Sokoto Journal of Geographical Studies (SJGS)

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ASSESSMENT OF SUSTAINABLE MOBILITY CHALLENGES FOR VULNERABLE GROUPS IN URBAN KANO, NIGERIA: A REVIEW OF PAST AND PRESENT RESEARCH

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Abstract ***https://doi.org/10.65760/sjgs.v3.i1.13***

Sustainable urban mobility is vital for inclusive development. However, vulnerable groups such as women, children, the elderly, and persons with disabilities still face significant barriers to safe and fair transportation. This study presents a review of past and current research on mobility challenges faced by these groups. It draws from peer-reviewed journals, grey literature, and global policies to evaluate inequalities in mobility, infrastructure shortages, and socio-cultural barriers that limit access. The findings reveal that, although numerous studies have examined transportation and road networks, few have focused on the intersection of sustainable mobility and the diverse needs of vulnerable populations in African cities. Urban Kano highlights these issues, as rapid growth, poor public transport, reliance on informal paratransit, and weak pedestrian and cycling infrastructure increase exclusion. Climate change, environmental damage, and social inequalities further block mobility. The study highlights significant gaps in research, especially in multimodal transport, walkability, mode choice, and gender-sensitive planning. It emphasizes the importance of equitable transportation policies, integrating non-motorized options, and engaging communities in planning to ensure safety, accessibility, and affordability for all. By aligning with Sustainable Development Goal 11, the paper advocates for rethinking transport systems through inclusive, climate-resilient, and people-centered solutions. Ultimately, meeting the mobility needs of vulnerable groups in Kano and similar cities is crucial for reducing inequality, promoting social inclusion, and enhancing the quality of life in rapidly growing urban areas.

Keywords: *Sustainable Mobility, Vulnerable Groups, Urban Transport, Inclusive Mobility, Non-motorised Transport, Sustainable Development Goal 11.*

Introduction

Vulnerable group is part of the population in a society with some characteristics that make them at higher risk of needing charitable support than others, being excluded or denied from some social services (Abrantes *et al*., 2023; Amann and Sleigh, 2021). These groups often possess specific attributes that make them face particular challenges, such as low levels of resilience, a need for humanitarian assistance, and exclusion from financial and social services available to the majority of the population. Globally, there are more than one billion persons with disabilities, representing 15% of the world population, with developing countries accounting for a disproportionate share of this figure (Martin Ginis *et al*., 2021). In Nigeria, the National Convention on Rights of Persons with Disabilities estimates that over 35.1 million people live with some form of disability (Peter et al., 2020). In addition to people living with disabilities, children and young people constitute a significant vulnerable group. The United Nations Population Fund (UNFPA) estimates that the global population aged 10-24 years stands at 1.9 billion, accounting for about 27% of the world's population. In Nigeria, there are approximately 31 million children, with at least seven million births recorded annually (Folayan *et al*., 2020).

Population ageing further intensifies vulnerability, particularly in urban areas. By 2050, one in every six people globally is expected to be aged 65years or older, with the population of this aged group projected to double between 2019 and 2050 across regions such as North Africa, Western Asia, Central and Southern Asia, Eastern and Southern Asia, Latin America, and the Caribbean (United Nations, 2019). Moreover, the number of people aged 80 years and above is expected to triple from 143 million in 2019 to 426 million by 2050 (United Nations, 2019). In Nigeria, the aged population is projected to grow at an annual rate of 3.2%, currently accounting for over 5.9 million people, with this figure expected to double by 2050. Women also represent a substantial proportion of vulnerable populations, particularly due to gender based inequalities in accessing basic resources and services. In Nigeria, women accounted for 49.6% of the total population in 2017, increasing to approximately 99.13 million by 2019 (National Population Commission, 2019). From 2017 to 2025, the projected population of women account of over 118 million. The growing population of vulnerable groups globally and nationally underscores the urgent need for inclusive urban transport systems that support multimodal, non-motorized, and accessible mobility options. In response to these challenges, this study aim to critically review past and present research on sustainable urban mobility, with particular emphasis on the challenges faced by vulnerable groups in urban Kano, Nigeria.

Conceptual Issues

This section evaluates existing concepts, theories, and issues relating to sustainable urban mobility among vulnerable groups in urban areas. The section examines a wide range of literature to critically review existing research and situate the arguments within the context of the study paper.

Urban Mobility in the New Urban Age

Based on the increasing global urbanization, the United Nations has declared the new urban age, also known as the contemporary urban age, since the beginning of the new millennium. The urban age is characterised by rapid urbanisation, population growth, and spatial expansion of cities. The agency maintained that the world is more urban than ever before, with over 3.3 billion people residing in urban areas. This has shaped how people move within urban areas (Ribeiro *et al*., 2024; United Nations, 2019). Mobility has a different meaning; in context, it is the movement of human beings, individuals, as well as groups, in space and time (Scorza *et al*., 2024; Wang *et al*., 2022). Mobility is one of the most important characteristics of human activity because it satisfies the need to move from one geographical location to another, a need shared by passengers and freight for different purposes. Urban mobility in this context extends beyond the movement of people and goods to encompass accessibility, equity, sustainability, and overall quality of urban life (Holden *et al*., 2020; Pereira *et al*., 2017). As cities expand, mobility faces challenges, including traffic congestion, high crime rates, environmental degradation, social inequality, and infrastructure deficits, among others. In many cities of the Global South, including Nigerian cities such as urban Kano, these challenges are further intensified by rapid population growth, an informal transport system, and weak institutional capacity.

Sustainable Mobility

Sustainable mobility is a global policy objective aimed at transforming the transport system to be environmentally sound, socially equitable, economically efficient, and safe for all road users (Chan *et al*., 2021; Banister, 2008; Gallo & Marinelli, 2020). It seeks to ensure that all people, regardless of income, gender, age, or physical ability, have access to jobs, health, and education through a reliable transport system (OECD, 2019; UN-Habitat, 2013). In addition to efficiency and safety, sustainable mobility emphasizes reducing greenhouse gas emissions, air pollution, and road traffic injuries while promoting non-motorised transport and public transit (ITF, 2017; United Nations, 2019). Equity and inclusiveness are the central principles, requiring transport

planning to explicitly consider the needs of vulnerable groups, including women, children, the aged, and people living with disabilities (Lucas *et al*., 2016; Uteng & Lucas, 2017). In many developing cities, however, population growth has exceeded public transport provision, limiting access to economic and social opportunities for the marginalized groups (UN-Habitat, 2020).

Vulnerable Groups and Vulnerable Road Users (VRUs)

Vulnerable group is part of the population in a country with a detailed feature that makes it at high risk of needing charitable support than others or being excluded from financial and social services (Kuran *et al*., 2020;Abrantes *et al*., 2023) According to Docherty *et al*., (2018) and Doğan *et al*., (2018) Pregnant women, the aging population, people with health conditions, and poorer households are considered vulnerable, with poor health resulting from living in deprived socio-economic circumstances, exacerbated by exposure to higher concentrations of air pollution. On the contrary, vulnerable road users are pedestrians and cyclists, and other special groups like people living with disabilities (PLWD) and children. According to International Transport Forum (2016), the concept of vulnerable road users is widely used in transport and road safety discourse. The term started in Europe, with planners and safety organisations, to categorise and describe non-motorised road users (pedestrians and cyclists) who are easily injured and killed in a dominant space. Vulnerable road users are people in need of special care, support, or protection because of age, disability, or risk of abuse or neglect. In other words, vulnerable road users are those who have less protection and are at a greater risk in traffic. Children, the elderly, women, and disabled people are considered a vulnerable group of people, since they have physical disadvantages compared to the average road user (Doğan *et al*., 2018; WHO, 2018).

Theoretical Perspectives on Sustainable Urban Mobility Among Vulnerable Groups

Understanding sustainable urban mobility, particularly for vulnerable groups, requires drawing from multiple theoretical perspectives that explain how transport systems can promote environmental sustainability, social equity, and economic efficiency.

Rawls Theory (Theory of Justice and Fairness)

Rawls theory of justice provides a normative framework for examining equity and fairness in urban transport systems. Rawls (1971: 1999) asserts that justice is the primary virtue of a social institution and that social and economic inequalities are only justifiable if they benefit the least advantaged member of the society. His principle is relevant to this study, as it supports transport investments that prioritize marginalized and vulnerable groups. In the context of urban transport, justice-based approaches frame mobility as a fundamental social good rather than a market commodity (Martens, 2016; Soja, 2010). Rawls expressed his ideas of justice as fairness in his two principles of justice. The first principle states that each person has the same indefeasible claim to a fully adequate scheme of equal fundamental liberties, which scheme is compatible with the same scheme of liberties for all. The second principle is that social and economic inequalities are to satisfy two conditions, they are to be attached to offices and positions open to all under conditions of fair equality of opportunity, and they are to be the most significant benefit of the least-advantaged members of society (the difference principle). Applying Rawls' principles to urban mobility highlights the moral obligation of cities to design transport systems that ensure access to opportunities for vulnerable groups (Barry, 1978; Dutta, 2017; Miller, 1977; Ren *et al*., 2021).

Factors Affecting Vulnerable Road Users' Safety

Vulnerable road users (VRUs), face disproportionate safety risks in the urban transport system. These risks arise from a combination of various factors such as driver and vehicle factors, demographic, cultural, and social safety risk factors, pedestrian safety risk factors, infrastructure,

failure to respect the right-of-way (ROW) of vulnerable road users, environmental, and climatic factors.

Drivers and Vehicle Factor

The type of vehicle plays a significant role among the factors that affect the occurrence and severity of crashes involving vulnerable road users. For example, in a collision of pickup trucks against pedestrians, the risk of death is 3.4 times greater than that of those involving regular passenger vehicles. In experience, lack of skill and risk-taking behavior is associated with the collision of young drivers (Ribeiro *et al*., 2024; Roudsari *et al*., 2004; Vanlaar *et al*., 2016; Yang *et al*., 2024).

Driver-Related Factors

Driver behavior and skills significantly influence the safety and mobility of VRUs (vulnerable road users). Excessive speed and aggressive maneuvers such as overtaking too closely or ignoring pedestrians crossing cause danger to vulnerable groups (Peden *et al*., 2004. Driving under the influence of alcohol and distractions such as the use of mobile phones while driving increase the risk of road traffic crashes involving vulnerable road users (Adeleke & Iyanda, 2024; Himanshi, 2020; Reddy *et al*., 2018; Rolison *et al*., 2018; Singh, 2017). Drivers may not anticipate the movements of pedestrians, cyclists, or children, particularly in mixed-use areas. Limited understanding of the needs of older adults or people with disabilities can lead to unsafe urban mobility (Martens, 2016; Soames Job *et al*., 2018). The non-compliance with traffic signs, pedestrian priority rules, speed limits, and poor enforcement exacerbates risk, and safe urban mobility for VRUs (Ren *et al*., 2021; Pereira *et al*., 2017).

Vehicle-Related Factors

The type, condition, and design of vehicles can either facilitate or hinder VRUs safety. Larger vehicles, such as trucks and buses, have bigger blind spots, making it hard to detect pedestrians and cyclists. Certain vehicles, like motorcycles, may be more unpredictable and pose specific risks to VRUs (Elvik, 2009;Ahmed *et al*., 2023). Poorly designed headlights, mirrors, or a lack of pedestrian detection systems reduce a driver's ability to see VRUs (Nieuwenhuijsen *et al*., 2017; WHO, 2018). The present modern safety technologies, such as automatic emergency braking and collision warning systems, are designed to improve VRU protection (Martinez *et al*., 2020; Miranda-Moreno *et al*., 2011). As opined by Peden *et al*. (2004), vehicle conditions and maintenance play a significant role in road traffic accidents among VRUs, such as faulty brakes, worn tires, or malfunctioning lights.

Demographic, Cultural, and Social Safety Risk Factors

There are cultural, social, and demographic factors that influence vulnerable road users' exposure to injuries. Some studies conclude that there is a relationship between the population demographics and the rate of pedestrian injuries, level of schooling, pedestrian habits, customs, and the socio-economic level of road users (Abdous & Mahmoudabadi, 2022; Miranda-Moreno *et al*., 2011; Onifade *et al*., 2022; Tian *et al*., 2022).

Demographic Factors

Demographic factors such as age, gender, disability, and health status significantly influence mobility patterns and vulnerability in urban areas. Children and older adults are at higher risk due to limited physical ability, slower reaction times, and difficulties crossing roads or navigating complex intersections (Pereira *et al*., 2017; Martens, 2016). Women often face safety concerns, such as harassment or assault during travel, affecting their freedom to move, especially at night or in poorly lit areas (Adhikari *et al*., 2020; Fielding *et al*., 2021; Mosha *et al*., 2022;

Vanderschuren *et al*., 2023). People living with disabilities encounter inaccessible infrastructure challenges, such as a lack of ramps, tactile pavements, or adapted vehicles (Martin Ginis *et al*., 2021;Martens, 2016; Pereira *et al*., 2017).

Cultural Factors

Cultural norms, travel behaviors, and societal expectations can shape mobility experiences. Societal stigma against women traveling alone or persons with disabilities may discourage them from using public transport (Uteng & Lucas, 2017). Cultural norms may favor motorized transport over walking or cycling, creating environments that are hostile or unsafe for pedestrians and cyclists (Pojani & Stead, 2017). Responsibilities such as caregiving or household duties may restrict women's travel time or route choices (Bergman Lodin *et al*., 2019; Nasrin & Chowdhury, 2024; Torre & Jacobs, 2021).

Social Safety Risk Factors

Social safety, including crime and harassment, directly affects mobility. Crime areas reduce mobility for children, women, and the elderly due to fear of assault, theft, or kidnapping (Haider & Iamtrakul, 2022; Tchinda & Kim, 2020; Yusuf *et al*., 2021). Sexual harassment in public transport or on the streets is a major barrier for women and girls (Fielding *et al*., 2021; Mosha *et al*., 2022). Areas with inadequate mobility infrastructure experience reduced mobility by vulnerable groups due to a lack of assistance, escorts, or communal oversight (Adeboje *et al*., 2020; Datta & Ahmed, 2020; Ebelechukwu *et al*., 2024; Nicoletti *et al*., 2023).

Pedestrian Safety Risk Factors

Issues related to pedestrians also have an important influence on their safety, including the use of drugs and/or alcohol, usage patterns, pedestrian volume, behavioral patterns, jaywalking, age, disabilities, risk perception, among others (Dumbaugh *et al*., 2024; Hossain *et al*., 2024; Mukherjee & Mitra, 2022).Alcohol use and other pedestrian behaviors are important contributors to their own risk, making it difficult for the agencies to predict and implement countermeasures.

Speed

Numerous countries have different speed limits for urban roads. In the Netherlands, 70% of urban roads are limited to 30km/h, while in Austria, the limit is 50km/h, with 30km/h for residential areas. Conversely, countries such as the US, India, and China do not have a specific maximum speed limit for urban roads. However, in Nigeria, speed limits vary based on the type of vehicle; the law imposes a maximum speed limit of 100km/h for cars on highways. Several studies have concluded that speed is one of the most influential factors for the occurrence and severity of pedestrian crashes (Eboli *et al*., 2017). The probability of injury to vulnerable road users due to the posted speed is calculated using Groeger's approach. Groeger used data gathered from a study conducted by Brian Tefft. According to the World Health Organization (2018), the probability of pedestrian fatality in meeting with a vehicle behaves logarithmically. This portrays the estimated probability of pedestrian fatality according to vehicle speed for elderly users (70 years old), all ages, and adults (30 years old).

The fatality pedestrian risk has a slight increase for impacts at 30 mph, and the probability of death increases significantly above 50 mph. The behavior of road users determines a country's road safety performance. Inappropriate speed is one of the significant causes of road traffic crashes, and it is observed that the higher the posted speed, the greater the risk of collision. (Jashami *et al*., 2024; Chevalier *et al*., 2016; Paul & Ghosh, 2018) In 2017, speed was recorded as the major contributing factor in 44% of fatal crashes (International Transport Forum, 2018). Table 1 shows the central road speed limit in Nigeria, the higher the speed of a vehicle, the

shorter the time the driver has to stop to avoid a crash. Traveling at 50km/h will require 13 meters to stop, while a car traveling at 40km/h will stop in less than 8.5 meters. Astapenko *et al*. (2019) specify that a 1km/h increase in speed results in a 3% higher risk of acrash involving injury, with a 4-5% increase in crashes that lead to fatalities. The relationship between speed and injury severity is acute among vulnerable road users, for example, according to Ramos (2015), pedestrians have a 90% chance of survival when struck by a car traveling at 30km/h or below, and less than 50% chance of surviving an impact at 45km/h. Vulnerable Road users have no chance of survival at 80 km/h.

Table 1: Speed Limit for Vehicles in Km/h

Type of Vehicle	Build up Area	Highway	Express
Motorcycles	50	50	-
Private cars	50	80	100
Taxi and Buses	50	80	90
Tankers and Trailers	45	50	60
Tow vehicles, while towing)	45	45	45
Tow vehicles, while not towing	50	60	70

Source: Nigerian Highway Code, 2021

Infrastructure and Services

Crosswalks

Pyrialakou *et al*. (2020) argue that the exposure of vulnerable groups to automobiles is directly related to the perpendicular distance they must walk when crossing a street or road, whether at intersections, midblock crossings, or any other road section. However, Raji *et al*., (2021), Shaaban, (2019) and Tani *et al*., (2021) contended that pedestrians are also exposed to the effects of traffic when walking along sidewalks without a physical barrier; direct exposure further occurs when pedestrians are crossing the road. In many countries, vulnerable road users especially children are over-represented among pedestrian casualties. The circumstances of accidents involving these two groups of road users differ. In crossing-related accidents, children are more likely to be struck by vehicles at the beginning of their crossing, whereas the aged are more frequently hit after reaching the halfway point.

Mix Land Use and Zoning

Mixed land use and zoning are utilized as a direct indicator of pedestrian exposure (Sun and Ertz, 2021). Mixed land use refers to the combination of various types of buildings with different uses in a single layout, such as residential, commercial, institutional, industrial, and Agricultural uses (Wegener & Fuerst, 2011). The percentage of neighborhood commercial and residential areas is directly related to a higher occurrence of pedestrian crashes, and the relationship between zoning areas and pedestrian risk is evident, particularly when zoning laws are applied. Shehadeh *et al*., (2024) observed that areas with higher pedestrian activity have higher pedestrian crash occurrence. Mixing land uses in Nigerian cities creates particular disadvantages for vulnerable groups, such as privacy, environmental quality, air pollution, noise, rubbish and litter, limited open space, and inconvenient parking restrictions (Fagorite *et al*., 2021; Odogun & Georgakis, 2019; Onifade *et al*., 2022; Zhang *et al*, 2019). In addition, there is a lack of location, structure, and design in residential areas, as well as a lack of zoning laws. Most urban areas are

characterized by overcrowding, congestion, slums, and urban sprawl due to inadequate land use and regulation. The location, structure, and design of land use in urban areas contribute to some of the key problems facing sustainable urban mobility.

Traffic Control Signs

The purpose of road traffic signs is to regulate traffic in a manner that promotes both traffic flow and road safety (Isa *et al*., 2022). Traffic control signs are divided into six categories: Regulatory signs, Warning signs, Guidance signs, Information signs, Road Markings, and Traffic signals. The presence of signals is considered a key safety factor because it allows for the control of traffic flow to enhance the safety of vulnerable road users (Ezeibe *et al*., 2019). The most severe pedestrian accidents in urban areas appear to be those occurring on road links outside marked zebra crossings or at junctions, particularly when a vehicle is traveling straight ahead (Mustapha *et al*., 2024). Non-signalised crossings on urban arterials are perilous for pedestrians when there is no central refuge. A narrow pavement is a factor in pedestrian accidents in areas where pedestrian traffic is particularly high at certain times of the day, especially in school zones.

Right of Way

The right-of-way (ROW) of pedestrians on side roads is often not respected by turning vehicles. Non-compliance with the right-of-way is a complex factor that encompasses several situations (Chen *et al*., 2020; Li *et al*., 2020). Right-of-way may have been ignored by a road user, either because of insufficient knowledge of the traffic rules or the local dispositions, or because of insufficient information taking, or because of perceptual problems, or again because of ill-designed road features that convey the wrong message (Chen *et al*., 2020). Insufficient information gathering by vulnerable road users, especially those from vulnerable groups such as cyclists or pedestrians, has been identified as a frequent factor in pedestrian and cyclist accidents cyclists, in general, display inadequate scanning behavior when crossing. Drivers frequently omit to give way to cyclists, particularly to child cyclists, and the same appears to be true for vulnerable road users on various types of crossings. Perceptual problems, where the elderly as well as children often find it challenging to estimate the speeds of approaching vehicles, as well as gaps and distances . However, this leads to short gap-acceptance, a pattern of behavior that tends to be classified under “risk-taking,” although risk assessments are erroneous. Similarly, Adetunji (2020) indicates that children and the elderly have trouble anticipating approaching traffic. The problem may be worse at night or in urban areas, where speeds are higher than usual. The lack of conspicuity is aggravated at dusk, dawn, and night, especially when public lighting is weak. The most serious problems seem to be the discovery of cyclists by drivers approaching from behind or alongside.

Environmental Effects of Mobility on Vulnerable Groups

Urban transport systems significantly contribute to air pollution, greenhouse gas emissions (GHG), and environmental degradation, disproportionately affecting vulnerable groups (ITF, 2017; WHO, 2018). Maintaining human life in a healthy environment for vulnerable groups is challenging due to the pollution risks associated with transportation. According to model calculations, every seventh person is exposed to harmful or disturbing road traffic noise and pollution (Fagorite *et al*., 2021). About half of the air pollution caused by nitrogen oxides and around one-fourth of the air pollution caused by particulate matter can be attributed to motorized transport (IQAir, 2019). Ozone generated by the combination of nitrogen oxides and volatile organic compounds poses a health risk. However, Air pollution is the most significant environmental risk to health today, estimated to contribute to approximately seven million deaths annually. In Nigeria, including urban Kano, according to the 2016 World Health Organization air pollution database, the air quality in several cities has reached $PM_{2.5}$ concentrations from

unhealthy to hazardous. The country is ranked 152nd out of 180 countries at the Environmental Performance Index for Air Quality. According to the World Health Organization (WHO), four of the 20 cities with the worst air quality recorded in the world are in Nigeria (with Onitsha and Anambra as the world's worst cities in terms of air quality), with Kaduna, Aba, and Umuahia among the top 20 measured by PM_{10}, ranking 8th, 9th, and 19th, respectively. An established indicator has been produced that air pollution has both short-term and long-term effects. It is the primary cause of respiratory and cardiovascular system issues associated with ozone exposure, such as eye and nose irritation, and lung impairment among vulnerable groups.

Infrastructure Deficit and Vru's Mobility Needs

An infrastructure deficit is a situation where infrastructural development fails to efficiently meet the population's needs regarding socio-economic development, growth, and general well-being (Adeboje *et al*., 2020; Datta & Ahmed, 2020; Dimuna, 2023). The infrastructural gap is significant as over 319 million people in Africa are living without access to reliable water, 659 million are living without basic sanitation, and only one billion people live more than 2km from all-season roads (Dimuna, 2023), with an estimated of over 97 trillion dollars in infrastructure investment worldwide needed by 2040 to support sustainable development, with two-thirds required in developing countries (McInnes, 2018). Vulnerable groups face barriers when accessing transport infrastructure, including health, education, and opportunities to enhance their livelihoods. Gender rights imply equal rights and opportunities for both men and women, as well as boys and girls. Women and Girls experience an increasing gender inequality in accessing basic infrastructure. (Ayeni and Ayeni, 2018). In Nigeria, there is a lack of gender inclusion in transportation planning, design, and participation of women as users, as well as in services and equipment.

Although other factors are related to differences in psychological and physical activity, infrastructure deficit may be a key factor affecting children's mobility in urban areas. The elderly pedestrians, due to the ageing process, experience deterioration in perception, cognitive, and motor skills, and complex problems are more likely to cause problems in decision-making (Adetunji, 2020; Azevedo *et al*., 2021; Barbosa & Fernandes, 2020). The absence of speed limits, speed bumps, cyclist route location, and environmental features does not reflect the right of way, thus creating confusion among drivers and vulnerable road users. Sustainable urban mobility challenges further exacerbate the economic and social isolation of people living with disabilities, pushing them further into poverty (Pérez-Peña *et al*., 2021).

Empirical Review

This section of the study paper outlines the methods, approaches, frameworks, strengths, evidence, results, conclusions, weaknesses, and gaps of previous studies. Ghaffarpasand *et al*. (2024), studies the impact of urban mobility on air pollution in Kampala, an exemplar sub-Saharan African city, as observed in open-access Google reports. The findings reveal a strong correlation between urban mobility and roadside PM2.5 levels, as well as a weaker relationship with urban PM2.5 levels. The study needs to identify the increase in air pollution associated with different modes of mobility in urban areas and its impact on vulnerable road users. Cinderby *et al*. (2024) examine inclusive, climate-resilient transport challenges in Africa using a nested scale approach, focus group discussions, interviews, the Delphi method, and an online questionnaire. Climate resilience and inclusive mobility policies are in place, but their implementation and transparency are poor. Develop inclusive policies that prioritize the needs of vulnerable groups and ensure equitable access to transport services. Nasrin & Chowdhury, (2024), study exploring transport mobility issues and adaptive behavior of women in a developing country. Focus groups and a revealed preference travel survey. They expressed that transport mobility challenges seem to be a significant burden to society and are often overlooked.

Hauslbauer *et al*. (2024), examine access over ownership: Barriers and psychological motives for adopting mobility as a service (MaaS) from the perspective of users and non-users in Berlin, Germany. Focus group discussion using content analysis Reveals That Socio-Economic factors play a minor role than expected, and use cases center around non-habitual trips. Maas, as a mobility service, needs to be integrated to meet the needs of vulnerable groups. Bozovic et al., (2024), Assess how street quality influences the walking experience: an inquiry into the perceptions of adults with diverse ages and disabilities in Heidelberg, Germany. The study's findings reveal that street quality, encompassing walking environments, traffic, and infrastructure, has a significant influence on the walking experience. Extreme weather and air pollution significantly affect the mobility of elderly adults, school children, and people living with disabilities.

Foshag *et al*. (2024) assess the needs of vulnerable population groups towards heat-sensitive routing in Heidelberg, Germany, using a participatory method and a city walk. The result of the study reveals that there are perceived hotspots for heat (such as large public spaces in the city center with low shading levels), resulting in fatigue or lack of concentration, and the assessment of heat adaptation. A heatwave response plan and resistance to urban planning through heat mitigation features within routes need to be incorporated. Amaral *et al* (2023), examine the journey to work of young adults with mobility disability on the digital technologies that support mobility, using a qualitative method. People with disability experience vulnerability in navigating the external environment when mobility is hindered by discomfort, commodification, or disorientation. Other vulnerable groups, such as women, the aged, and children, are also marginalized and excluded from the design of infrastructure in urban areas. Ashamu & Lawan, (2019) assess women's religion and contemporary public transportation services in Kano metropolis data was collected using interviews and participatory observation. The role of gender in public transportation, affordability, poverty, sexual harassment, gender biased transport system, safety, and security issues are not captured in the study. Azevedo et al., (2021) examine sustainable urban mobility analysis for elderly and disabled people in São Paulo. Quantitative method: Rainfall causes a reduction in the number of daily free fares in São Paulo.

Research Gap

Although several studies have been conducted on transport systems and traffic management in Nigerian cities, including urban Kano, most focus on vehicle flow, congestion, and infrastructure provision, with limited attention to inclusivity and vulnerability (Adetunji, 2020; Ashamu & Lawan, 2019; Fasina *et al*., 2020). Existing research rarely adopts a multimodal or equity-based perspective that integrates walking, cycling, gender, ageing, disability, and climate vulnerability within a single analytical framework (Lucas *et al*., 2016; Weiss *et al*., 2018). Furthermore, most urban mobility studies in Nigeria rely on secondary data collection involving vulnerable groups. This creates a significant knowledge gap regarding lived mobility experiences in rapidly growing African cities like urban Kano, Northern Nigeria's largest urban agglomeration.

Conclusion and Recommendations

This study highlights the persistent and interconnected mobility challenges faced by vulnerable groups in Kano city, one of Nigeria's fastest-growing urban centres. Rapid population growth, informal urban expansion, weak enforcement of transport regulations, and the dominance of informal paratransit systems have combined to create an urban mobility environment that is largely exclusionary. Despite national commitments to sustainable and inclusive transport under frameworks such as SDG 11, mobility systems in urban Kano remain car-oriented, fragmented, and insufficiently responsive to the needs of vulnerable road users. The review reveals that in Kano, inadequate pedestrian infrastructure, unsafe road crossings, limited public transport coverage, and the absence of disability-friendly design significantly restrict daily mobility, access to livelihoods, education, healthcare, and social participation. These challenges are further

compounded by climatic stressors, including extreme heat and seasonal rainfall, which disproportionately affect non-motorized road users and informal transport users. Consequently, vulnerable groups in Kano experience heightened exposure to traffic injuries, air pollution, heat stress, and social exclusion.

Based on these findings, several context-specific policy and planning recommendations are proposed. First, Kano State and municipal authorities should prioritize the development of safe, continuous, and shaded pedestrian networks, particularly around markets, schools, health facilities, and residential areas. Traffic-calming measures such as reduced speed limits, speed humps, raised crossings, and clearly marked zebra crossings should be enforced on urban arterials and collector roads to protect pedestrians and cyclists. Secondly, public transport reform in Kano must move beyond traffic management to embrace inclusive mobility planning. This includes upgrading buses and paratransit vehicles to accommodate women, children, older persons, and persons with disabilities, as well as regulating informal operators to improve safety, affordability, and service reliability. Integrating walking and cycling infrastructure with public transport nodes will enhance first- and last-mile connectivity for vulnerable users.

Thirdly, transport planning in Kano should incorporate climate-responsive design, such as tree-lined streets, covered walkways, and heat-sensitive routing, to reduce exposure to extreme weather conditions. Given Kano's hot semi-arid climate, climate adaptation measures are essential for sustaining non-motorized mobility and protecting vulnerable populations. Fourthly, participatory planning mechanisms should be institutionalized to ensure that vulnerable groups are actively involved in transport decision-making processes. Engaging women's groups, disability organizations, older persons, and community associations in Kano will help align mobility interventions with lived experiences and local priorities. In conclusion, addressing the mobility needs of vulnerable groups in Kano is not only a transport challenge but also a matter of urban justice, social inclusion, and public health. Implementing inclusive, climate-resilient, and people-centred mobility strategies in urban Kano will contribute significantly to reducing inequality, improving quality of life, and achieving sustainable urban development in Nigeria's rapidly urbanizing cities. Future research should prioritize primary data collection and participatory approaches in urban Kano to generate locally grounded evidence that can inform effective and inclusive urban mobility policies.

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