiri & Santillan, 2018). Separate from

the theme of high electricity subsidies, power theft remains a serious problem in the MCMA. For instance, the CFE reports that in the first semester of 2021, the company lost over US\$1.750mn in electricity thefts; this number is equivalent to a 36,6GWh which accounts for 11.6 % of CFE's total sales during the first six months of 2021 (Cervantes, 2021). Theft of electricity happens through several forms, including consumer meter tampering, illegal tapping (using a foul nightline or *diablitos*), and billing problems (unpaid bills irregularities or with billing) (Sharma, Pandey, Punia, & Rao, 2016; Smith, 2004; Wong, Blankenship, Urpelainen, Ganesan, & Balani, 2021). The shared element that these illegal activities have in common is that they result in revenue loss for the utility companies. Moreover, this crime represents a notorious challenge since it affects electricity distribution from power companies by short circuiting/overloading their systems, often disrupting the electricity supply to homes and commerce (Lewis, 2015) and affecting the performance and even damaging the customers' appliances. The negative effects are not only reflected in damages to appliances, but also, utility companies are frequently obliged to apply higher electricity tariff rates to maintain viability in supplying power. This results in higher electricity prices to legitimate customers (Winther, 2012). In the MCMA, the millions of illegal customers that steal electricity with wires (known as *diablitos* in Mexico) have pushed the electrical grid over the edge. Consequently, thousands of businesses and households have power outages everyday (Sullivan, 2002).

Research on this area suggests that corruption remains a persistent concern to prevent the theft of energy equipment or energy services (including non-technical losses in electricity supply, distribution or transmission) (Sovacool, 2021). For instance, Smith notes that one of the central reasons for electricity theft is the collaboration of customers and utility employees (Smith, 2004); this allows billing irregularities and misreporting without damaging the electricity meter. Electricity theft via illegal connections also raises safety concerns that range from electric shock and even the death of a person who operates it, wires that start sparking and could cause fire during extreme weather conditions killing persons who are inadvertently electrocuted after entangling with illegally strung throw-ups (Depuru, Wang, & Devabhaktuni, 2011).

In relation to the above, we would like to note that some of the reasons for illegal electricity connections are complex, as we later depict in our **Results** and **Discussion** sections. There, we show how people's diverse and complex rationales for stealing electricity are often accompanied as a coping mechanism to access this service. In this sense, we caution readers against judging or stigmatising those who are forced to resort to such tactics.

2.3. Transport and mobility within the MCMA

Like many other cities in the global south, the public transit systems in the MCMA is highly informal and often lacks security protocols, defined stops and instruments to report harassment and crimes (Tun, Welle, Hidalgo, Albuquerque, Castellanos, Sclar, & Escalante, 2020). Regardless of these flaws, approximately-two-thirds of all trips in the MCMA are made using public transportation. In the MCMA, around 49 million trips are made daily; about 53% are done using public transport, 17% private vehicles, and 30% use non-motorized transport (29% by foot and 1% bicycles) (OECD, 2019). In the MCMA, there are more than 5.5 million vehicles, and the average time per person per trip rounds two hours; however, those coming from the Metropolitan area to Mexico City's downtown could spend over five hours daily on transport. On average, residents from the MCMA could spend more than 19% of their income on transport; this is equivalent to \$815 pesos (~39.81 USD) each month. Furthermore, over 1065 people die on

transport related accidents every year; from these, 51.7 % are pedestrians.

The most popular mode of transport in the MCMA are *colectivos*; these are privately owned cars and operated minivans and minibuses that provide public transportation services (Guerra, 2014). The Man-bus approach is an extremely popular business model in the *colectivos*' dimension. In this model, the service is made through individual concessions and earnings per passenger. The World Resource Institute, however, argues that this financial scheme is not sustainable since it prevents periodic renewal of the fleets and continuous service improvement. This model, additionally, does not generate confidence in the financial sector and makes it more expensive by limiting and preventing the granting of loans (WRI, 2015). The rapid motorization and urbanization rates in the MCMA have also led to great differences in the provision of public transport infrastructure. For instance, the Metro system is only available in two-thirds of all districts of Mexico City, and access to it remains very limited in the State of Mexico. Only about 25 % of Mexico City's population have access to the Metrobus,¹ while in the State of Mexico, only about 13 % of the population can access the Mexibus² (OECD, 2015b). These circumstances affect low-income people the most, particularly those living in the outskirts of Mexico City and the MCMA who could spend more than 25% of their income commuting and have limited alternatives to move (UN-HABITAT, 2017).

Regarding accessibility barriers in transport, research notes that issues related to saturation --public transport often exceeds the transport system capacity with a high agglomeration of people-- and the long peak travel schedules operate as key barriers (Mejía-Dorantes & Villagrán, 2020). Meanwhile, another study reports that although minibuses ("microbus") are the most popular mode of transport, users have noted a lack of professionalization of drivers, the age of microbuses and other issues that put passengers at severe risk (Mejía-Dorantes, 2018). Another study indicates that public transport in Mexico is expensive compared to its quality since this has poor regional coverage, operates without quality control, and is insecure and unreliable (Crôte, Noland, & Graham, 2010). These elements affect the users' experiences while using public transport services and operate as hindrances since they impede the city's enjoyment and negatively affect the passengers' wellbeing. Consequently, when income increases, households tend to buy motorized vehicles rather than continue using public transport (Díaz & Medlock, 2021). Guerra notes that minor improvements such as safer, lane or signal priority and more comfortable vehicles could have enormous societal and economic benefits and remove some of the barriers mentioned above (Guerra, 2014).

2.4. Environmental health and toxicity within the MCMA

Since mountains and volcanoes surround the MCMA region, it frequently traps air enabling the accumulation of pollutants. Due to such characteristics, during the 90's decade, the MCMA was regarded as the city with the worst air quality worldwide (Mage et al., 1996). Currently, although air quality has improved, it is still the cause of 4000 premature deaths yearly, with costs surpassing 30 billion Mexican pesos to society (International Transport Forum, 2017; Parry & Timilsina, 2010). Indeed, all municipalities within MCMA exceed the World Health Organization's standard of annual 10 $\mu\text{g}/\text{m}^3$ (López-Feldman, Heres, & Marquez-Padilla, 2021). Another study reports that the annual benefits from a 10%

reduction of PM_{10} and a 10 % reduction in ozone for all days of the year in Mexico City would result in \$920 million and \$160 million (both estimates in U.S. 2015 dollars) respectively (Davis, 2017). Most policies to improve environmental quality target the transport sector since this accounts for about 75% of nitrogen dioxide emissions (a precursor for ozone) and 40% of particulate formation (Parry & Timilsina, 2010). This positions the MCMA as one of the largest emission sources of atmospheric pollutants in the central Mexico plateau (Carabali et al., 2021). The Mexican authorities have tried to mitigate these negative effects by forcing people to stop using private cars and by decreasing the production of industries to reduce ozone precursors emissions. However, such efforts have not been well received by the population and have had palliative results (Velasco & Retama, 2017).

However, not all environmental issues emerge from the use of transport. Other studies suggest that MCMA's urban growth has been chaotic with little consideration for environmental aspects (Brandon, Gorenflo, Rodrigues, & Waller, 2005). For instance, constant deforestation and the persistent removal of surface water bodies led to the systematic reduction of land surfaces, an element that regulates climate in the MCMA. Such dynamic has not only led to a number of extreme weather events in this region (e.g. more intense storms), but also puts the population under higher risks of landslides and urban floods (Vargas & Magaña, 2020). Consequently, changes in minimum and maximum temperatures and increased rainfall have augmented the climate risk in the MCMA in the last years and has led to more recurrent and intense extreme weather events.

3. Research design and conceptual approach

We thus sought to execute a research design that could capture the human elements and lived experiences of the three main themes above (environmental toxicity and exposure, transport and mobility, and household energy use). To better understand the lived experiences of people living in MCMA slums, we explain our conceptual approach and research design in this section.

3.1. Mixed-methods research design

Since there were no secondary datasets, to the authors' knowledge, depicting the nexus between mobility and energy poverty of slum-dwellers from the MCMA, we generated our own. In this sense, our research approach consisted of (i) site visits and naturalistic observations, (ii) community and household interviews in slums, (iii) two focus groups with urban and rural slum-dwellers from the MCMA (iv) and a targeted literature review to provide background and contextualize our results.

Given the systematic exclusion of transport and energy planning documented in Section 2, we assumed it extremely important to conduct direct interviews with slum-dwellers from the MCMA themselves. We conducted 51 *household and community interviews* with slum-dwellers of Ecatepec, Nezahualcoyotl, Chimalhuacan, Texcoco and Teotihuacan and two focus groups one rural ($n = 9$) and one urban ($n = 9$), with participants from different locations from the MCMA with their descriptions summarised in Tables 1 and 2. In terms of recruitment and sampling, the research team worked with Observatorio de Desarrollo Regional y Promoción Social A.c to facilitate the site visits and initially communicate with residents. Once the research team was physically in each location, we recruited people through snowballing. People within the municipalities would often direct us to people they knew and who then agreed to participate in our study. This means our sample is illustrative and purposive, but by no means representative.

¹ The Metrobus is a bus rapid transit (BRT) system that has served Mexico City since line 1 opened on 19 June 2005.

² The Mexibus is a bus rapid transit (BRT) system that located in Mexico City and part of the State of Mexico.

Table 1

Overview of community and household interviews by location, respondent number, gender and general description (N = 51).

Municipality	Neighborhood /colonia	Respondent number	Gender	General description*
San Juan Teotihuacán	Jagüey de Reyes	Teo01	Female	An adult who just quit her job as a waitress and has four progenies
San Juan Teotihuacán	Jagüey de Reyes	Teo02	Female	Elderly adult, currently unemployed,
San Juan Teotihuacán	Jagüey de Reyes	Teo03	Male	An adult who works as a construction worker and has three progenies (all male)
San Juan Teotihuacán	Jagüey de Reyes	Teo04	Male	A young adult who works as a construction worker
San Juan Teotihuacán	Jagüey de Reyes	Teo05	Male	A young adult who works as a cashier in a hardware store
San Juan Teotihuacán	Jagüey de Reyes	Teo06	Male	A young adult who works in a tortilleria as a deliveryman.
San Juan Teotihuacán	NA	Teo07	Male	An elderly adult who owns a clandestine bar inside his house. He used to work in a slaughterhouse
San Juan Teotihuacán	NA	Teo08	Female	A young adult who works as a housemaid and as sex worker
San Juan Teotihuacán	Teotihuacan de Arista Centro	Teo09	Female	An elderly adult housewife. She has three daughters
San Juan Teotihuacán	Teotihuacan de Arista Centro	Teo10	Female	A young adult who owns a street stall selling souvenirs
San Juan Teotihuacán	Teotihuacan de Arista Centro	Teo11	Female	A young adult
San Juan Teotihuacán	Teotihuacan de Arista Centro	Teo12	Female	A young adult currently unemployed.
San Juan Teotihuacán	NA	Teo13	Female	An adult who works as a seamstress
Ecatepec de Morelos	Almarcigo Norte	Eca01	Female	An adult who is currently unemployed. She has two progenies and used to work in cleaning services.
Ecatepec de Morelos	Almarcigo Sur	Eca02	Female	An adult who sells Yakults in the streets (she represents the neighborhood)
Ecatepec de Morelos	Granjas Ecatepec	Eca03	Male	An elderly adult who sells sweet bread on his bicycle
Ecatepec de Morelos	Granjas Ecatepec	Eca04	Male	An adult who used to work in the construction industry
Ecatepec de Morelos	Luis Donaldo Colosio	Eca05	Male	An elderly adult who lives with his family and works as a waste picker (trash collector)
Ecatepec de Morelos	La Florida Ciudad Azteca	Eca06	Male	An adult who works for the federal government. He has a daughter and a son.
Ecatepec de Morelos	Polygono 3	Eca07	Female	An adult who works selling new and old stuff in the market. She has one street stall. She has a daughter with cerebral paralysis and cancer.
Ecatepec de Morelos	Los Sauces	Eca08	Female	An adult who works as a teacher in a cultural center. She is also a housewife.
Ecatepec de Morelos	Los Sauces	Eca09	Female	An adult that sells fruits, candies, and food in a store at the entrance of her house. She has two daughters.
Ecatepec de Morelos	San Andres Ocotlan	Eca10	Male	An adult that works in the entertainment industry. He lives alone with two dogs
Texcoco	La Magdalena Panoaya	Tex01	Female	An elderly adult who looks after her granddaughter. She works selling quesadillas and works as a housemaid twice a week
Texcoco	16 de Septiembre	Tex02	Male	An adult peasant. He lives from whatever the field provides.
Texcoco	16 de Septiembre	Tex03	Male	A young adult that works in a cafeteria inside a federal government's building
Texcoco	NA	Tex04	Female	An adult housewife with two progenies.
Texcoco	La Magdalena Panoaya	Tex05	Female	An adult that works as a seamstress and has two progenies.
Texcoco	Vicente Riva Palacio	Tex06	Female	A young adult housewife with two progenies
Texcoco	Vicente Riva Palacio	Tex07	Female	An adult with one daughter. She works as a cashier in a drugstore.
Texcoco	Vicente Riva Palacio	Tex08	Female	An adult that works as a seamstress with one son
Texcoco	Vicente Riva Palacio	Tex09	Female	An adult with four progenies how has a garment factory insider her house
Texcoco	NA	Tex10	Female	A disabled adult that sells fruit in a street stall. She has a daughter (who just started college).
Ciudad Nezahualcóyotl	Rey Neza/Vias Ferrocarril	Neza01	Female	An young adult housewife with three progenies
Ciudad Nezahualcóyotl	Rey Neza/Vias Ferrocarril	Neza02	Female	An elderly adult who lost her job during the pandemic. She used to work in landfills sorting waste
Ciudad Nezahualcóyotl	Rey Neza/Vias Ferrocarril	Neza03	Female	An elderly female that works cleaning the sanitary facilities of parks and gardens. She is looking after her granddaughter while her daughter works in the USA
Ciudad Nezahualcóyotl	Rey Neza/Vias Ferrocarril	Neza04	Female	A young adult with three progenies that works in cleaning service for TV Azteca
Ciudad Nezahualcóyotl	Rey Neza/Vias Ferrocarril	Neza05	Female	An elderly adult that sells corn in the streets
Ciudad Nezahualcóyotl	Rey Neza/Vias Ferrocarril	Neza06	Male	An elderly adult who cannot walk. He is currently unemployed.
Ciudad Nezahualcóyotl	Rey Neza/Vias Ferrocarril	Neza07	Female	An adult that works doing miniature sculptures of saints and virgins. She has three dogs
Ciudad Nezahualcóyotl	Rey Neza/Vias Ferrocarril	Neza08	Male	An elderly adult that works as a waste picker collecting materials for recycling. He has five grandchildren
Chimalhuacán	Plateros	Chi01	Male	A young indigenous adult who works as a music teacher.
Chimalhuacán	Plateros	Chi02	Female	A young indigenous adult who is currently a teacher for adults that did not finish high school. She has two progenies.
Chimalhuacán	Plateros	Chi03	Male	A young indigenous adult who is currently a college student.
Chimalhuacán	Plateros	Chi04	Female	A young indigenous student with one daughter.
Chimalhuacán	San Pablo	Chi05	Female	An elderly adult
Chimalhuacán	Kochitenco	Chi06	Female	A young adult housewife with two progenies. She works from home doing handcrafts
Chimalhuacán	San Lorenzo	Chi07	Female	An elderly adult who sells nopalitos in a street stall
Chimalhuacán	Los Olivos	Chi08	Female	An elderly adult who lives with her son. She is currently unemployed
Chimalhuacán	Los Olivos	Chi09	Female	A young adult who informally recycles iron and still. She is also studying networks engineering
Chimalhuacán	Los Olivos	Chi10	Male	An elderly adult who is disabled. He works selling cigarettes, candies and snacks at the entrance of his house

Source: Authors. *All interviews are anonymized to protect respondents (who constitute a vulnerable group) and fully adhere to institutional ethics requirements.

Table 2

Overview of participants from the focus groups by location, respondent number, gender, age group and general description (previous employment status and current employment status) (N = 18).

A. Rural Focus Group Participants general characteristics from the rural focus group (n = 9)					
Location	Respondent number	Gender	Age group	Current employment status	Previous employment status
Tlalpan/CDMX	RTLAL01	Female	36–45	Looks after cars parked on the streets	Sold clothes on a street stall
Tlahuac/CDMX	RTLAHC02	Female	18–24	Housewife	Peasant
Tlahuac/CDMX	RTLAH03	Female	25–35	Housewife	Student
Tecamac/State of Mexico	RTECA04	Male	18–24	Student	Worked on a street stall
San Juan Teotihuacán/State of Mexico	RSJT05	Male	18–24	Works delivering industrial materials	–
Tlahuac/CDMX	RTLAH06	Female	25–35	Student	Worked on a street stall
Tlalpan/CDMX	RTLAL07	Female	46–54	Looks after cars parked on the streets	Housewife
San Juan Teotihuacán/State of Mexico	RTEO08	Male	36–45	Works for a decentralized federal institution	Peasant
Tecamac/State of Mexico	RTECA09	Female	25–35	Student	–

B. Urban Focus Group					
Participants general characteristics from the urban focus group (n=9)					
Location	Respondent Number	Gender	Age group	Current employment status	Previous employment status
Tlalpan/CDMX	UTLAL01	Male	18–24	Student	Student
Venustiano Carranza/CDMX	UVCO02	Male	25–35	Works for a clothing company	Student
Alvaro Obregón/CDMX	UA003	Female	25–35	Works as a manager for a small firm	Student
Ecatepec/State of Mexico	UECA04	Female	55–74	Housewife	–
Tecamac/State of Mexico	UTECA05	Male	55–74	Unemployed	Bus driver
Ojo de Agua/State of Mexico	UODA06	Female	25–35	Housewife	Student
Nezahualcoyotl/State of Mexico	UNEZA07	Female	18–24	Works for a social service agency	Student
Chimalhuacan/State of Mexico	UCHI08	Male	25–35	Unemployed	Human resources manager in a medium-firm
Iztapalapa/CDMX	UIZTA09	Female	36–45	Own a small-medium enterprise	Works for the Federal government

Source: Authors. *All interviews are anonymized to protect respondents (who constitute a vulnerable group) and fully adhere to institutional ethics requirements.

The data collection took place between November and December 2021 and focus groups and interviews were conducted in Spanish and then translated to English by authors of this research (one of the authors is a Spanish native speaker). Each interview lasted between 15 and 60 min. Roughly more than half of our participants currently live in informal settlements, whereas the rest accepted that they initially settled there illegally, but their situation has changed and are legally established now. Therefore, as Fig. 2 illustrates, our selection included a mix of residency types and living conditions (including informal settlements built of wood, corrugated bitumen cardboard (lamina), bricks and formal settlements such as blockhouses).

All interviews were recorded and then fully transcribed, translated and coded. In terms of coding, our techniques of data analysis were inductive. That is, the authors of the article carried out all interviews; there was no necessity for inter-coder agreement (given transcripts were not exhaustive or that long), and we adopted a completely grounded or empirical method that was not guided by any specific conceptual framework to avoid potentially biasing the results.

After completing the interviews, the research team undertook a thematic analysis of the results. Thematic analysis is a “*type of qualitative analysis*” used to “*analyse classifications and present themes (patterns) that relate to the data*” (Alhojailan, 2012:39). Thematic analysis thus refers to a form of pattern recognition that involves identifying core themes (in this case, peoples’ lived experiences about transport, mobility, and health) via the careful reading, and rereading, of the material (Fereday & Muir-Cochrane, 2006). Similar to other approaches within the social sciences such as ethnography, phenomenology, and content analysis, thematic analysis extracts meaning from data and encompasses the pin-pointing, sharpening, recording, and/or evaluation of recurring themes (Javadi & Zarea, 2016). In our case, our thematic analysis can capture, in detail, diverse interpretations concerning energy use, mobility, and health. Although we did end up engaging with the literatures on energy and transport poverty, peripheralization, and spatial justice (see Section 3.2), this was after data collection was complete. Our interview guidebook and questions are presented in Annex I.

Our decision to conduct household interviews in these five locations was influenced by the focal characteristics of each site summarised in Table 3—these ranged from high delinquency rates, poverty levels, number of rural inhabitants and accessibility to services. Fig. 3 provides photographic evidence of each of the locations visited.

Throughout our research, we rely on many original photographs collected during the field research and site visits, including some that reveal the faces of slum-dwellers, including their children. We got explicit permission to use these images by the respondents themselves or by their parents in the instance they were children. Our study did receive formal ethics approval from the Social Sciences & Arts Cross-Schools Research Ethics Committee at the University of Sussex, with Reference Number ER/DDF20/2.

Finally, we conducted a *targeted literature review* of the policy and academic literature surrounding the MCMA to triangulate findings better, embed our study in the existing literature, and identify research gaps. We utilized both Google Scholar and ScienceDirect and searched for documents using the terms “Mexico City Metropolitan Area,” and “Mexico City,” published in the past twenty-five years alongside the terms “energy,” “energy poverty”, “transport”, and “public transport.” We cite most of these studies throughout our article, showing where they confirm our findings.

3.2. Conceptual approach

In addition to grounding our study in sound empirical data, we also sought to make a conceptual connection and advancement by engaging with three categories of literature and related themes.

The first themes are *transport and energy poverty*, sometimes called mobility injustice or fuel poverty (Lowans, Furszyfer, Sovacool, Foley, & Rooney, 2021; Martiskainen et al., 2021). Energy poverty deals with the inability of homes to pay for satisfactory energy services and supplies of electricity or heat (Sovacool, 2012). Energy poverty often translates into poorly heated homes, with an extensive variety of associated health impacts, including premature heart attacks, increased risk of circulatory and respiratory disease in adults, increased risk of social isolation and mental health illness, asthma in children and thousands of winter deaths



Fig. 2. Mix of residency types and living conditions: Panel A shows a brick house in Texcoco. Panel B shows corrugated bitumen cardboard (lamina) home in Netzahualcoyotl. Panel C Shows a home built with lamina and wood in Netzahualcoyotl. Panel D shows a blockhouse in Ecatepec.

among the elderly ([Rudge & Gilchrist, 2005](#); [The Comptroller and Auditor General, 2003](#)).

In the case of Mexico, energy poverty is a prevalent issue. For instance, [Cao and Frigo \(2021\)](#) note that the Mexican Constitution does not mention any formalized rights related to energy access; instead, the Constitution's only references to this issue are limited to public health concerns and biological survival. That same study shows inconsistencies in the Mexican law when the authors suggest that although there are references to energy efficiency (article 71), renewable energies (article 71) and energy savings (articles 71 and 83), it fails to provide measures to make energy accessible and available to users. The lack of safeguards addressing energy poverty ought to take more relevance when a study shows that 41.9% of the Mexican population (52.4 million people) lives in multidimensional poverty, a composite measure of several indicators of social deprivation, and 7.4% (around 9.3 million people) live in extreme multidimensional poverty conditions ([CONEVAL, 2019](#)). In terms of energy poverty, [Garcia-Ochoa and Graizbord \(2016\)](#) revealed that about 7.2% of households (more than 2.17 million)

live in what they call 'extreme energy poverty' (i.e., deprived of five out of six "basic" energy services).

Transport poverty is meant to capture the lack of mobility services needed to participate in society, resulting from the unaffordability, inaccessibility or unavailability of transport ([Lucas, 2012, 2018](#); [Mattioli, Lucas, & Marsden, 2017](#); [Mullen & Marsden, 2016](#)). The links between health and transport poverty are also negative and include social inclusion, increased illness rates and increased vulnerability to pollution ([Council, 2001](#)).

Although public transport in the MCMA is relatively cheap, with the highest tariff for busses being 26 pesos (~1.26 USD per trip), for the Metrobus 30 pesos (~1.45 USD per trip) and the Metro costing 5 pesos (.024USD per trip), significant problems are evident. These include concerns over accessibility (geographic exclusion), exposure to high levels of pollution, insecurity, lack of alternatives and traffic jams. For instance, outdoor air pollution causes five deaths per 10 thousand inhabitants annually in the region. Moreover, MCMA's urban design is for personal vehicles rather than other mobility alternatives (e.g. cycling and walking). This has

Table 3

Overview of the general characteristics of the municipalities visited to conduct household interviews and site visits.

Municipality	Poverty and population	Perceptions and data on delinquency	Access to services
Ecatepec de Morelos	Ecatepec de Morelos has more than 1,645,352 inhabitants, 48.5 % males and 51.5 % females; around 40 % live in conditions of poverty, and 6 % live in extreme poverty. Only about 0.07 % of its population live in rural areas. 64.06 % of its population is economically active, and 6.22 % are unemployed. The municipal population density corresponds to 1,065 inhabitants per square kilometres.	Ecatepec occupies 18th place in Mexico's index crime, and it is where its residents feel the most unsafe in the country. For instance, 94.4 % of their population (over 18) feel insecure in Ecatepec. Regarding public transport, most of the population (over 94 %) feel unsafe while using it. This may sound unsurprising given that Ecatepec is the municipality with the highest number of complaints about robberies with violence in public transport with 748 open files. In Ecatepec, there are 64 robberies in public transport for every 100 thousand inhabitants.	In 2020, 0.16 % of Ecatepec's population did not have a sewage system, 0.94 % did not have a water supply network, 0.069 % did not have energy access, 64.9 % of all households have internet access.
Ciudad Nezahualcóyotl	Ciudad Nezahualcóyotl has more than 1,077,208 inhabitants, 48.3 % males and 51.7 % females; around 35 % live in conditions of poverty, and 3.5 % live in extreme poverty. Only about 0.01 % of its population live in rural areas. The municipal population density corresponds to 16 436.2 inhabitants per square kilometres.	Ciudad Nezahualcóyotl is one of the most violent municipalities in Mexico, since it occupies 44th place in Mexico's index crime. The public perception of insecurity in Ciudad Nezahualcóyotl is 71.1 %; however, the percentage increases to 84.2 % when this focuses on transport. There are 54.41 robberies in public transport for every 100 thousand inhabitants in this municipality.	In 2020, 0.042 % of Ciudad Nezahualcóyotl's population did not have a sewage system, 0.3 % did not have a water supply network, 0.061 % did not have energy access, and 68.7 % of all households have internet access.
Chimalhuacán	Chimalhuacán has more than 705,193 inhabitants, 48.9 % males and 51.1 % females; around 52.3 % live in conditions of poverty, and 9.17 % live in extreme poverty. Only about 0.3 % of its population live in rural areas. The municipal population density corresponds to 16 13,183 inhabitants per square kilometres.	Chimalhuacán is one of the most dangerous municipalities of the State of Mexico. The public perception of insecurity in Ciudad Nezahualcóyotl is 71.6 %. In terms of transport, 7 out of 10 residents feel insecure. This is perhaps because there are 27.42 robberies in public transport for every 100 thousand inhabitants in this municipality.	In 2020, 0.042 % of Chimalhuacán's population did not have a sewage system, 0.83 % did not have a water supply network, 0.2 % did not have energy access, and 51 % of all households have internet access.
Texcoco	Texcoco has more than 277,562 inhabitants, 48.6 % males and 51.4 % females; around 39.4 % live in conditions of poverty, and 6.4 % live in extreme poverty. About 13.62 % of its population live in rural areas. The municipal population density corresponds to 539.83 inhabitants per square kilometres.	Texcoco is yet another violent municipality; it occupies 11th place of the most dangerous municipalities in Mexico. The authorities identified that the greatest possibility of being mugged in public transport is boarding in Ecatepec to travel on the Mexico-Texcoco highway on a Tuesday between 06:00 and 09:00 h.	In 2020, 1.69 % of Texcoco's population did not have a sewage system, 8.25 % did not have a water supply network, 0.023 % did not have energy access, and 54.1 % of all households have internet access.
Teotihuacan	Teotihuacan has more than 58,507 inhabitants, 48.2 % males and 51.8 % females; around 49.9 % live in conditions of poverty, and 3.74 % live in extreme poverty. About 7.44 % of its population live in rural areas. The municipal population density corresponds to 641.4 inhabitants per square kilometres.	We could not find relevant information about perceptions and data on the delinquency of Teotihuacan.	In 2020, 0.86 % of Teotihuacan's population did not have a sewage system, 3.42 % did not have a water supply network, 0.22 % did not have energy access, and 45.9 % of all households have internet access.

Source: authors, compiled from ([Animal Politico. \(2019\), 2019](#); Ayuntamiento Constitucional, 2015; DataMexico, 2021; INEGI, 2021; INFOBAE, 2020).

led not only to longer roads and a worryingly ever-increasing vehicle fleet (average annual rate of 5.3%) but also to the development of isolated and segregated neighbourhoods. Therefore, although accessing public transport may be cheap for some users, to get to their destination, they must take several bus trips, ride the Metro and sometimes pay for a taxi or a combi. This leads to a considerable increment in costs and time, higher exposure to violence and crime, and critical exposure to outdoor air pollution.

As our research unravels, we will show how transport and energy poverty can often occur simultaneously and reinforce each other leading to a "double energy vulnerability" ([Simcock et al., 2021; Sovacool & Furszyfer, 2022](#)).

The second theme engages with the process of *peripheralization* emerging from the social justice and environmental politics literature ([Park & Sovacool, 2018](#)). Peripheralization depicts the marginalization of some communities and how they frequently have environmental issues imposed on them (on occasions, without their consent). Research notes that such a procedure provides a way to uncover how politics and democracy (or the lack of them), political power (or the lack of it), and patterns of environ-

mental inequality are linked. The same study reports that peripheralization commonly has five interconnecting drivers: (i) marginalized groups are economically excluded with little control over community revenue or employment; (ii) they often face significant environmental threats and are environmentally degraded; (iii) they are culturally marginalized either by having strong feelings of powerless and isolation and by becoming ambivalent about their status; (iv) they are geographically marginalized and often incentivized or forced to occupy peripheral remote or spaces in society; and (v) they often have limited political power over the decisions that are made over their community ([Blowers & Leroy, 1994](#)).

Issues around peripheralization in Mexico have so far focused on industrial contaminants in the north and border regions with the US and the resulting emissions related to proximity to industrial facilities ([Grineski & Collins, 2008, 2010](#)). Meanwhile, [Chakrabarti et al. \(2015\)](#) undertook a national analysis to investigate water disposal of toxic metals. The study showed a positive association between marginalisation (those living in poorer communities) and pollution, with robust evidence suggesting that low-income

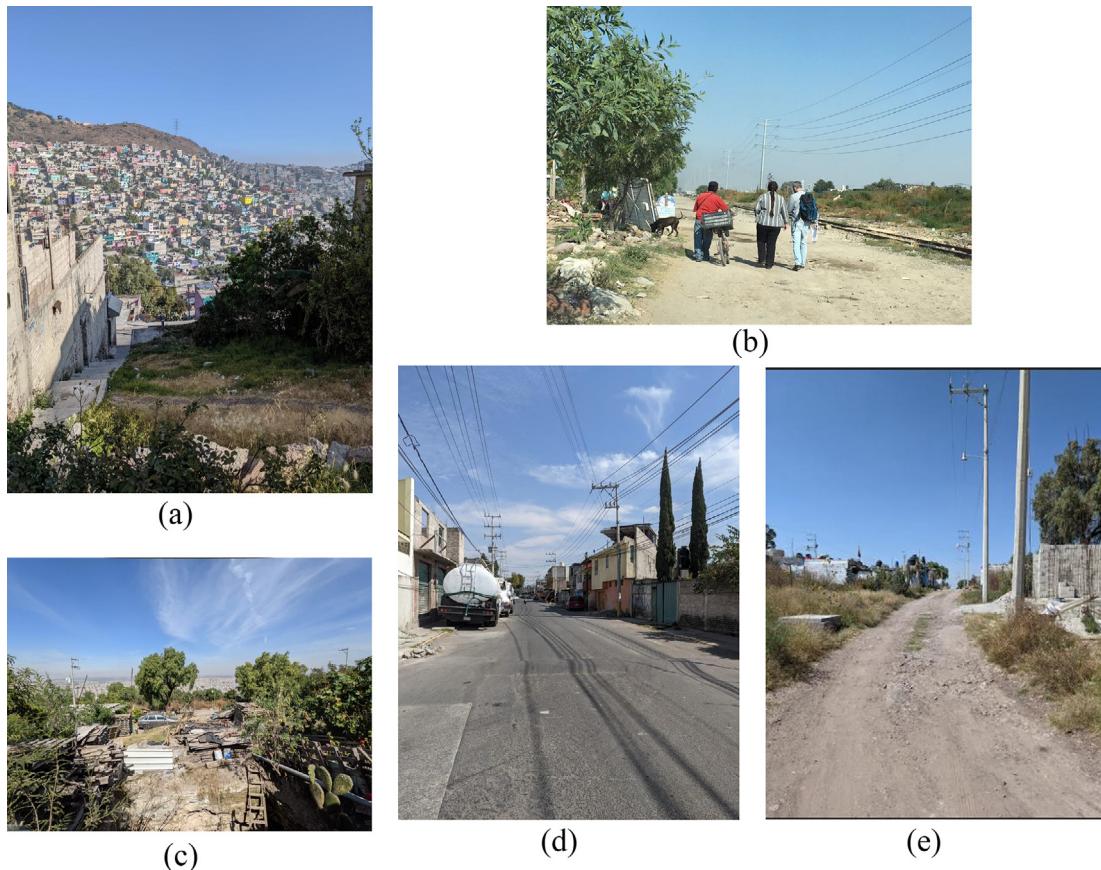


Fig. 3. Overview of five site visits conducted for this research. Panel A shows Ecatepec. Panel B shows Netzahualcoyotl (Las Vias). Panel C shows Chimalhuacan. Panel D shows Texcoco. Panel E shows Teotihuacan.

locations have higher exposure to toxic water pollutants. Finally, Lome-Hurtado and colleagues ([Lome-Hurtado, Touza-Montero, & White, 2020](#)) showed that vulnerable groups in Mexico City are exposed to higher levels of pollutants (i.e. PM₁₀ and ozone) compared to those with a higher socioeconomic status.

The last theme calls for *spatial justice*, pertinent to our research since this stream of literature indicates potential coping strategies and remedies for addressing injustice ([Brock, Sovacool, & Hook, 2021](#)). [Soja \(2010\)](#) notion of spatial justice is apt to our study since it calls on researchers to understand better how social hierarchies can become rooted in spatial or geographic patterns that might result in "*unjust geographies*". The same study finds a number of approaches to challenge spatial injustice. The first is reimagining the city (or, for our case, marginalized groups) not as neutral but as an active struggle over resources and therefore over competing interests. The second approach suggests changing geographies and acknowledging our inherent ability to influence, shape, and direct future outcomes. The third deals with participatory democracy. In this approach, Soja calls for more representative and inclusive forms of decision-making that reflect the interests of marginalized groups or local communities. The last approach encapsulates sustainability in cities. In our case, this would be to marginalized groups and how they familiarize themselves with long-term holistic sustainability with improvements in community wellbeing and health.

Issues around spatial injustice are perhaps more notorious in rural and indigenous communities in Mexico. For example, the Wixaritari's³ territory and subsistence have been threatened by Glo-

bal North mining companies, which now own 70 per cent of their sacred territory. The activities in their region are linked to the extraction of gold and silver in opencast mining. In consequence, not only community leaders have been murdered, but also the Wixaritari have been forced to move from their territories, their lands have been contaminated, and their culture has been threatened. ([Reporte Indigo 2017](#)). Another relevant case is presented in the state of Oaxaca, a region shaped by an indigenous identity where high marginalisation and inequalities prevail ([Velasco-Herrejon & Bauwens, 2020](#)). This area has been recurrently studied to showcase renewable energy systems' effects on indigenous groups and their consequences on environmental injustices ([Dunlap, 2021; Dunlap & Arce, 2022; Ramirez & Böhm, 2021](#)). The importance of this area takes more relevance when 84% of its population live under moderate, high or very high grades of marginalisation and present high levels of income inequality, at a 43.4 coefficient in the GINI 2016 Index ([CONAPO, n.d.](#)). As our research unravels, spatial injustice is not limited to rural and indigenous communities but also exists in urban and semi-rural environments.

We will come back to these themes (poverty, peripheralization, and justice) in [Section 5](#) of the paper.

4. Results: Energy, transport, and health from slum-dwellers' lifestyle

This section presents our results organized in the dimensions of housing and energy needs, mobility and transport, and wellbeing and health. These align with our background [Sections 2.2, 2.3, and 2.4](#).

³ An indigenous group located in the southern part of the Sierra Madre Occidental.

4.1. Housing and energy needs

Given that most people living in slums and informal settlements often situate under precarious circumstances, finding safe and affordable accommodation is perhaps the first and most significant issue these communities face. We defined “slums” or “barrios populares” as a group of people living under the same roof in an urban area who lack at least one of the following conditions: (i) adequate living space, that is, no more than three people share the same room; (ii) effortless access to safe water at an affordable price and in enough quantities; (iii) durable housing that can provide shelter to householders against extreme climate conditions; (iv) access to adequate sanitation, for example, public toilets ought to be shared by a reasonable number of people; (v) and tenure security that prevents forced evictions (UN-HABITAT, 2003). We use the term “slum” throughout the paper not in a pejorative sense, but as a term people residing their self-identify with.

In addition to living in slums, most of our participants live in informal settlements. The main characteristics of these are the following. (i) homes are built in high-risk areas, near river edges, lagoons, mountains and are exposed to floods and landslides; (ii) homes have limited access to services such as water, gas, electricity, kitchen and sewer (sewer or drainage); (iii) homes are built with poor construction materials which do not offer enough protection to householders from cold winds, storms, sand and landslides (Aguilar, 2008). Other characteristics that situate people living in slums and informal settlements in a vulnerable position is that most of them do not have access to social security services, work in the informal sector, and, due to the precarious living conditions, often have health difficulties (Riley, Ko, Unger, & Reis, 2007; Roy et al., 2019). TEO04 noted this explicitly when he stated that:

“Living here is not easy. During the rainy season, all the water pours inside the house because it is built with laminas, so it is always humid and, if it rains hard, all of our clothes end up wet. Plus, I think homes made of laminas have terrible insulation because when it is hot outside, inside the house gets too hot to handle, and when it is cold, you freeze to death. Look, we do not have a door to protect us from the wind, instead, we have these blankets that do nothing in winter and during rainy seasons. Also, when the plague (COVID-19) got here, it was too cold, and my children had to go to the hospital. I do not know if the cold made things worst, but we were all severely ill.”

Our site visits also revealed a persistent lack of amenities and accommodation insecurity as Table 4 and Fig. 4 illustrate. Most of our participants lived in housing precariousness, with their homes often built from materials such as cardboard, lamina and wood or a combination of these materials with bricks and concrete. Striking examples of insecurity and deprivation included sheets acting as doors, poisonous animals inside homes, loose wires, flooding, noxious fumes from nearby waste and lack of adequate water.

High expenditures on energy services (gas and electricity) were often reported as paramount to maintaining decent living standards and contributing to poverty. As Table 5 summarises, from those participants who paid for their energy services, almost all struggled to pay for their bills. Often mentioning that the “high gas and electricity prices are pushing them to cook with wood again” with Fig. 5 providing some photographic evidence. Another participant said “either I pay for my energy services or eat.” Other participants commented that their electricity bills varied “dramatically” from “\$450 to \$1700 pesos” and they could continue to go up to so they “always need to be prepared to face that extra expense.” Other ideas circled around the notion that since users could not

Table 4
Slum-dwellers' perceptions of housing insecurity and deprivation of amenities.

Respondent	Confirmatory statement
UECA01	<i>Here in the hills, it gets very cold in the winter, and as you can see, we do not even have doors. The only thing that can protect us from the cold drafts are these sheets that we use as doors, but the cold air slips right through them. Now that my dad is an elderly person and my sister gave birth, we need to be extra careful, and we are trying to keep the house as warm as possible. However, we stopped using wood to warm the home because we knew it is bad for my nephew and my dad's health</i>
TEO07	<i>Our house is a mess. Since the house's structure is made of laminas, in winter, it gets too cold and in summer gets too hot. Also, during the rainy season, all the house gets damped because it is too humid. We also get poisonous animals inside the house. So we always need to be extra careful of those.</i>
ECA07	<i>All the wires from the block are over my garage and are left loose, hanging at a very low height. I asked CFE to come and move these wires because my daughter has cerebral paralysis and could suffer from a deadly accident, but they never came, so I did it myself and moved the cables up to my rooftop.</i>
TEX10	<i>Although nothing has ever happened to me, I recognized the risks of having all these wires hanging so low. The concerns increase when it rains, because people can get electrocuted to death if something wrong happens.</i>
ECA08	<i>After the flooding this summer, my home was flooded for three days. The depth of the water was 15–20 cm. After that, all the structure of my house was damaged. Now, it is colder around here, and the walls are fucked. Of course, no one will come and help us out. Fixing the structure of this house will be something that we will have to pay for on our own.</i>
NEZA01	<i>There is an open wastewater channel on the other side of the railways, and sometimes the smell is too strong that I feel nauseous and have headaches. I know my children hate that smell too, but I think we are getting used to it</i>
NEZA06	<i>They should stop throwing their garbage at us; sometimes, the smell of the wastewater channel is too strong, and we get all nauseous. In summer and during the hot months, because of the trash, there are thousands of flies, and we often joke that flies eat our food before us, so that is why we have learned to eat faster than them.</i>
CHI08	<i>I live next to the wastewater channel and I'm tired people coming around here and dumping their trash. Living next to the wastewater channel is awful. It is full of dead animals, and sometimes they even throw human corpses in it. It is hard to sleep here because the smell of the channel is unbearable. People should start respecting us and come and clean our streets more often because this is inhuman.</i>
UECA04	<i>I never feel safe, not even in my own home. Imagine how dangerous it is where I live that not even Uber or the police officers come up here because they are too afraid. Even when the authorities are around there, they cannot do anything because they know they will be outpowered and outnumbered by the neighbourhood. This is like an anarchist jungle; there're no institutions and there's a lack of authority, and only the meanest and strongest survive. I can tell you that where I live, there is a constant decadence of the youth, authorities, and the environment. The infrastructure where I live does not exist. I receive water every-three months. If I want to cook or shower, we need to buy it from the water pipe, and during the rainy season, we have a water catchment system. Otherwise, we could spend months without having access to water</i>
RTLAH03	<i>In my home, we get water twice a week, and it is very uncomfortable. In summer, when it is too hot, I feel dizzy all the time, and because we do not have water, there is no way to refresh yourself. Now, imagine that with COVID, no one had water to wash their hands. Every-one home got the virus and all my neighbours too. We all need the water to wash our hands and stop the spreading of COVID.</i>
UIZTA09	

Source: Authors.

pay for their electricity bills, they had to start stealing it, arguing that “CFE are the real thieves here because they extorsion low-income communities.”

Expenditures on gas were in most cases related to heating water and cooking; none of our participants had an energy system to heat



Fig. 4. Housing precariousness in MCMA slums. Panel A shows blankets and sheets used as doors in Netzahualcoyotl, Teotihuacán and Chimalhuacan. Panel B shows analogous water catchment systems in Chimalhuacan.

their homes. Electricity expenses were related to appliances (e.g. washing machines), television use, and mobile phone charging. However, we found it surprising that from a total sample of 69 participants (i.e. households and the focus groups) 33 openly admitted to stealing electricity, while others, although they did not explicitly mention in the interviews they stole electricity, they did not have a meter installed. Some of the main reasons for electricity theft that are reported in the literature include the following: high electricity prices, corruption, poor enforcement of the law against electricity theft, and poor quality of power supplied (Lewis, 2015; Sharma et al., 2016; Smith, 2004; Wong et al., 2021; Yakubu, 2018). However, our research goes beyond these and found that at least in the MCMA, other reasons for stealing electricity existed as Table 6 presents. For instance, “unfair bills”, and political reasons contributed to steal electricity, some participants even mentioned that the only thing that united their community was the fight to stop paying their electricity bills. Others, especially in the rural areas, noted that the only way to access electricity was by “stealing it” because otherwise, the “electricity network did not reach their homes.” Fig. 6 provide some evidence of electricity theft.

4.2. Transport and mobility patterns

Mobility and transport also contributed to poverty and reflected inequality in access to vehicles, busses, metro and taxis. Indeed, research indicates that the lack of appropriate access to transport is a potential aspect that may trigger social exclusion (Grahama Currie et al., 2010; Lucas, 2006). For our case study, mobility constraints particularly affect low-income people living on the outskirts of Mexico City since these residents often have fewer

alternatives to move and economic resources. Research indicates that transport expenses are the second-highest necessity families spend on their income (18.5%). However, this percentage increases for MCMA's residents who could spend as much as 25% of their economic resources on commuting only (UN-HABITAT, 2017).

Regarding ownership of vehicles (including motorcycles), from our sample of 69 participants, only about 28% ($N = 20$) of our respondents said they owned vehicles. From those that did own a vehicle, none of them was new except one, and some were approaching 25 years old. Table 7 illustrates the expenses of owning a car, with some participants commenting that “owning a car is no longer a luxury; it is a need” and that “gasoline represents my biggest expenditure” some participants even compared the expenses they do on their car “with having another family”. Others said they could “walk” to their workplace, but they “never feel safe.” Others commented about the risks of walking and getting mugged, assaulted, or robbed.

4.3. Health, wellbeing and quality of life

Housing, energy (electricity and gas), transport, and mobility patterns not only affect slum-dwellers, but such factors often induce negative impacts on health, wellbeing, and perceived quality of life. Table 8 illustrates a broad spectrum of issues raised in our interviews. For instance, participants reported how their health has been deteriorating for cooking with wood. Meanwhile, most of the issues raised regarding transport were related to being mugged and how their health has been affected by the long journeys they do commuting. However, in the case of females, they were not only exposed to being robbed, but almost all participants experienced

Table 5

Slum-dwellers estimations of electricity and gas consumption and expenditures.

Respondent	Confirmatory statement
NEZA02	<i>I do not pay for my electricity, but on gas, I used to pay about \$300 pesos (~14.65 USD) each month, sometimes less. I am 84 years old, and I am unemployed. How do you expect me to pay that much for the gas each month? I started using wood again after I lost my job, and I don't think I'll ever be able to use gas again in my current circumstances. I will die cooking with wood. Gas is incredibly expensive and is a vital element to all households; we should all have access to it regardless of our income.</i>
TEO04	<i>We pay on gas \$350 pesos (~17.09 USD) and on electricity about \$500 pesos (24.42 USD). That expenditure represents a big chunk of our salary. Therefore, sometimes we are unable to afford these services. What happens next is that we cook our food with wood and heat the water for bathing with wood too. I do not mind cooking with wood, sometimes food even tastes better, but bathing is horrible (laughs)</i>
CHI01	<i>I struggle to pay for my gas and electricity services most of the time. When I run out of gas, we replace it with wood. At least for as long as we get the economic resources to buy gas again. When they cut our electricity, we need to use candles and lanterns. In gas, we must spend about \$400 pesos (~19.54 USD) and on electricity about the same.</i>
UA003	<i>In my home, we use a gas tank every month, and on electricity, I used to pay \$450 pesos (~21.98 USD) each bimester. Now that I'm a student, I do not work anymore. Therefore, we had to cut some expenses, such as electricity; we stopped paying for it. When we do not have any other option, we cook with wood, but we avoid it. I pay about \$1000 pesos (~48.84 USD) on gas and electricity each month, and each month is difficult to afford these expenses. For instance, whenever we are unable to pay for gas, I have to cook with wood, or I go to a friend's house so they can cook the food for me.</i>
RTE008	<i>I stopped paying for my electricity bills because the receipts were coming extremely high; before, we used to pay about \$250 pesos (~12.21 USD), and the next thing we knew was that we needed to pay \$2800 pesos (~136.76 USD). That is when we decided to stop paying CFE. On gas, we spend around \$500 pesos (~24.42 USD) each month. I mostly struggle to pay for my gas when I do not have a job as a housemaid or my tortillas are not selling. When that happens, I need to cut in other expenses so I can afford to pay for my gas. What I meant is that we often do not get to eat very well or we cannot afford clothes or the presents that my children would like to have.</i>
TEX04	<i>I spend around \$450 pesos (~21.98 USD) on gas and on electricity about \$200 pesos (~USD 9.77). However, once I had to pay CFE \$1700 pesos (~83.03 USD). I needed to use most of my savings because my income wasn't enough to pay that bill. I felt they extorsion me because I always paid my bills on time, and I really did not understand what changed that month. In fact, I am certain that I am the only person in this neighbourhood that actually pays for its electricity. I am not a thief, CFE is the real thief here because they extorsion low-income communities and take advantage of honest people.</i>
TEO02	<i>I pay between \$300 (~14.65 USD) and \$500 (~24.42 USD) pesos for electricity, but I really don't understand why. Look, I only have one lightbulb and a fridge; nothing else. The only explanation I see is that the fridge is the appliance that consumes that much because it is too old. In gas, I spend around \$175 (~8.55 USD) pesos every month. On gas, I spend around \$400 pesos monthly. I spend \$100 (~4.88 USD) pesos each week. My electricity receipts are very expensive. I often pay between \$800 (~39.07 USD) and \$1300 pesos (~63.50 USD) pesos each bimester. I've asked why my bills come so high, and they said 'it is what it is, it is what the meter indicates'. So, I have no other alternative but to pay.</i>
CHI08	<i>In electricity, the highest I've paid is \$800 pesos (~39.07 USD), but my mom received a receipt of \$10,000 pesos (~488.83 USD). I still do not understand why my bills come so high because I do not have that many appliances, perhaps it is the internet, my phone or my laptop, but I highly doubt it. I asked many times for an explanation, but they never listened; it was like talking to a wall. Thank God they've never cut my electricity.</i>
UOA006	<i>In electricity, the highest I've paid is \$800 pesos (~39.07 USD), but my mom received a receipt of \$10,000 pesos (~488.83 USD). I still do not understand why my bills come so high because I do not have that many appliances, perhaps it is the internet, my phone or my laptop, but I highly doubt it. I asked many times for an explanation, but they never listened; it was like talking to a wall. Thank God they've never cut my electricity.</i>
NEZA03	<i>After I lost my job, I started cooking and heating my water with wood. Since then, I've stopped worrying about paying my gas bills which were draining my savings, and since I do not pay rent, electricity or water, I do not have many struggles. Plus, wood is free, people throw it away, and I collect it; with that wood, I cook.</i>

Source: authors.

some sort of sexual harassment. Some participants even spoke about the *police* getting robbed, about being kidnapped by corrupt taxi drivers, and “*all sorts of sexual violence*.” Fig. 7 shows slum-dwellers cooking with firewood and how they are exposed to hazardous air pollutants.

These interview statements corroborate numerous quantitative indicators and statistics revealing startling crime rates in the MCMA region, where crime impunity is rising at only 0.9 of crimes being prosecuted and 6.4 out of 100 being reported ([Observatorio Ciudad de Mexico Seguridad y Justicia, 2021](#)). Access to basic services and time spent on transport also account for alarming issues affecting the health of residents in the MCMA. For instance, multiple studies indicate the deleterious health impacts of using wood as fuel ([Mazumder et al., 2019; Simkovich et al., 2019; Who, 2018](#)) and how these are particularly harmful to vulnerable groups such as children, pregnant women and the elderly ([Furszyfer et al., 2020; LaFave et al., 2021](#)). Other studies have investigated the negative health impacts of hazardous air pollutants exposure in Mexico City and the MCMA ([Carabali et al., 2021; Kelly & Zhu, 2016; Menezes et al., 2005](#)). Finally, although not as amply studied as the previous subjects, research has depicted how the time spent on transport affects passengers’ health ([Boniface, Scantlebury, Watkins, & Mindell, 2015; Tranter, 2010](#)). Our study, thus, corroborates previous findings reporting how vulnerable groups are more prone to experience long-term illness, health problems or disabilities ([Ekbrand & Halleröd, 2018; Ridley, Rao, Schilbach, & Patel, 2020; Van Cleemput, Parry, Thomas, Peters, & Cooper, 2007](#)) and also how slum-dwellers may not be aware how poor their health outcomes are compared to other groups.

5. Discussion: Poverty and vulnerability, perpetual peripheralization, and spatial justice

Our results revealed the complicated patterns of poor energy services and housing, dangerous, insecure and expensive mobility patterns, and degraded wellbeing and quality of life. Our research also indicates that these patterns are influenced by three themes, extreme poverty, perpetual peripheralization, and spatial injustice. The next section explores these themes and illustrates how each acts as a driver but also as a consequence or result.

5.1. Extreme energy and transport poverty

MCMA’s slum-dwellers are prone to the “double vulnerability” of energy and transport poverty since they pay a substantial percentage of their income on mobility and energy services. For instance, most of our participants commented that their greatest household expenditure was on transport, either paying for public transport services or gasoline. Consequently, slum-dwellers could have little money to cover other services such as health, education, electricity or gas. This ought to make more sense since a large percentage of our participants (see [Tables 1 and 2](#)) were unemployed or belonged to the informal sector (e.g. looking after cars on the streets or selling fruits/candies in the street market). In addition, more than 84% of our participants (N = 60) commented that they struggled to pay their transport services and energy bills. In many cases, participants argued that the high electricity prices pushed them to steal it (see [Table 6](#)). At the same time, other experiences consisted in either paying for these services, eat or paying for medicines. To illustrate such cases ECA 07 and TEO02 commented, respectively:

In total, I spend about \$1300 pesos (~63.50 USD) on gas and electricity per month. I honestly think that every-one in this neighbourhood must struggle to pay for their energy bills. That is why everyone steals it, but we don't. Not stealing electricity puts you in a dif-



Fig. 5. Cooking stations to cook using wood. Panel A. shows a cookstove in Netzahualcoyotl. Panel B. shows a wood storage facility in Chimalhuacan. Panel C. Shows a comal in Teotihuacan. Panel D shows a wood cooking station in Texcoco.

ficult position because you either pay the gas or cut your electricity use. It is hard to have some slack to cover both. In other cases, either you eat or pay for your energy services. You cannot have them both.

if we pay for gas and electricity, we do not have enough to pay for other things. As an older woman, if I pay for gas and electricity, I do not have enough money to pay for my medicines. I often feel I am sacrificing my health because I can never afford my medicines to pay for basic services. I do not think that's fair, I should have the right to feel healthy without sacrificing my basic needs.

As noted above, energy and transport poverty are not limited to affordability alone; instead, to address these issues, we need to approach them through a multidimensional lens. We consider that for people not to live in energy and transport poverty these ser-

vices must be available when needed, adequate, of sufficiently good quality, be affordable and legal, healthy and safe, and reliable and convenient.

For instance, there is research suggesting that although energy poverty is associated with income, it could also occur when households are not income-poor (Simcock, Frankowski, & Bouzarovski, 2020) but are still unable to maintain a comfortable temperature indoors or use desired energy services (Cong, Nock, Qiu, & Xing, 2022; Sovacool, 2015). In terms of transport poverty, something similar happens. People experiencing these circumstances are not limited to monetary reasons, but it could also influence that individuals live in areas poorly served by public transport, have no access to paved roads or are people with disabilities (Churchill, 2020; Grahama Currie et al., 2009; Mejia-Dorantes, 2018; Mejía-Dorantes & Villagrán, 2020). Our research corroborates these previous points and also indicates that energy and transport poverty

Table 6

Slum-dwellers reasons and explanations to steal electricity.

Respondent	Confirmatory statement
ECA02	<i>We do not pay for our electricity. We do not even have a contract with CFE; we do not have a meter, and two families live in this property. We steal our electricity. Once a technician from CFE came to put the wires and meters to stop us from continuing stealing, but the neighbours came up with a plan, and we decided to bribe the CFE technician so we could continue stealing electricity, and we have been in the same position for years.</i> <i>We live in an alleyway, and most people living on the same street do not pay for their electricity bills. I dare to say that no one there pays for electricity. I know that no one pays for electricity because a technician from the electricity company offered to make a direct connection to every-one on the block, and we all accepted the deal. Our street is a slope with six homes, and we all take electricity from the same source. I have not paid for my electricity for the last two years, and I know more than 30 people from my neighborhood who do not pay for their electricity either.</i>
UTLAL01	<i>My dad has been stealing electricity for over 15 years.</i>
RTECA04	<i>My parents have been stealing electricity for at least ten years. Maybe for even longer.</i>
ECA08	<i>To be honest, I am happier stealing electricity because I don't need to worry about paying for it. With time, you kind of get used to not paying. Perhaps my zip code is betraying me, but I would always rather steal electricity than pay for it (laughs).</i>
TEX02	<i>I am currently stealing my electricity. Because when Luz y Fuerza left, CFE made a mistake and started charging us more, much more than what we used to pay. Before I paid \$400 pesos (~19.54 USD) every-two months, when CFE came, my electricity receipt was \$1800 pesos (~87.92 USD). Since they never told me why did I owe them so much, I never paid them. When I refused to pay, they cut my electricity. However, I didn't have access to electricity for four hours only, because as soon as they cut my lights, I hired a mister to fix the wiring and since then, I've been stealing my electricity. I've been stealing electricity since Felipe Calderon, so more than eight years now.</i>
CHI05	<i>In electricity, we don't pay anything. We are currently stealing it. I refuse to pay because in the government they are always stealing, so I'm not going to pay for something that I didn't use or consume. CFE came one day, without previous warning to install a meter. After they installed my meter, it turns out my electricity consumption increased to almost \$2000 pesos (~97.69 USD). I was unable to pay that bill, and after that, I decided to steal.</i>
RTLAH02	<i>When Luz y Fuerza stopped operating and CFE took over, many of my neighbours and I complained that our bills were excessively expensive and didn't match what we consumed and with our previous receipts. For instance, before, with Luz y Fuerza, I paid between \$200 (~9.57 USD) and \$250 (~12.21 USD) pesos and with CFE once my receipt came of \$1500 pesos (~73.26 USD). So many of us gathered and protested against the increase in electricity prices. So we put signs outside our homes, refusing to pay for this service and giving our support to Luz y Fuerza. Ever since we have not paid for our electricity.</i>
ECA04	<i>I don't pay for my electricity, and I think the only time this neighbourhood was united was when we all refused to pay for unfair electricity bills. I remember when they wanted to install the meters, we made a mess. We organized a revolution. We kicked them out and we threatened them never to return or 'they'll see'. We were against prepaid meters because some neighbours started receiving extremely expensive electricity receipts from \$8000 (~390.74 USD) to \$15000 (~732.64 USD) pesos from one day to another. But that only happened when they installed the prepayment meters. That's why we got rid of them and refused to pay for a service we did not use.</i>
UNEZA07	<i>The house that we bought was uninhabited, and out of nowhere, I received a CFE receipt for \$480 pesos (~23.44 USD). When I asked them why I had been charged, they said that my meter was not working well, but I still needed to pay. Even if you are right, they will never lose money, you can never defeat them, is either you pay for an unfair bill, they cut your electricity or you start stealing. There is no way they'll say, OK, we got it wrong. Here's your accurate bill. Now, I'm paying 50 pesos (~2.44 USD) only because I tweaked my meter.</i>
TEX09	<i>On electricity, I spend a lot. They took my meter away the other day because I couldn't afford my bill, which was unusually high. I needed to pay \$10000 pesos (~488.43 USD), and now, because I didn't have enough money, I have to pay \$15000 pesos (~732.64 USD). They never explained to me why I owe them so much or why my bill came so high. Before, I used to pay \$52 pesos (~2.54 USD) every-two months, and I wouldn't be able to pay my current debt unless I won the lottery.</i>
UCHI08	<i>Yes, where I live, seven houses on my street, including us, are stealing electricity from the same source, so even if you want to pay, the service will be the same. Plus, you may even be charged more, and you'll have to pay for whatever your neighbours are consuming. We have tried to reach an agreement with CFE, but we have a debt of \$22000 pesos (~1074.54 USD) we wanted to stop stealing, but we cannot afford to pay that amount. So they told us, "there is no space for agreements. Either you pay, or you pay." And how do they expect me to pay that much if I'm unemployed?</i>
RTLAH06	<i>I used to live in Milpa Alta, since it is very rural, we never paid for our electricity. However, now that I moved to Mixquic in Tlalhuac, a developing rural neighbourhood, we have no services there. We don't have a drainage system or internet. We do not have access to proper energy services either. So what we did was steal our electricity from the main street because they have big transformers there. So all the neighbourhood gathered and agreed to cooperate in paying for the wiring to steal from the transformer. However, it is often the case that the wire burns or someone steals it. So we need to gather again to fix the situation. In fact, not long ago, the transformer burned, so we asked CFE to install new meters and extend the grid. Since this is a rural zone with sown fields and we have a debt, they said they wouldn't enter and install the electricity services. We think that CFE is pushing us to steal because they do not want to join our community and provide access to this service.</i>

Source: authors.

often overlap and reinforce each other. Fig. 8 captures the faces of some people experiencing energy and transport poverty simultaneously.

As we previously reported, many slum-dwellers accessed energy and transport services experiencing economic struggles or even as electricity thieves. However, our interviewees also commented about another wide variety of coping strategies, including solidarity among family members and neighbors, getting fuels for free and tricking traffic regulations and authorities, as Table 9 indicates.

5.2. Perpetual peripheralization

Most often, slum-dwellers exist in Mexican society's perpetual economic, social, political, and spatial peripheralization. Table 10 presents intolerable but nevertheless salient and persistent patterns of racism and discrimination lived by our respondents. Such actions included racism against their indigenous background, discrimination against their socioeconomic status and taking advantage of not being fluent in Spanish; these actions often made our

respondents feel "judged". Respondents also talked about constantly feeling out of place, being unfairly targeted by the police, being refused service due to their skin color, and being verbally assaulted or treated like "rats".

For Flores and Telles, patterns of exclusion and discrimination in Mexico are present in personal characteristics such as skin colour and class origin; such elements reproduce social inequality within the Mexican society (Flores & Telles, 2012). The same study notes that darker children are particularly prone to attend lower-quality schools where graduation rates are lower because their (also darker) parents are more likely to be poor. They conclude that such systemic prejudice might reflect discrimination in earlier generations. However, research indicates that indigenous people in Mexico are particularly prone to be victims of discrimination among vulnerable groups. For instance, a recent study notes that the indigenous population's precarious living conditions in Mexico have been systematically greater than that of the non-indigenous population. The same study notes that the indigenous population has historically presented situations of poverty and vulnerability where seven out of ten indigenous people live in poverty.



Fig. 6. Evidence of electricity theft and street advertising calling the neighbourhood not to pay their electricity bills. Panel A shows electric poles with tangled wires in Ecatepec and Chimalhuacan. Panel B shows a household lacking an electricity meter in Ecatepec. Panel C shows two street advertisements calling energy users to stop paying their electricity bills and join their groups.

Table 7
MCMA slum-dwellers patterns of car ownership and walking. Source: authors.

Respondent	Confirmatory statement
UECA04	The gasoline prices are too high, plus the oil. If your tire is flat, it costs a lot of money to replace it. However, owning a car is no longer a luxury; it is a need.
UTECA05	Maintenance is very expensive, and the gasoline prices keep going up. The government promised us that the price of fuels would go down, but it keeps increasing. It is very stressful thinking about how much we need to spend to keep our cars rolling.
UCHI08	I haven't paid my tenancy taxes in seven years. It is too expensive. I cannot afford it.
TEO05	I'd rather spend a fortune to keep my car up to date by paying taxes and gasoline than riding public transport during peak hours and risk being mugged.
RTLAH06	Having a car is like having another family (laughs) because you spend the same maintaining your vehicle as what you would spend on them. You need to wash it, pay taxes, put gasoline, insure it, change lights and tires and invest in a good sound system. I reckon you end up paying more because it costs a fortune if the vehicle stops working.
NEZA08	Transport is essential to living and to work. It takes you to your work and returns you to home. Gasoline represents my biggest expenditure; I spend around 900 pesos weekly (~43.96 USD) in gas to fill up my pickup truck.
CHI04	We stopped walking. This zone is too dangerous, and it is impossible to walk around here without feeling threatened. If you go out walking, you need to be with two other people. Otherwise, people will try to rob you, or God knows what else they can do to you.
NEZA05	I could walk to my workplace, but I never feel safe.
ECA04	I was the luckiest of the whole block. It took me less than 10 min to get to my workplace walking. Now that I am retired, I stopped walking.

(CONEVAL, 2018). This means that 8.3 million indigenous in Mexican territory are living in poverty. Nevertheless, what is more striking about these statistics is that from this 70%, 3.2 million indigenous people live in extreme poverty (H. Molina, 2018).

Tellingly, only three participants from our entire sample own low-carbon energy sources; in their case, the sources consisted of solar technologies. The benefits of these technologies were noted by RTLAH03, TEX05 and UIZTA09, respectively:

My dad with solar PV is saving a lot on their energy bills. If we could all have access to these technologies, perhaps it would be easier to generate savings.

I have solar water heating. It was expensive to get in the first place, but it is a great investment. I'm extremely happy with this technology.

Solar water heating has been extremely useful to us, we have saved a lot of money on gas. Now, using solar water heating has become extremely valuable because we keep watching that gas prices have increased massively.

The patterns of marginalization against the adoption of cleaner technologies (e.g. solar PV, electric vehicles and hybrid cars) persisted in not having the economic resources to access them. This, although slum-dwellers were genuinely interested in adopting them. To this RTECA09, RTLAH03, UCHI08 and UTLAL01 stated respectively:

I've seen that hybrids do not consume much gasoline and are way cheaper than owning a petrol car in the long run. Having a hybrid car could also help me build savings and cut expenses. Unluckily, the prices for those are beyond our reach. I would never be able to afford one at their current price.

Table 8

Slum-dwellers perceptions of declining health and quality of life.

Respondent	Confirmatory statement
NEZA08	I have been robbed three times on public transport. Once I recognized the robbers and they didn't take anything from me but my phone, they allowed me to keep my money. The other time children aged 14–15 entered the bus and robbed it with knives, they took what I had on me, which were \$20 (0.98 USD) pesos.
ECA02	Busses and combis are the absolute worse. If you are carrying an object of value, they will take it from you, and if you do not have anything on you, they will punch you because you do not have anything to give away. Not long ago, I saw how some crooks robbed a combi, and a passenger was a police officer. So when she tried to defend herself and the other passengers, the robbers shot her in the head and chest. It is very hard to recover after seeing something that gruesome. Hardly you will ever feel safe in a combi. What was worst was that there were some teenagers in the combi and a few children. I wondered how they felt after seeing that?
ECA07	I was robbed four times in 10 days. The fourth time I was robbed, I recognized the crook and told him: "you took my phone the other day, I don't have anything else on me". So he tried to take my glasses, but I stopped him and told him: "please, don't take these away, I'm almost blind". So he allowed me to keep my glasses. He didn't take anything else from me but my coins. But it felt like a win because I kept my glasses.
TEO08	They have stolen my phone more than three times on the bus. I hate those fucking pickpocketers. Once I took a cab in the night because there weren't any busses around and they kidnapped me, the driver took everything from me and beat me almost to death. After that, I've never felt safe again in a taxi.
TEO02	Once, I got kidnapped in a taxi. I remember I wanted to crash the taxi; I wanted to die before falling in the claws of that guy. Later, they tied me with a cord and threw me in the middle of the night in "la colonia los Patos". I thought I was going to die because when I woke up, the floor was burning hot and it smelled like sulfur. But I wasn't dead, they just threw me in a pile of burning trash blindfolded and with my hands tied.
NEZA01	Being a woman in public transport is even worse. Once I was coming from my dad's house at night, I was alone with three other men. One of them was looking and staring at me. I decided to ignore him until he started screaming at me. When I turned my head, I saw that he was masturbating. I panicked and screamed so loud that the other passengers and the driver kicked him out of the bus. I felt even worse than the time I got robbed.
UODA06	My boyfriend lived 20 min walking away from my home. Since it was late, I decided to take a cab. For this journey, the taxi usually charged me 30 pesos (~1.47 USD), and this time we were at 47 pesos (~2.30 USD), and the cab was going extremely slow. So I told the driver I wanted to get off now. When I tried to open the door, he closed it very violently, and he had already unzipped his pants and he was pulling his underwear down, he was naked when he jumped at me. I remember thinking, 'I'm going to die'. I do not know how, but I kicked him with my knee, and I opened the door and ran until I saw an open store. The woman from the store saw me pale and shaking, and she walked me home. When I went to the police station to denounce the crime, they actually made me feel as if I was guilty, they asked me things like what I was wearing or if I seduced him. They didn't ask me about how he tried to rape me.
RTLAH03	Women in public transport suffer from all sorts of sexual violence. There are a lot of perverts, regardless of the transportation mode.
RTLAH06	Women are the most vulnerable group in Mexico City, regardless of their age. We cannot dress as we like because we are afraid of someone raising our skirts or grabbing our private parts. If you like wearing miniskirts, I'm sorry, you are not allowed to wear them anymore. As soon as you get on the bus, men stare at you and stalk you with their eyes. When you try to defend yourself and say something back at them, they make you feel like it was your fault. They'll say things like: "you should not wear clothes like that if you don't like men staring at you." I feel our freedom is constrained, and I feel attacked and vulnerable most times whenever I'm on the streets. The other day I went to Mexico City's downtown with my sister. We were power napping on the bus, and I woke up to my sister screaming at a man because he was touching her. The man only said, "don't pretend you don't like this," and he left. How does he pretend she liked that? They must be fucked in the head if they think that is the reality.
NEZA02	I know that cooking with wood is bad. Now that I've been cooking with wood daily again, I've had more trouble breathing. The doctor told me my lungs are already blocked and that I need to stop using wood, but I do not have any other way to prepare my food or heat my water, so how else do you want me to do this?
CHI04	Yes, if we do not have gas, we need to cook with wood, and the smoke affects our health, more the children's health. For example, just when you arrived, I was preparing lunch, cooking with wood (you saw me), and now my eyes are burning, and I need to cough. I feel that my lungs are blocked whenever I cook with wood. In the long run, I know cooking with wood will affect my health
TEO	When it is too hot, you feel dehydrated and you get insulated. Whenever it is too cold, I have had pneumonia. I also think that if I get sick so often, it is because I spend so much time on the bus that I do not have enough time to sleep and rest. I feel sleepless most of my days, and I think that it has been affecting my health more than being hot or cold.
ECA01	Transport has also affected my health. Imagine being in the city center's traffic for so long, inhaling all the toxic pollutants coming out from cars? That has definitely affected my health. I can feel it in my breathing. Plus, to arrive at my work on time, I used to wake up at 4 am to arrive there at 7 am. Then, I left my job at 18:00, and I came home by 21:00, sometimes even later. So all the time I was feeling tired. On the bus, whenever I got a seat, I fell asleep, and on more than one occasion, I missed my stop because I could not wake up. I don't think it was normal how exhausted I felt every day. Now that I stopped working, I feel that my breathing has improved, and I do not feel tired all the time.

Source: authors.

The government should provide incentives to low-income families to afford solar PV technologies and hybrid cars. They know that most of our expenses go in energy and transport, having access to these technologies could generate great economic benefits to all that struggle to pay for these services.

I've seen that most countries are starting to use clean energy, but not here. In Mexico, the president is betting on oil and instead of promoting solar PV and other technologies, they are giving more power to the CFE. The same company that has neglected us for years.

Who wouldn't like to have one [electric vehicle]? but are truly expensive. I haven't seen a single one parked in my neighbourhood. I do not know anyone who owns one.

We argue that peripheralization and discrimination exacerbate energy and transport poverty. Indeed, research suggests that people belonging to ethnic minorities, low-income neighbourhoods or with some disabilities are more likely to experience energy (Carley & Konisky, 2020; Ivanova & Middlemiss, 2021; Memmott, Carley, Graff, & Konisky, 2021) and transport poverty (Churchill, 2020) or both simultaneously (Sovacool & Furszyfer, 2022), as our research suggests.

Participant RTLC03 captured how discrimination and peripheralization contributed to exacerbating energy and transport poverty as well as patterns of marginalization when she noted that:

I feel angry about the inequality in Mexico City because rural areas and poor communities do not have the same resources and are always left behind. I've never heard that people living in Santa Fe or Polanco spend more than a week without water, but where I am from happens all the time, and it is not fair. We also pay our taxes, and we are humans like them. The government treat us like rats and I would ask them to stop treating us as such. It doesn't matter how often we complain about the lack of water and how it affects us; our voices are never heard. I have never seen people from Polanco or Santa Fe striking because they have everything, water, paved roads and energy access. For us is different, I feel that the State has abandoned us.

5.3. Spatial justice

Less glumly, the last section of our discussion suggests a way towards achieving a degree of spatial justice for slum-dwellers, with a set of recommendations for future policy at the local level.



Fig. 7. Evidence of slum-dwellers cooking with wood and exposed to hazardous air pollutants. Panel A. shows a couple cooking breakfast exposed to hazardous air pollutants emerging from wood combustion in Chimalhuacan. Panel B. Shows a mom and her daughter cooking quesadillas with industrial pieces of wood in Texcoco. Panel C shows a local sweatshop in Texcoco where two women are exposed to indoor air pollution and microfibers.

Our first recommendation calls for urban planners to design low-cost housing programmes based on the population's needs. For instance, rather than extending the grid network to provide access to slum-dwellers in informal settlements, the government could promote renewable energies by installing roof solar PVs and solar water heating systems. In this way, the CFE could mitigate the technical losses emanating from electricity thefts, help low-income groups cut expenses from gas and electricity, while helping reduce the use of pollutants fuels such as wood and other residues.

Authorities should focus on reducing the criminal rates emerging from transport services. Most of our respondents shared the vision that due to corruptive practices within the police department, the transport systems in the MCMA were a hot spot for crime. For instance, UTECA05 and ECA02, TEX10 and TEO06 commented, respectively:

Cameras in combis and inside the metro are important; however, if the police do not act against the crooks, they will continue stealing and killing.

When I used to work, I left my home at 4:00 am, and many times the bus or combi driver drove under the influence of drugs and alcohol. Regardless of how bad they drove, the police never did anything to stop them. And in the handful of times the police actually stopped them, the driver slipped 50 pesos to let him go. The drivers risk every-one's lives and never get stopped by the police. I do not understand how the authorities leave them running free on the streets.

Everyone knows who the criminals are, but you cannot tell the police officers because they most certainly are working together, so you do not know who to trust.

However, corruption and accountability are not limited to the police department. Our two participants from Tlahuac demanded procedural justice from the authorities involved in the Tlahuac Metro Accident, where at least 24 people lost their lives, yet no one has been found guilty of this gruesome accident. To this, RTLAH02 and RLAL03 commented, respectively:

I don't think money will solve this issue. A human life has no price; giving away money and building again Line 12 does not fix the existing corruption problem in Mexico. Families were destroyed after losing a father and a mother, which cannot be fixed with money, it can only be fixed with justice.

They took the only dignified means of transport to my home; innocent people lost their lives because of corrupted authorities who wanted to fill their pockets. I and every-one I know wants justice from this tragedy. Corruption needs to end.

Other studies (Niner, 2003) have noted that feelings of exclusion and discrimination are often justified given existing policies relating to land ownership and land use planning. Therefore, shifting the status from *illegal* settlements to formal/legal settlements could generate huge benefits that range from access to services to regain their identities. NEZA07, NEZA08 and UIZTA articulated respectively:



Fig. 8. Slum-dwellers classifying themselves as in extreme energy and transport poverty (i.e., spending more than 50% of monthly income on mobility or energy services). Panel A. Shows a vulnerable energy user from Ecatepec pointing how low the electricity wires are hanging from her garage. Panel B. Shows a waste collector from Ecatepec telling us about his struggles paying the gas and how CFE has never provided him with a meter. Panel C Shows a woman and her daughter living next to the waste channel in Netzahualcoyotl. Panel D. Shows an elderly woman from las Vias Netzahualcoyotl.

Table 9
Mechanisms for coping with extreme energy and transport poverty in the MCMA.

Respondent	Confirmatory statement
TEO11	Whenever I do not have enough money to pay for the gas or electricity, I need to ask family and friends for money.
NEZA01	When we run out of gas, I need to ask my mother-in-law for a loan or ask permission to cook in her house. We don't have any other option.
NEZA06	Wood is free, people throw it away, and I collect it; you can find it anywhere for free. As long as it is wood, it will burn.
CHI02	The municipal authorities provide the wood; we have a deal with them to have access to this resource for free.
UCHI08	If you live in the State of Mexico and you do not have your car taxes in order, you can easily get away with it because you know where the police officers are located or else you can always bribe them. That is cheaper than paying the taxes.

Source: Authors.

I feel discriminated against in terms of my energy services. Since we live in an illegal settlement, whenever we have tried to pay for our energy services, these have been denied to us. For them, we do not exist; we are only thieves. We also want to pay for our electricity services to get proof of residency. Right now, we only have one way to prove who we are, and that is through our photo-voting card. For the authorities, as we live in these conditions, we do not exist.

I also feel discriminated against because the authorities are not recognizing our rights to have energy access. As we are illegals, they do not want to provide us with this service. They are telling us that we should be content with what we have now. They do not see us like humans, since they have a home and a steady job, they think they are better than us; for them we are not equals; they are always looking down at us and treat us like inferiors. There are 265 families living here and they would only turn their heads at us near elections, around that time, then we do exist.

Table 10
Patterns of discrimination, intolerance, and violence within the MCMA.

Respondent	Confirmatory statement
CHI03	<i>I have felt discriminated against. My mother tongue is Mixteco, and when people hear me talking, they look at me funny. They sometimes say, 'what does this Indian wants now'. They judge us for our thoughts, dressing, and appearance. That kind of discrimination has always existed, and I do not think it will go away easily.</i>
TEX02	<i>I think people should stop judging low-income individuals with an indigenous background. People should not judge because of how we speak and how we dress. We should all be treated equally, and we are asking them very kindly to respect our customs and values; it doesn't matter how we speak or how we dress; what really matters is how we think.</i>
CHI02	<i>I have also felt discriminated against many times while riding public transport. When I arrived at Chimalhuacan, I didn't know people would look at my indigenous background, but they did. Since my skin is darker, and I have a different accent, they look at me as if I do not belong here. I felt people judged me every time I opened my mouth.</i>
CHI06	<i>Many indigenous and low-income communities are not well informed, we never questioned why we spend so much on gas and electricity services. Many family members and even some friends do not speak proper Spanish, and when they try to complain, there is no one able to understand them, so their voice remains unheard. I think people take advantage of the fact they do not speak fluent Spanish.</i>
TEX01	<i>I have felt discriminated against by the CFE. Once, we got a fine because they said we were electricity thieves, only because we are the poorest household of this block. However, we were the only ones who were paying their electricity bills. The people who were actually stealing it didn't do anything to them. When we asked for an explanation, they never listened to us, and they just asked us to pay, so we did. But they treated us very badly. I felt discriminated against and judged.</i>
ECA01	<i>What I would like is to be heard and not be discriminated. I have been discriminated against for my age, my indigenous background and because we are poor. They have told me, "return to the mountains, fucking Indian" I want to be treated with more dignity. In terms of energy, I feel discriminated against all the time because I've told the electricity company over a hundred times to come and fix the wires. I have explained the situation with my child and how risky it is to have these wires hanging in my garage. I've been asking for the same for years, but they have never come, and now I am certain they will never fix this. I feel discriminated against because sometimes I feel they treat me differently because I am an elderly woman.</i>
NEZA02	<i>I cannot find a job because of my background, age, and because I am illiterate, no one will give me a job. I feel discriminated against because no one will ever hire me again.</i>
NEZA04	<i>We have felt discriminated too. When my daughters couldn't take the online classes because they didn't have internet access, they never paid attention to our claims when we asked for support. My daughter lost a year of her life because we had no resources to join online classes. Millions of people experimented the same. We didn't have any other options but to stop our lives because we did not have access to the internet. My brother, who lives a few blocks away from here, also lost his job because he had no computer. I wonder who's going to help my daughter recover that year. Just because we do not have any money to have the equipment doesn't mean we don't want to go to school. What will happen if there's another lockdown? Will my daughter lose another year?</i>
TEX02	<i>I've felt discriminated against when CFE came to install a technology I did not even know about. They treated everyone in the town very badly. One of the technicians even ran over one of my cows. Imagine how careless they were. They even sent the army because we didn't let them in. So when CFE came, I did feel discriminated against because they were behaving as if they were better than us.</i>

Source: Authors.

I live on the border between Iztapalapa and Tlalhuac, and if Iztapalapa is fucked, Tlalhuac is a rural town. Ten minutes away from where I live, people are still riding horses, and many of them live in extreme poverty. They do not have access to water and a drainage system, and authorities have tried to evict them more than

once. All these problems are because they are living in illegal settlements, and the authorities do not recognize them and want them out.

6. Conclusion

To explore the lived experience of energy and mobility poverty in Mexico's informal settlements, we conducted two focus groups with 18 urban and rural participants, interviewed 51 households, and conducted site visits to five locations in the MCMA. Our research showed that most participants experience a "double energy vulnerability," circumstances whereby people simultaneously face an intensified risk of energy and transport poverty. Moreover, we revealed that energy and transport poverty are exacerbated by peripheralization, marginalization and discrimination and that poverty experiences are not limited to affordability; instead, energy and transport poverty must be addressed through a multidimensional lens.

Slum-dwellers represent one of the most vulnerable groups in urban areas, and a particularly vulnerable class of people within the MCMA region. Through extensive field research and focus groups, our study has revealed how housing, transport and energy needs are vital to their lifestyles but also a leading cause of their most significant social struggles. Many slum-residents spend up to half of their income on mobility and energy services, but primarily on transport, often accounting as their main household expenditure. In other cases, our study indicated that due to the increasing energy prices, slum-dwellers had found themselves needing to cook with wood regardless of the harmful effects on health or had been pushed to steal electricity. Our research also showed how slum-dwellers often expose themselves to inadequate housing and poor service conditions that could often negatively affect their wellbeing. Such conditions range from being robbed or murdered using public transport to electrocuting themselves installing *diablitos* to steal electricity.

The continuous peripheralisation of slum-dwellers in the MCMA could help as an uncomfortable reminder that extreme poverty, racism and discrimination exists even in industrialised cities such as Mexico City. Even though the current government's priority is "to help the poor", such issues persist and unsurprisingly, rather than seeing an improvement in their living conditions, our respondents saw the opposite, more decadence, corruption, poverty, discrimination and worse services. This research could also help remind us that low-income groups have daily struggles to survive and are often victims of violence against them and corrupted practices that put at risk their subsistence. For these communities, energy, mobility, and environmental health are not merely services or luxuries; they are instrumental and core aspects of achieving better qualities of life for themselves, their indigenous groups, and their children.

CRediT authorship contribution statement

Dylan D. Furszyfer Del Rio: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **Benjamin K. Sovacool:** Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Supervision, Project administration.

Data availability

Due to the ethical concerns of sharing qualitative data gathered from respondents from a vulnerable group, the interviews and focus groups transcripts cannot be made available.

Declaration of Competing Interest

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

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