Strengthening Public Transit Equity in Evacuation Planning through a Community-Centered Approach

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ABSTRACT

Disasters caused by extreme weather and human-initiated events continue to disproportionately impact vulnerable and underserved communities. While these communities often rely on public transit to travel, most North American jurisdictions still lack a fundamental understanding of equity-centered needs or evacuation plans that incorporate public transit use. Consequently, this paper conducted a community-centered methodology with eight focus groups in February 2023 among historically underrepresented groups in evacuation planning. Comprising 52 participants in Edmonton, Alberta, the groups included carless residents, people with disabilities, older adults, lower-income households, racial and ethnic minorities, recent immigrants, parents/guardians of young children, and women. Thematic analysis of the focus group data was performed using MAXQDA. Participants identified challenges and concerns related to public transit costs, possible overcrowding, and inadequate assistance services for people with disabilities and the medically fragile during evacuations. The focus groups largely looked to emergency management offices and transportation agencies to ensure public transit reliability, affordability, and accessibility. Surprising references were also made to public transit as a potential tool for community cohesion during disasters. Finally, we found that each group had specific insights based on their vulnerability. For example, while lower-income households prioritized increased frequency of transit services during emergencies, older adults called for trained medical staff and accessibility features. We offer several policy recommendations to enhance both resilient and equitable evacuation planning.

Keywords: Evacuation Planning, Transportation Equity, Public Transit, Underserved and Vulnerable Populations, Disasters

1) INTRODUCTION

Disadvantaged populations, including those without access to reliable transportation, face considerable challenges during evacuations. In the wake of Hurricane Katrina in 2005, approximately 100,000 people in New Orleans lacked access to personal transportation required to evacuate the city (*1*). Those who wanted to leave the city by public transportation were often required to pay for the services which presented a barrier for lower-income households (*1*). Older adults, people with disabilities, and tourists who were either unable to drive or lacked access to private transportation likewise faced difficulties evacuating and were most negatively affected by the hurricane (*2*, *3*). We define these groups (and many others) in the context of transportation as underserved, or those that do not have sufficient access to transportation resources, destinations, and/or services, particularly in an evacuation context[1].

Nearly two decades after Hurricane Katrina, evacuation strategies continue to overlook the needs of underserved populations. A recent study focusing on the 50 largest American cities found that only seven cities in the United States had strong evacuation plans that included multimodal transportation strategies and evacuation assistance services for populations with limited mobility (*4*). As a rapidly changing climate continues to threaten cities, it is increasingly necessary to adopt a more equitable, multimodal approach to evacuation planning. Public transit has been shown to play a critical role in evacuating vulnerable and carless populations (*5*, *6*). However, public transit evacuation studies generally lack equity considerations and thus fail to address the specific challenges faced by underserved groups who rely on transit the most.

Our objective in this paper is to work towards an understanding of the unique transportation needs of different underserved populations to inform more equitable approaches to evacuation planning. We also share the research process (efficient and informative focus groups) which can be undertaken by jurisdictions and can provide equity-centered planning for resource-strapped disaster planners. To guide our research, we asked the following research questions:

1. What challenges do underserved populations generally face during evacuations?
2. What are the unique transportation needs of different underserved groups in the context of an evacuation?
3. How can emergency evacuation planners and transportation agencies equitably meet the identified needs and challenges of underserved populations?

Using the urban area of Edmonton, Canada as a case study, we conducted eight focus groups with a total of 52 participants. Findings from these focus groups provide valuable insights directly sourced from underserved populations themselves. Recommendations aim to add to a toolkit for emergency management offices and transit agencies to more effectively address the transportation needs of different underserved groups during evacuations.

We organize our paper as follows. First, we present a brief review of the existing literature focusing on public transit evacuations and how diverse transportation needs can be accommodated during emergencies. Second, we describe the methodologies used for both data collection and analysis. We then present the results from each focus group organized by vulnerability. Finally, we offer recommendations for stakeholders involved in evacuation planning and discuss the paper's limitations and conclusions.

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[1] The term "vulnerable populations" is often used to describe these groups in the disaster context, which can sometimes disregard systemic and historic inequities. We prefer the term underserved in our research, though this term itself carries its own limitations and may not be common (or correct) phrasing in the future.

2) LITERATURE REVIEW

Natural disasters such as Hurricane Katrina and Hurricane Rita demonstrated the inequalities that existed between those who could successfully evacuate and those who could not. Many of those left behind were from vulnerable groups that have been historically underrepresented and underserved in planning (*7*). These disasters showed that cities are still inadequately prepared to evacuate those who primarily rely on public transit and do not have access to reliable personal transportation. It should be noted that our equity discussion in this review takes a normative approach rather than a positive one. That is, we focus on how transportation systems "ought to" function to be truly equitable (*8*). Given this context, we divide the review into two parts. First, we examine literature related to public transit evacuation planning in general and then on specialized transportation for underserved groups. We end with key gaps that this research aims to address.

2.1) Public Transit Evacuation Planning

Extensive research has been conducted on modeling traffic flow and managing automobile congestion during emergency evacuations. However, as (*9*) noted, the same cannot be said for public transit evacuation planning. For example, hundreds of transit and school buses were flooded in New Orleans during Hurricane Katrina (*5*), showing that while these resources existed, a lack of planning and strategic operations inhibited their usefulness. During Hurricane Rita, more than 2.5 million people evacuated by automobiles, creating impassable traffic that left many stranded or out of fuel (*1*). Disasters such as these have illustrated the need for a more comprehensive multimodal approach to evacuation planning.

To build a framework, previous research identified four critical issues that need to be addressed in planning public transit evacuations (*10*). These included identifying potential evacuees, determining their locations, understanding their needs, and providing the transportation resources they need. With regard to identifying evacuees, the National Response Framework in the United States has emphasized inclusivity toward those who have additional needs in the areas of communication and transportation and those who need extensive medical care (*11*). These considerations have been expanded to include the elderly, children, people with disabilities, carless residents, tourists, and those with limited English proficiencies (*12*, *13*).

Related to evacuees' locations, several researchers have studied and analyzed pick-up locations and bus allocations for public transit evacuations. This has involved using both linear programming models (*14*) and mixed integer linear programming (*16*, *17*, *18*). It should be noted, however, that researchers seeking to optimize pick-up locations should do so based on the spatial distribution of carless and vulnerable populations to increase the potential for helping those with the greatest need for evacuation assistance (*6*). Pick-up locations should be easily recognizable in neighborhoods, offer large enough spaces for people to gather as they wait for transit, and be close to major roads for easy access (*14*, *15*).

A report from (*18*) further highlighted the importance of building adequate capacity for public transit evacuations. This involves ensuring adequate availability of drivers and transit vehicles (e.g., public buses, school buses, paratransit vehicles, and subways/ trains) (*17*, *19*). Literature has also noted that agencies should keep an inventory of transit vehicles and their drivers with clearly established instructions for emergencies (*1*). Despite these recommendations and more concerted efforts with public transit evacuation planning (e.g., the City of New Orleans (*20*)), many North American jurisdictions do not have public-facing transit plans for disasters (see (*4*) for the U.S. context). A cursory search further determined that in most large Canadian cities, evacuation plans are *ad hoc* rather than pre-planned (*21*, *22*). This trend could result in a lack of preparedness and consequently, insufficient resource allocations for transit-dependent populations.

2.2) Accommodating Diverse Transportation Needs During Evacuations

Despite research on optimizing transit allocations and pick-up points, the specific needs and associated equity metrics for underserved groups have not always been defined. As such, work has recommended that emergency management offices move beyond the use of the "special needs category" and instead specify the unique functional needs that vulnerable groups have to better address them (*23*). Similarly, while some vulnerable groups may simply require transportation, others, such as older adults and those with disabilities, may require a significant amount of assistance to be safely and effectively transported (*5*). This diversity of needs calls for identifying vulnerable individuals and assessing their needs prior to an evacuation (*5, 23*). Cities are recommended to develop and maintain evacuation assistance registries in order to pre-identify specific transportation needs (*18, 24*).

Apart from identifying the population and their needs, it is important to consider how to communicate with vulnerable groups during emergencies. A study on evacuating underserved populations recommended transmitting information through accessible media, trusted sources and in languages that the groups can understand (*25*). Moreover, community-based organizations (CBOs) have often already earned the trust of the vulnerable groups they serve. Effective engagement of these organizations can help communicate with vulnerable populations (*26, 27*).

Emergency management offices should further consider adopting and preparing specialized transportation for individuals with specific needs. For example, research noted that while transit buses can be allocated to non-ambulatory people, such as the carless, door-to-door services with trained operators may be required for the medically fragile (*4*). Moreover, it is recommended that emergency responders utilize local paratransit providers who are typically familiar with the needs of those with limited mobility and possess vehicles capable of transporting medical equipment (*28*).

Finally, for public transit to meet the needs of vulnerable communities effectively and equitably during evacuations, decision-makers could seek avenues for collaboration with these communities. In a review of local emergency plans in seven US states and territories, researchers found a general pattern of disengagement with members of the disability community during disaster response planning (*13*). Consequently, local emergency offices sometimes create evacuation plans with a limited understanding of the knowledge, needs, and first-hand experiences of vulnerable populations.

2.3) Key Research Gaps

While there is a growing understanding of the need for multimodal evacuation planning with clear public transit operations, key gaps remain in the literature. First, we found that there is a lack of equity considerations in public transit evacuation research. Many studies seek to understand how to optimize public transit operations during disasters. However, few incorporate equity considerations for vulnerable/underserved populations. Second, we found a pattern of generalization of vulnerable populations groups as "special needs". This can lead to overlooking transportation needs that are specific to a particular group. Finally, we noted a general lack of involvement of vulnerable populations during evacuation planning. This presents a missed opportunity in terms of developing plans that cater to specific transportation needs.

In this research, we contribute to the literature by providing an understanding of the transportation needs of different vulnerable/underserved groups during evacuations, using the urban area of Edmonton, Canada as a case study. While each community will need to conduct a similar methodology to capture geographic, cultural, social, and risk differences, Edmonton offers a relatively strong case for other mid-sized North American cities with moderate disaster risks, including weather-induced and hazardous-material events.

3) METHODOLOGY

To understand the unique transportation needs of a diverse range of underserved/vulnerable populations, we conducted eight focus groups in Edmonton with 52 participants. Previous research has shown that 90% of themes are discoverable after three to six focus groups (*29*) and that saturation of themes can be achieved within eight focus groups (*30*). Our decision to conduct eight focus groups to reach theme saturation is consistent with existing literature.

We specifically conducted focus groups among carless residents, people with disabilities, older adults, lower-income households, racial and ethnic minorities, recent immigrants, parents/guardians of young children, and women. Our objectives in conducting the focus groups were 1) to understand the transportation needs and challenges specific to particular underserved groups and 2) to create participatory spaces for underserved groups to provide their insights and inform more equitable evacuation planning. This process can be duplicated in other communities for greater validity.

3.1) Data Collection

To obtain eligible participants for our focus groups, we employed a two-pronged approach. First, survey participants from a related study on resilience hubs (*31*) and evacuations, were given the option to participate in the focus groups and were selected on a first-come, first-serve basis. Second, we obtained focus group participants by connecting with CBOs and non-governmental organizations (NGOs) that specifically work with underserved communities in Edmonton. We offered a $300 honorarium to CBOs and NGOs to help send emails to possible participants. Participants were also selected on a first-come, first-serve basis. All participants were incentivized with a $75 gift card for their time. This enabled us to minimize self-selection bias from those with extreme opinions and encourage participation from those who would have otherwise not been interested in the research topic (*32*). We also found it to be an equitable way to show the value of the participants' information and insights. Criteria used to determine the eligibility for each focus group participant are further detailed in **Table 1**. The eight focus groups were conducted online in February 2023 in the evening. An online, evening format was chosen to reduce transportation, work, and childcare conflicts. Each focus group was 90 minutes long and followed a semi-structured format with one moderator. The eight focus groups were recorded and transcribed by an external service provider. The research team then verified the accuracy of each transcript.

We asked a series of semi-structured questions to focus group participants. Several questions relevant to this study included the following:

1. Consider a situation where you have been ordered to evacuate due to a hazard. Will you be more likely to evacuate or not evacuate?
2. To what extent do you feel prepared for an evacuation?
3. What type of transportation mode will you use to evacuate and why?
4. What would motivate you to use public transportation over a personal vehicle/other mode?
5. How comfortable would you be to share accommodation/medical information with registries in case of an emergency?

    We note that our questions did not specifically identify the type of hazard. However, this ambiguity was chosen for Edmonton since one hazard is not dominant (i.e., it is moderately at risk for flooding, wildfires, smoke, blizzards, heat waves, and hazardous material events).

TABLE 1. Focus Group Overview

Focus Group Population	Focus Group Eligibility	# of Participants	Meeting Date
Carless Residents	Without a vehicle or reliable access to transportation	7	February 14, 2023
Individuals with Disabilities	Have physical or mental disabilities or have a family member with a disability	8	February 2, 2023
Older Adults	65 years or older	6	February 7, 2023
Lower-Income Households	Household annual income below $50,000 in Canadian Dollars	4	February 15, 2023
Racial and Ethnic Minorities	Not in a dominant ethnic group and may suffer discrimination based on physical and/or cultural traits	7	February 16, 2023
Recent Immigrants	Immigrated to Canada in the last 3 years	8	February 21, 2023
Parents/Guardians of Young Children	Parent/guardian of at least one child the under the age of 18	6	February 22, 2023
Women	Identify as a woman	6	February 23, 2023

3.2) Data Analysis

To identify and analyze recurrent themes from our focus group data, an iterative coding process was employed. A codebook was developed by adopting two approaches defined by (*33*): theory-driven and data-driven coding. The initial codebook development process involved first developing theory-driven codes that were generated based on theoretical frameworks that guided our research (*33*). These included codes related to evacuation decisions, transportation modes during evacuations, and general evacuation preparedness. Data-driven codes were then developed by reviewing each focus group transcript to identify themes and patterns. Transcript review was conducted at the paragraph level as described by (*33*). After comparing identified themes across focus groups, we then added to our codebook major themes that emerged during the data-driven coding process.

Thematic analysis of the focus group data was performed using MAXQDA software. Two members of the research team each applied the created codes to corresponding text segments within the transcripts. Differences in coding were discussed and resolved to create one comprehensive codebook. After refining

the codebook, we used MAXQDA to compare code frequencies (i.e., the number of times a particular code was identified in the coded text segments). For example, with regard to modes of transportation during evacuations, this method of analysis enabled us to identify transportation modes that were more frequently mentioned across all the focus groups. Finally, we used the Code Matrix Browser (a tool that displays code assignments per transcript) to analyze code distributions across each focus group (*34*). This enabled us to understand the themes that emerged within specific underserved groups.

TABLE 2. Sample Codes and Definitions

Parent Code	Definition	Code
Evacuation Decision	A respondent's decision to evacuate or not evacuate	Will evacuate
		Will not evacuate
		Decision is context-dependent
Evacuation Preparedness	The respondent's level of preparedness to evacuate (e.g., knowing what actions to take, where to seek for information)	Prepared
		Not prepared
Mode of Transportation	The different preferred modes of transportation during an evacuation	Drive
		Walk
		Bus
		Bike
		Carpooling
		Train
Emergency Registries	The level of comfort with providing accommodation/ medical information to emergency registries	Comfortable
		Not comfortable
Transportation Themes	Any instances where respondents indicated a preference for better operations, frequent services, and reliable transit schedules	Reliable services
	Any instances where respondents made a reference to the cost of public transportation	Affordable prices
	Infrastructural features that enable people to use public transit without barriers	Accessible features
	The ability of public transit to accommodate many passengers at once	Ability to evacuate many at once
	Any instances where participants expressed a need for both physical and medical assistance in transit during evacuations	Assistance on transit
	Relationships and community closeness facilitated by using public transit during an evacuation	Social cohesion

4) RESULTS

We first present an overview of the MAXQDA codes, code frequencies (the number of times each code was referenced during the focus group discussions), and the corresponding percentages in **Table 3**.

TABLE 3. Overview of Code Distribution

Parent Code: Evacuation Decision		
Code	**Code frequency**	**Percentage**
Will evacuate	47	83%
Decision is context-dependent	10	17%
Will not evacuate	0	0%

Parent Code: Evacuation Preparedness		
Code	**Code frequency**	**Percentage**
Not prepared	24	53%
Prepared	17	38%
Uncertain	4	9%

Parent Code: Mode of Transportation		
Code	**Code frequency**	**Percentage**
Drive	32	32%
Public transit	24	24%
Walk	19	19%
Ride with friends/family	10	10%
Taxi	5	5%
Disaster-dependent	5	5%
Bike	2	2%
Carpooling	1	1%
Other	1	1%

Parent Code: Emergency Registries		
Code	**Code frequency**	**Percentage**
Comfortable	44	88%
Security concerns	6	12%

Parent Code: Public Transit Themes		
Code	**Code frequency**	**Percentage**
Reliable services	21	23%
Accessibility features	21	23%
Affordable prices	17	19%
Social Cohesion	12	13%
Safety	11	12%
Ability to evacuate many	9	10%

Findings from the code distributions show that, while a large majority of the focus group participants would evacuate from a disaster (83%), many of them (53%) were unprepared for an emergency. Driving was the preferred mode of transportation during an evacuation (32%), followed by public transit (24%), and walking (19%). Many of the participants further reported being comfortable with sharing information with emergency registries (88%) whereas 12% expressed concerns regarding personal data protection. Finally, among the public transit themes that emerged during the focus group discussions, reliable services and accessibility features were most cited (23% each). These themes are further explored in the following sub-sections.

4.1) Focus Group Summaries

4.1.1) Carless Residents

Among the carless residents, a surprising majority (5 out of 7) indicated a preference for walking over other modes. Being unable to afford public transit fares was identified as an obstacle for some of these participants. Moreover, others referred to the discomfort that comes with overcrowding when buses are limited during a disaster. On the other hand, only 2 out of 7 participants reported a preference for public transit, stating that this would be the fastest option for them during an evacuation. Participants discussed the need for pre-defined bus routes sent to communities and pre-identified shuttles to evacuate children stranded in schools during a disaster. Finally, participants in this focus group considered the role of public transit accessibility and equity, with one participant stating that priority during an evacuation should be given to children, older adults, and people with disabilities.

4.1.2) People with Disabilities

People with disabilities had mixed responses related to mode choice. Three participants reported a preference for public transit, indicating that they would otherwise be unable to evacuate due to an inability to drive. Another three stated a preference for a personal vehicle, noting that this option would provide the most comfort, control, and flexibility during an emergency scenario. Two participants reported that they would have to rely on assistance from family and friends in order to evacuate safely. Participants from this group called for stronger public transit accessibility for people with disabilities including those who use wheelchairs, walkers, or crutches, and those who have guide dogs for assistance. Participants further emphasized the importance of having trained staff to provide physical and medical assistance to those in need during an evacuation. Finally, participants discussed the need for sufficient public transit capacity to avoid overcrowding.

4.1.3) Older Adults

When asked about transportation modes for an evacuation, three participants from the older adults group indicated that they would seek evacuation assistance from family and friends. One participant described mobility challenges that would inhibit an evacuation without significant support from others. In contrast, two participants stated that they would use public transit, remarking that it could serve as a tool for togetherness and cohesion during disasters. They discussed the significance of being with other people in public transit and consequently finding "comfort and strength" during a disaster. The other participants indicated a varied preference for transportation modes (e.g., personal vehicle, taxi, or bike). These participants reported overcrowding and a lack of reliability as potential barriers to using public transit. Within the older adults' group, recommendations were given for public transit to be comfortable for evacuees in order to accommodate people with fragile health conditions. Participants also urged that trained personnel should be made available on buses to provide medical or physical assistance.

4.1.4) Lower-Income Households

Among the lower-income households, two participants stated that they would prefer to drive during an evacuation. The rest of the group was equally split between taking public transit and walking. The primary concern with regard to public transit within this group was whether buses and trains will be reliable and readily available for evacuees. Participants remarked that particularly during an emergency scenario, transit agencies should ensure efficient operations as transit reliability is necessary for those with no alternative transportation modes. Participants further commented on the importance of having pre-identified bus schedules and sending these out to evacuees. The lower-income focus group continued with the theme of social cohesion. Participants stated that using public transit can be an essential tool for community togetherness during disasters and can replace sentiments of anxiety with a sense of calm.

4.1.5) Racial and Ethnic Minorities

Within the racial and ethnic minorities group, participants were nearly equally divided between public transit and personal vehicles during an evacuation. Among those who chose public transit (3 out of 7), safety emerged as a key theme. Participants noted that driving during an evacuation could lead to panic, traffic congestion, and crashes. These participants remarked that taking public transit would ensure better road coordination alongside cohesion with neighbors and other evacuees. Conversely, those who were inclined toward personal vehicles identified overcrowding and discomfort as concerns with public transit. Overall, participants within this focus group noted that while public transit could provide a safe alternative to using personal vehicles during evacuations, operations have to be frequent, reliable, and sufficient.

4.1.6) Recent Immigrants

When asked about transportation mode, a majority of those who recently immigrated to Canada (5 out of 8) stated they would walk to the nearest emergency shelter during an evacuation. Some of the remaining participants stated a preference for personal vehicles and only one participant would use public transit. With regard to these choices, those who preferred to walk were particularly concerned about traffic congestion during an evacuation whereas those who chose personal vehicles stated concerns with bus timings and irregular bus schedules during emergencies. Public transit was a preferred choice for one of the participants who explained that public transit drivers generally follow safety directives from emergency management offices and would know safe routes. While public transit reliability was a clear theme in this group, participants also discussed the key role that government agencies have in ensuring transportation availability and predetermining safe routes.

*4.1.7) Parents/Guardians of Young Child(ren) Under 18*

The parents/guardians of children were split between public transit (4 participants) and personal vehicles (2 participants). Among those who indicated a preference for public transit, participants discussed how both trains and buses have the capacity to carry a significantly larger number of people than personal vehicles, thus reducing traffic congestion during evacuations. On the other hand, those who stated a preference for personal vehicles reported concerns with buses being few or simply unavailable during evacuations. During the discussion, participants further pointed to the necessity of having accessible infrastructure for parents traveling with children in strollers. In the end, parents of young children suggested that transit agencies and emergency planners need to ensure enough buses with sufficient capacities and accessibility features (such as for strollers).

4.1.8) Women

Within the women's group, there was a unanimous consensus that using a personal vehicle would be a preferred mode of transportation during an emergency. A primary reason provided for this strong preference was that evacuating with children and luggage would be burdensome on public transit. Participants expressed concerns with both overcrowding and the financial cost of using public transit to evacuate. In addition, participants were apprehensive regarding the reliability of public transit since bus schedules would likely fluctuate, hindering their ability to evacuate quickly or get to a shelter. The women recommended better operations and clear communication of transit schedules during emergencies. Participants in this group further urged transit agencies and emergency management officials to consider offering fare-free transit services during an emergency, particularly for evacuees from lower-income families.

4.2) Overall Observations

During the analysis, we paid particular attention to the preferred modes of transportation during evacuations and the challenges and needs related to these modes. A distribution of the mode choices is presented in **Figure 1**. We found that around 24% of the focus group participants would take public transit in an evacuation, far larger than previous evacuations, such as the 1% modal split for hurricane evacuations (*35, 36*). Many participants also chose driving (32%) and walking (19%) while citing concerns such as overcrowding and lack of accessibility when using public transit.
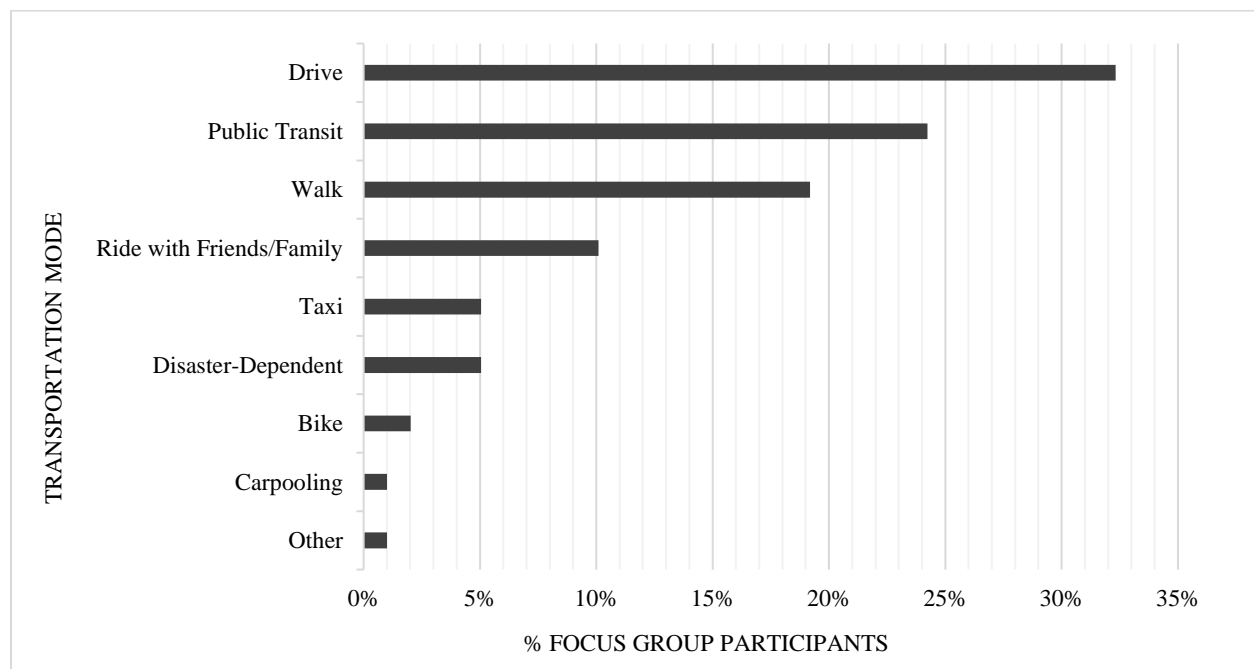

Figure 1 Mode preference distribution during evacuations

Using MAXQDA and content-based coding, several common themes related to public transit were identified from the focus group discussions. **Figure 2** shows the breakdown of public transit codes (n=91 codes) by topic area and **Figure 3** specifies the number of times the codes were cited by each focus group. We found that reliability and accessibility were most frequently cited across all the groups, each accounting for 23% of the coded frequencies (see **Figure 2**). Regarding reliability, participants were primarily concerned about whether buses would be readily available and at regular intervals during an

evacuation. They further raised concerns about overcrowding and called for sufficient transit capacities. Accessibility was a particularly significant theme among older adults and people with disabilities (see **Figure 3**). Many of these participants further noted that they would not be able to evacuate without receiving significant physical and medical assistance from family and friends or other evacuees.

Affordability was another issue during our discussions, comprising 19% of the identified themes. It was a particularly key theme among the women and the lower-income households (**Figure 3**). Some participants noted that their only viable mode of evacuation was by foot as they would otherwise be unable to afford the cost of public transit.
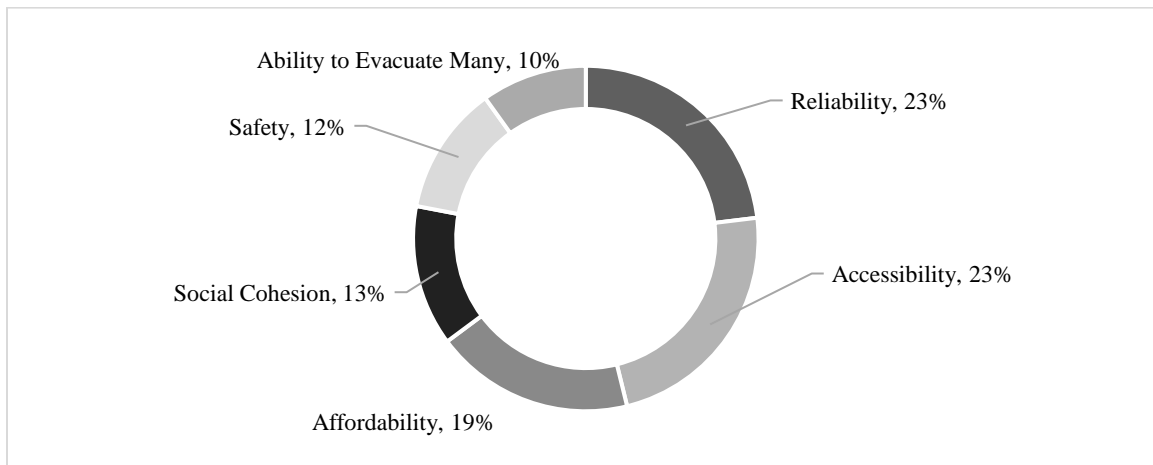
Figure 2 Topical breakdown of public transit themes identified from focus group discussions (n= 91 codes)

A surprising theme from the focus group discussions was that of public transit as a tool for social cohesion during disasters. Representing 13% of the identified themes, participants, particularly from the older adults' group (**Figure 3**), noted that evacuating with other people in public transit can reduce feelings of anxiety and panic that come with emergencies. Reliable transit services could also bring a diverse range of people together and provide opportunities for community members to offer both physical and emotional support. Other themes that emerged were safety (12%) and public transit's ability to evacuate many residents (10%) (**Figure 2**). These themes were particularly common among parents/guardians of young children (**Figure 3**). This group noted that both buses and trains should be safe for evacuees given their ability to evacuate many residents and thus reduce congestion during evacuations.
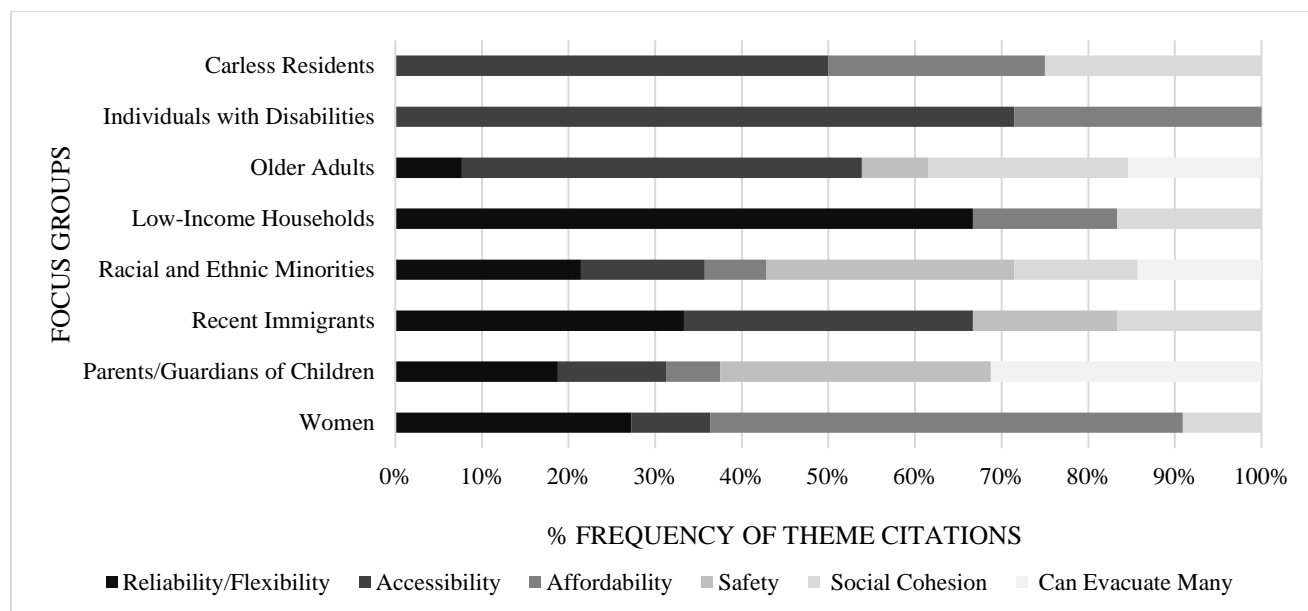
Figure 3 Transportation themes identified by focus group

5) POLICY RECOMMENDATIONS

Based on the results and the identified themes, we offer the following recommendations for local emergency management offices and transit agencies in **Table 4**. We grouped the recommendations based on key themes for simplicity.

TABLE 4. Policy Recommendations Based on Identified Themes

Key Themes	Recommendations
Reliability and Flexibility	• Emergency management offices should collaborate directly with transit agencies to create evacuation plans that include preliminary bus schedules and bus routes for disasters. • Inventories can be created with a list of drivers who would operate transit vehicles during emergencies. • Emergency management offices could establish contacts with local schools and school bus operators to ensure adequate transportation capacity during evacuations.
Accessibility and Assistance	• Emergency management agencies should build ongoing partnerships with paratransit providers to provide specialized transportation for people with disabilities.

	• Transit during evacuations can have trained medical staff who can offer personalized support for evacuees who need physical or medical assistance.
	• Disaster registries could further be established and used to identify residents with mobility constraints and medical needs. This would enable emergency responders and transit providers to prepare both transportation and medical resources that directly meet pre-identified needs and challenges.
Affordability	• Municipalities should promote free public transportation, which would assist multiple underserved populations including those who may face financial barriers. • Price gouging policies and laws should be enacted and enforced to prevent high costs for other modes of transportation.
Social Cohesion	• Emergency management offices and transit agencies could consider ways to build social capital, such as creating volunteering opportunities for community members to assist transit users during emergencies, hosting community events in and around transit stations, and engaging underserved populations in preparing for transit evacuations.

To create evacuation plans that effectively and equitably meet the needs of underserved communities, the insights and opinions of these very communities should also be integrated into the planning process. This process will likely require ongoing collaborations with NGOs, CBOs, faith-based organizations, and the general public. Including non-traditional affected parties in planning has been shown to create trust and a sense of ownership among vulnerable groups (*37*). Therefore, we recommend that emergency management officials and transit planners engage communities by creating spaces for open dialogue where underserved groups are given the opportunity and resources to advocate for their needs.

Through our study, we also found that many of the participants, particularly, recent immigrants, were not aware of emergency preparedness actions and did not know where to seek information and resources. For this reason, we recommend that emergency management offices consider making evacuation plans (including pick-up locations and bus routes) publicly available and accessible in multiple languages.

6) STUDY LIMITATIONS

While this study provides practical insights into the transportation needs of underserved groups during an evacuation, several limitations should be taken into consideration. First, focus group participants were recruited through online forms and the discussions were conducted through a synchronous online platform. Consequently, those with limited internet access were restricted from participation. However, the online platform added schedule flexibility and widened our participant pool by removing barriers around location and transportation. Second, we recognize that existing literature on the number of focus groups required for theme saturation has been primarily based on homogeneous groups (*29*). The heterogeneity of our sample may have affected theme saturation. To maintain a balance between heterogeneity and homogeneity (*38*), we conducted a heterogeneous series of focus groups each with

homogeneous participants based on vulnerability (see **Table 1**). With this approach, we were also able to leverage group cohesion and encourage participation through shared experiences. Finally, it is important to note that 52 focus group participants represent only a small fraction of the underserved population in Edmonton. The insights from the focus groups may not completely represent those of the selected underserved population or the general population. Moreover, external validity to other communities in North America is somewhat limited, and a community-centered approach (such as the one presented in this study) should be undertaken to identify unique characteristics, actions, preparedness levels, and transportation needs.

7) CONCLUSION

Evacuation planning in North America is still largely centered around automobiles. However, simply planning for public transit evacuations is not enough. Policymakers, emergency management officials, and transit agencies are responsible for meeting the needs of transit-reliant populations during emergencies.

Understanding these populations' transportation needs and challenges is a step forward in creating equitable evacuation plans and increasing resilience during disasters. To achieve this objective, we used Edmonton, Alberta as a case study and conducted a series of focus groups based on specific vulnerabilities. First, participants highlighted the necessity of ensuring transit reliability during emergencies through adequate transit capacities and pre-identified bus schedules, routes, and drivers. Second, participants discussed the vital need for both physical and medical assistance alongside transit accessibility for evacuees with limited mobility and the medically fragile. Third, emphasis was placed on public transit affordability to ensure that residents are not hindered from evacuating due to financial barriers. Finally, participants shed light on the underappreciated role of public transit in fostering community cohesion and togetherness during disasters.

Emergency management and transit agencies can begin to address these needs by prioritizing public transit reliability, affordability, and accessibility. In addition, as our study has shown, social capital around public transit could be built and harnessed to foster community resilience. To move towards more equitable practices in evacuation planning, the insights and opinions of underserved populations require consideration *and* integration. By including the voices of the most underserved, equity considerations can be more effectively incorporated into evacuation planning.

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AUTHOR CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: V. Wambura, S. Wong; data collection: all authors; analysis and interpretation of results: all authors; draft manuscript preparation: all authors. All authors reviewed the results and approved the final version of the manuscript.

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