The Stakeholders' Walkability/Wheelability Audit in Neighbourhoods (SWAN): Protocol for a Mixed Methods Study

Atiya Mahmood, Farinaz Rikhtehgaran, Rojan Nasiri, Niloofar Hedayati, Sepehr Pandsheno, Aislynn Sharrock, Diana Juanita Mora, Sogol Haji Hosseini, François Routhier, Ben Mortenson

Submitted to: JMIR Research Protocols
on: May 21, 2024

Table of Contents

The Stakeholders' Walkability/Wheelability Audit in Neighbourhoods (SWAN): Protocol for a Mixed Methods Study

Atiya Mahmood[1*] PhD; Farinaz Rikhtehgaran[1*] MA; Rojan Nasiri[1*] MA; Niloofar Hedayati[1*] MA; Sepehr Pandsheno[2*] MA; Aislynn Sharrock[1*] BA; Diana Juanita Mora[3*] BA; Sogol Haji Hosseini[1*] MA; François Routhier[4] PhD; Ben Mortenson[5] PhD

[1]Department of Gerontology Simon Fraser University Vancouver CA
[2]Urban Studies Program Simon Fraser University Vancouver CA
[3]Faculty of Health Sciences Life Science Simon Fraser University Vancouver CA
[4]Rehabilitation Department Université Laval Quebec CA
[5]Department of Occupational Science & Occupational Therapy University of British Columbia Vancouver CA
[*]these authors contributed equally

Corresponding Author:
Atiya Mahmood PhD
Department of Gerontology
Simon Fraser University
2800-515 West Hastings Street
Vancouver
CA

Abstract

Background: The prevalence of sensory, cognitive, and mobility disabilities in Canada underscores the need to address environmental barriers. This study adapts and validates the Stakeholders' Walkability/Wheelability Audit in Neighbourhoods (SWAN) tool to assess built environment challenges for individuals with disabilities, aiming to inform policy changes for accessibility and inclusivity.

Objective: This study aims to: (1) adapt the mobility tool for those with hearing, vision, or cognitive disabilities, (2) validate it for researching environmental barriers for people with disabilities, including older adults, and (3) offer insights for policy changes in the built environment, contributing to literature and guiding future research.

Methods: The research is based on community based approach, and will be conducted over four phases within an 18-month period in British Columbia. An advisory committee, including individuals with disabilities, will provide insights through participatory research. The first phase involves conducting a literature review, tool consolidation, and pilot testing. Phase two entails identifying street intersections for data collection using GIS layers and discussions with municipal officials. Phase three involves collecting data across various streams of disabilities. The fourth phase includes data analysis and knowledge mobilization.

Results: Data collection is scheduled to conclude in the summer of 2024, involving over 80 eligible participants across four streams in pre-identified hotspots. The results are expected to be published in the winter of 2024.

Conclusions: This study addresses the increasing challenges faced by individuals with sensory, cognitive, and mobility disabilities in navigating the built environment. It highlights the limitations of existing research in capturing diverse experiences within these populations and introduces the Stakeholders' Walkability/Wheelability Audit in Neighbourhoods (SWAN) tool as a crucial solution. The study focuses on adapting and validating the SWAN tool for individuals with various disabilities, aiming to identify environmental barriers and inform policy changes. The ultimate goal is to enhance accessibility and safety standards, fostering inclusive neighborhood spaces for all individuals.

(JMIR Preprints 21/05/2024:60553)
DOI: https://doi.org/10.2196/preprints.60553

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**

Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.

Only make the preprint title and abstract visible.

No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**

Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v

Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http

Original Manuscript

The Stakeholders' Walkability/Wheelability Audit in Neighbourhoods (SWAN): Protocol for a Mixed Methods Study

Atiya Mahmood[1], Farinaz Rikhtehgaran[2], Rojan Nasiri[3], Niloofar Hedayati [4], Sepehr Pandsheno[5], Aislynn Sharrock[6], Diana Juanita Mora[7], Sogol Haji Hosseini[8], François Routhier[9], Ben Mortenson[10]

[1,2,3,4,8] Department of Gerontology, Simon Fraser University
[5]Urban Studies Program, Simon Fraser University
[6]Department of Psychology, Simon Fraser University
[7] Faculty of Health Sciences Life Science, Simon Fraser University
[9] Rehabilitation Department, Université Laval
[10] Department of Occupational Science & Occupational Therapy, University of British Columbia

ABSTRACT

Background: The prevalence of sensory, cognitive, and mobility disabilities in Canada underscores the need to address environmental barriers. This study adapts and validates the Stakeholders' Walkability/Wheelability Audit in Neighbourhoods (SWAN) tool to assess built environment challenges for individuals with disabilities, aiming to inform policy changes for accessibility and inclusivity.

Objective: This study aims to: (1) adapt the mobility tool for those with hearing, vision, or cognitive disabilities, (2) validate it for researching environmental barriers for people with disabilities, including older adults, and (3) offer insights for policy changes in the built environment, contributing to literature and guiding future research.

Methods: The research is based on community based approach, and will be conducted over four phases within an 18-month period in British Columbia. An advisory committee, including individuals with disabilities, will provide insights through participatory research. The first phase involves conducting a literature review, tool consolidation, and pilot testing. Phase two entails identifying street intersections for data collection using GIS layers and discussions with municipal officials. Phase three involves collecting data across various streams of disabilities. The fourth phase includes data analysis and knowledge mobilization.

Results: Data collection is scheduled to conclude in the summer of 2024, involving over 80 eligible participants across four streams in pre-identified hotspots. The results are expected to be published in the winter of 2024.

Conclusion: This study addresses the increasing challenges faced by individuals with sensory, cognitive, and mobility disabilities in navigating the built environment. It highlights the limitations of existing research in capturing diverse experiences within these populations and introduces the Stakeholders' Walkability/Wheelability Audit in Neighbourhoods (SWAN) tool as a crucial solution. The study focuses on adapting and validating the SWAN tool for individuals with various disabilities, aiming to identify environmental barriers and inform policy changes. The ultimate goal is to enhance accessibility and safety standards, fostering inclusive neighborhood spaces for all individuals.

Keywords: *age and accessibility, disability experiences, community engaged research, inclusive urban design*

Introduction

The number of people living with sensory (hearing and vision), cognitive, and mobility disabilities is increasing in Canada. In 2019, five percent of people aged 15 and older had a hearing disability, and in 2020, 567,000 people were living with a cognitive disability (Government of Canada, 2019b) . About a quarter (24.1%) of the population living with disabilities are aged 65 and older (Government of Canada, 2019a). Research has shown that these population encounter various challenges while navigating the built environment (Bigonnesse et al., 2018; Prescott et al., 2020). These challenges vary among different types of disability. For instance, individuals who are deaf or hard of hearing (DHH) face safety concerns while navigating due to difficulty in hearing traffic (Ham et al., 2021). Those with cognitive disabilities encounter wayfinding challenges, particularly in areas lacking green spaces and amenities (Bigonnesse et al., 2018; Prescott et al., 2020). Individuals with mobility disabilities find it especially challenging during inclement weather when routes become inaccessible (Prescott et al., 2020). People with vision disabilities also face difficulties due to the lack of accessibility in public spaces and transportation systems (Seetharaman et al., 2024).

In this paper, individuals with little or no functional hearing are referred to as "deaf," while those with milder hearing loss are called "hard of hearing" (Ham et al., 2021). People living with cognitive disabilities, such as dementia and mild cognitive impairment (MCI), experience worsening cognition over time (Hugo & Ganguli, 2014). Mobility disabilities may require the use of mobility assistive technologies (MAT) such as wheelchairs, scooters, or canes (Arvanitakis & Bennett, 2019). People with vision disabilities, or visual impairment (VI), refer to challenges in visual performance that standard methods cannot correct (Naipal & Rampersad, 2018).

Limited research exists on the role of environmental factors on mobility and social participation of individuals with disabilities, creating a gap in the literature (Bigonnesse et al., 2018; Kapsalis et al., 2022; Prescott et al., 2020; Rosso et al., 2011; Seetharaman et al., 2024). The Stakeholders' Walkability/Wheelability Audit in Neighbourhoods (SWAN) tool was developed as a user-led audit to capture objective and subjective data on micro-level neighbourhood features, aiming to fill this gap (Biglieri & Hartt, 2021; Bigonnesse et al., 2018; Mahmood et al., 2019).

The SWAN tool allows individuals with disabilities to assess the facilitators and barriers to mobility in their neighbourhoods across five domains: Functionality, Safety, Appearance & Maintenance, Land Use & Supportive Features, and Social Aspects. The SWAN tool is an adaptation of the SWEAT-R tool that captures the perspective of persons with disabilities (PWD) (Mahmood et al., 2019). Moreover, the development of the SWAN tool included a comprehensive literature review and incorporated aspects of other user-led tools, such as the Microscale Audit of Pedestrian Streetscapes (MAPS) (Cain et al., 2012; Sallis et al., 2015), the Built Environment and Active Transport (B.E.A.T.) Neighbourhood Assessment (Glanz et al., 2016), and Jane's Walk: Walkability Checklist (Hess and Farrow, 2010).

Previous research using the SWAN tool was primarily done with individuals with mobility disabilities using MAT (Routhier et al., 2019). To incorporate a wider variety of disability experiences, the SWAN tool has been adapted to accommodate individuals' sensory disability (hearing and vision) as well as those with cognitive disabilities, including early stages of dementia and mild cognitive impairment (MCI). This adaptation enables these populations to systematically evaluate their neighborhoods.

Utilizing a Community-Based Participatory Research (CBPR) approach, the SWAN tool was developed in collaboration with a committee of individuals with lived and/or professional experience, ensuring that diverse perspectives and needs are integrated into the research process. This approach promotes self-advocacy among participants and facilitates policy changes that are reflective of community needs (Tremblay et al., 2018).

Objectives

This study aims to: (1) adapt the mobility tool for individuals hearing or vision as well cognitive disability, (2) to validate the tool for researching barriers in the built and social environment for PWD, including those with vision, hearing, cognitive, and mobility disabilities (including older adults), and (3) to provide insights for decision-making and policy changes in modifying the built environment.

This protocol paper aims to contribute to existing literature and guide future studies on how individuals with cognitive, sensory, or mobility disabilities experience their built environment. The goal is to fill knowledge gaps and provide evidence-based results for municipalities and communities to implement necessary policy changes for a safe and accessible living environment.

Methods

Study Design

The research will be conducted over four phases within an 18-month period in British Columbia. An advisory committee, including individuals with disabilities, will provide insights through participatory research. They will meet two to three times to offer feedback on ongoing phases, ensuring the project addresses identified gaps.

The first phase involves conducting a literature review, tool consolidation, and pilot testing. Phase two entails identifying street intersections for data collection using GIS layers and discussions with municipal officials. Phase three involves collecting data across various streams of disabilities. The fourth phase includes data analysis and knowledge mobilization.

Ethics

This study has been reviewed and approved by Simon Fraser University, and University of British Columbia (H21-01234) Ethics boards. To protect identities, names and any other information that might identify a participant, will be removed from transcriptions and field notes. Any photos taken as part of data collection that could potentially identify individuals will be blurred. All data will be collected, managed, and stored in accordance with university research ethics procedures and all data will be anonymized. We perceive that the risks for physical or emotional harm to the participants associated with the proposed research to be minimal. The time and effort required by participants is minimal and there is no deception or other manipulation of participants. Given that participants might share difficult experiences, which may lead to emotional/and or psychological distress, the researcher will make clear at the beginning and throughout the interview that participation is voluntary, and participants can withdraw their consent at any time without harm.

Phase 1: SWAN Tool Development Process

To conduct the walking/wheeling audits with DHH individuals and those living with cognitive and vision disabilities, the original SWAN tool (that is, SWAN for MAT users) will go through an adaptive process that involves consulting both academic and grey literature, and consultations with

PWD and/or persons with professional experience.

Academic/Grey Literature Review and Mapping

Eight databases will be utilized to gather crucial information on DHH individuals and those living with cognitive and vision disabilities, focusing on their experiences and interactions with the safety and accessibility of the outdoor built environment. Identified articles will undergo full-text screening and be mapped to the existing SWAN domains, such as Functionality of Street Crossings, Functionality of Sidewalks, Safety of Street, and Personal Safety of Pedestrians. This mapping process allows for the collation of similar concepts to pinpoint areas where the tool may need expansion or clarification to better support these specific populations. Grey literature searches will also be conducted to supplement the academic literature findings.

Content Comparison and Tool Consolidation

After developing the newly adapted tools, they will be charted in Excel alongside the original SWAN tool for content comparison, sequencing of questions, and language simplicity and consistency. Upon review of all tools, they will be finalized as the Hearing and Mobility Tool, the Dementia Tool, and the Vision Tool.

Pilots

To test the functionality of the tools in the field, four pilots will be conducted with PWD from the four populations of interest. These pilots will serve as an opportunity to try the tools with participants and gather feedback on the questions, content, process, and flow of data collection. Since data collection involves a walking/wheeling method, both the research team and participants will experience this process in the field, allowing for adjustments to be made accordingly. For example, the pilots will help identify if pausing in specific areas of the sidewalk to answer questions is necessary or if participants prefer answering questions read aloud by the researcher. During the pilot sessions, particular attention was given to ensuring the clarity and comprehensibility of the terminology used in the tools. This was done to ensure individuals with different levels of abilities could easily understand the features being inquired about.

Following the pilot session with individuals with vision disabilities, substantial adjustments were implemented to improve the tool's readability. These changes encompassed modifications to align the tool with CNIB standards, ensuring adherence to best practices for accessibility in both design and functionality. These adjustments, informed by participant feedback and collaboration with CNIB standards, are aimed at fostering a more user-friendly and inclusive experience for individuals with vision disabilities during data collection.

Phase 2: Identification of Data Collection Locations through Community and Research Project Partnerships

To identify meaningful areas for data collection, the research team will undertake a stepwise approach, namely 1) generating prioritized sites for consultation, and 2) hosting an interactive community forum.

Intersections for Data Collection

The research team identifies data collection areas in six partner municipalities across Metro

Vancouver using open-source data and ArcGIS. They focus on pedestrian-involved collisions data, integrating additional layers such as transportation hubs (e.g., sky train stations) and city center locations to create maps and identify "hotspots" for data collection. The outcome is maps highlighting seven to ten intersections in each municipality. Subsequently, the team meets with municipal officials to discuss and prioritize three to four intersections for the data collection per municipality based on their feedback and guidance.

SWAN Community Forum

The second step involves hosting an interactive forum with PWD, community partners from senior centers, and municipal officials. The goal is to understand challenges at intersections and surrounding areas, examining barriers and facilitators to mobility. The forum will also explore designing interventions based on evaluating these areas in relation to municipal priorities and funding.

Phase 3: Participant Recruitment, Coordination and Data Collection

Finalizing the tool and confirming selected intersections enables the research team to proceed with participant recruitment for the four populations: individuals with cognitive, mobility, hearing, and vision disabilities, starting with those living with cognitive disabilities.

Recruitment

The research team will recruit participants from community centers, relevant PWD-serving organizations, and healthcare connections. This ongoing process targets DHH individuals, those with hearing and vision disabilities, early stages of dementia or MCI, and MAT users. To streamline participant onboarding, a researcher will act as the Central Administrator. This individual will verify eligibility, review study details, consent, online tool training, and COVID-19 protocols with participants before scheduling data collection sessions. Sessions will be scheduled based on participant and research team availability. The lead Research Assistant (RA) for each session will maintain communication with participants and ensure all necessary documents (SWAN tools, consent forms, equipment) are ready for efficient completion of the audits.

On-site Preparation Research Team

On the day of data collection, the lead and accompanying RA will arrive in advance to assess the presence and accessibility of public washrooms. Additionally, they will identify either an indoor or covered location for the completion of the SWAN Secondary Observation Form (SOF). This form will be filled out in the format of a 15 to 20-minute qualitative interview.

On-site Preparation Participant

Before starting the audit with the participant, the lead RA will review the consent form to ensure the participant understands the study objectives, use of collected data, and their right to withdraw. Next, a demographic form will be completed to contextualize the participant’s answers. The participant will be oriented on the path of travel using a map of the intersections to be covered. The lead RA will accompany the participant throughout the walking/wheeling audit, providing assistance as needed or taking a more active role by reading questions aloud, based on the participant's preference.

SOF (Secondary Observation Form)

The SOF includes open-ended questions similar to those in the SWAN tool, encouraging discussion and reflection from the participant. Responses will be either audio recorded or handwritten based on the participant's consent choice. By incorporating the secondary observation interview guide, the SWAN tool gains a more comprehensive understanding of participants' interactions with their neighborhood.

Home and Community Environment (HACE) Survey

During the data collection phase, two complementary tools were utilized: the HACE tool and the SWAN tool. Participants could either complete these tools themselves or have assistance from a secondary research assistant (RA). This dual approach enhances the validation process, providing a more thorough assessment of the research variables.

The HACE (Home and Community Environment) tool, designed as a self-report measure, was directly administered by the participants. It aims to evaluate various factors within an individual's home and community environment that might influence their level of community participation. In this study, the HACE tool serves as an additional validation measure for the effectiveness of the SWAN tool (Keysor et al., 2005).

The initial HACE prototype consisted of 44 items assessing physical, attitudinal, and political aspects of home and community environments. Specifically, questions related to the Community Mobility domain were included in the SWAN project's data collection process.

Sidewalk Accessibility Index

The Sidewalk Accessibility Index (SI) serves as an indicator to assess the performance of sidewalks and public spaces, focusing on the needs and expectations of wheelchair users to define accessible routes within urban road networks. It considers various variables that contribute to the comfort and safety of wheelchair users, weighted according to their perceptions(Ferreira & da Penha Sanches, 2007)

In the SWAN project, the SI is used as a complementary tool for validation purposes. During data collection, a secondary research assistant completes the SI, which gathers data on four key aspects related to sidewalks: evenness, maintenance, width, and surface quality. However, the SWAN project focuses solely on these sidewalk-specific factors and does not inquire about the suitability of pedestrian crossings.

Sidewalks and public spaces should provide an environment that meets the needs of all users, ensuring comfort and safety regardless of physical limitations, whether temporary or permanent. The SI variables are designed to describe aspects of comfort and safety related to pedestrian movement along the block and crossing street intersections. The completion of the SI in the SWAN project is done by the research assistants (RAs) in the field, not by the participants themselves.

Finalization of Data Collection

The participant will then be provided with an honorarium for their time spent, and if required, discussion of a second data collection will take place to complete any outstanding segments. The lead RA is responsible for ensuring the completion of all documents along with uploading and storing of data collected appropriately. Finally, a reflection form is completed by the researchers to reflect on the data collection.

Phase 4: Data analysis

The analysis will focus on validating the SWAN tool, which collects both quantitative and qualitative data. Objective and subjective scores will be calculated for its five domains. In order to verify the validity of the SWAN tool, two additional audit tools will be used to collect data including HACE (Home and Community Environment instrument) (Keysor et al., 2005) and SI (Sidewalk Accessibility Index) (Ferreira & da Penha Sanches, 2007). Walk score results for the audited area will also be compared to the SWAN result for further validation. Details on tool validation methods can be found in the section on tool validity. Additionally, the Inter-Rater Reliability (IRR) of the SWAN tool will be assessed. More information is provided in the Inter-Rater Reliability (IRR) section.

Quantitative data from SWAN and other tools will be entered and organized in Microsoft Excel. This includes coding/scoring based on the codebook and calculating domain scores within Excel. For further analysis, R programming language in RStudio will be utilized for Inter-Rater Reliability (IRR) and tool validity assessments. Qualitative responses from SOF will be entered and analyzed in NVivo software. More details on qualitative data analysis can be found in the SOF Analysis section. The specific steps of data analysis are outlined in the following sections.

Data Cleaning and Reorganization

After data is entered and prior to moving forward with the analysis, certain questions will be moved to their original domains. The questions were moved to a different domain for efficient data collection. Although they were physically sequential on-site, they are better organized in a separate domain for analysis. For example, questions about street safety features were placed in the Function of Street Crossing domain during data collection but belong to the Safety domain.

Weighting of Scores

The primary step in calculating scores for street segments involves assigning weights to both the domains and sub-domains, ensuring a total cumulative score of 100 for all domains. These weights are determined through a comprehensive literature review and expert recommendations.

For individuals who are Deaf or Hard of Hearing (DHH), use Medical Assistance Technology (MAT), and have cognitive disabilities, the domain weights remain consistent. However, there is a slight variation in the vision stream weighting, reflecting the unique needs of individuals with visual impairments. Specifically, the "Appearance and Maintenance" domain is considered less critical. Therefore, in the Vision stream, it receives a weight 5 points lower than other streams, which is then added to the "Sidewalk Functionality" subdomain.

Functionality and Safety are deemed the most crucial domains for neighborhood accessibility for individuals with disabilities. Consequently, each of these domains will be assigned the highest weight. Functionality is divided into Crossing Functionality (20 points) and Sidewalk Functionality (15 points in vision stream, 10 points in other streams). The same weights will apply to Safety subdomains, Traffic Safety at 20 (covering pedestrian and vehicle interaction safety) and Personal Safety at 10 (focusing on subjective safety perceptions).

The Land Use and Supportive Features domain, recognized as the second most critical, will receive a weight of 20. Appearance and Maintenance will be weighted at 10 for vision and 15 for all other streams, due to overlapping questions within the Land Use and Supportive Features domain. In contrast, the Social Aspects domain, with a limited set of 5 questions focusing on subjective assessments, will have the lowest weight.

Subsequently, a detailed review of questions within each domain and subdomain will extract essential concepts and elements. The assigned weight will then be evenly distributed among these identified concepts/elements to avoid undue emphasis on specific concepts. For instance, the 20 points allocated to the sub-domain of crossing functionality will be evenly divided among concepts (e.g., curb ramp, crosswalk, pedestrian signal) within that sub-domain. Finally, the weight assigned to each category of questions will be equally distributed among all questions within that category to ensure a balanced weighting process.

Table 1. Domain/Sub-domains weight

Domain/ Sub Domain	Vision Stream	Other Streams
Functionality	30	35
Crossing Functionality	20	20
Sidewalk Functionality	10	15
Safety	30	30
Traffic Safety	20	20
Personal Safety	10	10
Land use and supportive features	20	20
Appearance and maintenance	15	10
Social Aspect	5	5
Total	100	100

Objective Scores

There will be three steps to calculate the objective score for each domain. First, responses to questions will be converted into numeric codes based on the code book. Second, these codes will be multiplied by the question's weight to calculate the question's score. Third, the scores for all questions within a domain will be summed and divided by the maximum possible score for that domain. To make the aggregated objective score easier to understand, it will be multiplied by 100% for each domain.

Some questions in the SWAN tool are reverse-coded to avoid confusion. For instance, a positive response to the presence of a certain physical feature indicating a barrier (e.g., “transition from the curb ramps into the crosswalk causes problems”) would be scored as "1", though it is not a facilitator in this context. These questions were reverse-scored as needed to ensure the total score includes only true "Yes" scores.

In addition to the final objective score for each domain, a total score for the SWAN tool will be calculated by averaging the scores for each domain. This total score will facilitate comparisons between different audited segments.

Codebook

In the SWAN tool, response options typically include "Yes," "No," "Don’t Know," and "Not Applicable." However, for individuals with vision disabilities, an additional option, "Can’t not detect," is provided for cases where the participant cannot clearly see the object but is aware of its existence. When participants with vision disabilities choose this option, it is treated as equivalent to selecting "No," as the object is not detectable or functioning properly for the user. During the coding process, a value of "1" will be assigned for the presence of an assessed environmental feature that enhances walkability/wheelability, and "0" for its absence. Reverse-coded questions, such as "The outdoor patio(s) is/are an obstacle to walking/wheeling," will use "0" to represent the presence of this barrier and "1" to denote its absence.

For items referring to "one side or both sides" of a street segment, they will be grouped together as a scale. For example, "Are there curb ramps/cuts present?" will be coded as "2" if they are present on both sides, "1" if present on only one side, and "0" if not present at all. The same approach applies to items with a positive or negative impact on walkability/wheelability.

In addition to general and two-sided questions, the SWAN tool includes questions about the direction of traffic, with responses like "one-way" and "two-way". Through a disability lens, "one-way" responses will be coded as "1" and "two-way" as "0" since crossing one-way streets is less complex.

Responses like "not applicable" and "don't know," based on the data collection area and participants' familiarity, will be excluded from the scoring system to ensure it accurately reflects Walkability/Wheelability factors.

Table 2- Different types of questions and scoring rationale

Type of question	**Possible responses to questions and their code**					**Missing**
General questions	Yes=1 (0 in case of reverse coding)	CD, No=0 (1 in case of reverse coding)		Not applicable=98	Don't know=97	Missing=99
Both sides questions	Both sides=2 (0 in case of reverse coding)	One side=1	Neither side=0 (2 in case of reverse coding)	Not applicable=98	Don't know=97	
Directional questions	One-way=1	Two-way=0		Not applicable=0	Don't know=0	

Subjective Ratings

Participants in the SWAN tool provides subjective ratings using a five-point Likert scale at the end of each domain. This scale ranges from “poor” (scored as “1”) to “excellent” (scored as “5”), reflecting their subjective experience of the assessed domain. These ratings are averaged and converted into percentages to indicate participants' subjective perceptions of the audited segment. Comparing these subjective scores with the objective scores may reveal interesting findings.

Open-Ended Questions and SOF Analysis

Qualitative data collection began with open-ended questions in the SWAN tool, allowing participants to share detailed insights on the built environment. For instance, questions asked about the materials used for sidewalks. Descriptive statistics were used to organize the diverse perspectives from these responses. The Secondary Observation Form (SOF) acted as an interview guide, supplementing the open-ended questions and Comment Photo Tracker Sheet to build the qualitative dataset. The analysis followed key steps: familiarization, coding, generating themes, reviewing, defining, and naming themes.

Familiarization, Transcribing, and Cleaning Data

Raw qualitative data underwent transcription and cleaning using Otter.ai for accurate text conversion. This process ensured a clear and reliable dataset for analysis. The research assistant, familiar with the data from both collection and cleaning, gained an in-depth understanding through Otter. Ai's transcription.

Framework Development and Open Coding

The coding process began with open coding after transcribing and cleaning a subset of data. A preliminary coding framework was created and refined with more data, including coding three detailed interviews to develop a codebook. Group discussions ensured accuracy and clarity in the coding framework, allowing flexibility for emerging themes. The final codebook was then transferred to NVivo for systematic analysis.

Generating, Reviewing, and Naming Themes

Thematic analysis was applied to the cleaned data to identify patterns and overarching themes. Barriers and facilitators within the built environment were coded, aligning with SWAN tool domains. Following Braun and Clarke's principles (2014), this analysis provided in-depth insights beyond observations. Group discussions ensured coherence and relevance to research questions, making themes understandable to external audiences.

Writing Up

In the final step, the team elaborated on each theme, discussing their significance with evidence from the data, including quotes. This comprehensive write-up aimed to convey theme frequency, importance, and deeper implications within the research context.

Demographics Form Analysis

Descriptive statistics summarized demographic data from the form, calculating central tendency and dispersion using R. This allowed contextualization of audit scores based on personal characteristics like age and gender. Integrating objective scores, subjective ratings, qualitative data, and demographics provided a holistic understanding of participants' lived experiences and their neighborhood's-built environment.

Inter-rater Reliability (IRR)

The reliability of the SWAN tool will be determined by calculating Inter-Rater Reliability (IRR) using the paired observer method.The assessment of IRR provides a way of quantifying the degree of agreement between two or more coders who make independent ratings about the features of a set of subjects (Hallgren, 2012). The general trend in ratings is important, not the absolute value assigned by each of the raters, and the variation between ratings and measurement error is accounted for in IRR (Gisev et al., 2013).The reliability of the SWAN tool will be determined by calculating IRR using the paired observer method. The IRR will compare the objective scores of the older adults or person with mobility disability and the secondary research assistant. This will be calculated both in percentage agreement and Cohen’s Kappa to compare the results. Percentage agreement is a straightforward measure that calculates the proportion of agreement between two observers as a percentage of the total observations; however, In 1960, Jacob Cohen critiqued use of percent agreement due to its inability to account for chance agreement. He introduced the Cohen’s kappa, developed to account for the possibility that raters actually guess on at least some variables due to uncertainty (McHugh, 2012). Cohen suggested the Kappa result be interpreted as follows: values ≤ 0 as indicating no agreement and 0 .01–0 .20 as none to slight, 0 .21–0 .40 as fair, 0 .41– 0 .60 as moderate, 0 .61–0 .80 as substantial, and 0 .81– 1 .00 as almost perfect agreement (Cohen, 1960).

Tool validity

To validate the SWAN tool, correlation analyses will be conducted between its domains and other environmental audit tools used in data collection: HACE, SI, and Walkscore. HACE and SI scores will be normalized using formulas outlined in their respective papers (Ferreira & da Penha Sanches, 2007; Keysor et al., 2005), while Walkscores for the audited area will be obtained online. After examining data distribution, appropriate correlation analysis method, Pearson correlation, will be applied to assess associations between scores from different tools. Pearson Correlation lies between -1 and 1. Values near 0 means no (linear) correlation and values near ± 1 means very strong correlation. The negative sign means that the two variables are inversely related, that is, as one variable increases the other variable decreases. Following table gives a guideline on the strength of the linear relationship corresponding to the correlation coefficient value (Chan, 2003).
As no comprehensive audit tool similar to SWAN was identified in existing literature, each additional audit tool was purposefully selected to assess the validity of specific SWAN domains. Therefore, SI will be compared with functionality, HACE with safety, and Walkscore with land use and supportive features. The matrix in Table N illustrates which SWAN domains or subdomains will be compared with measures from HACE, SI, and Walkscore tools.

Table 3- Similarity between swan domain/subdomains and other tools

	Domains and sub-domains of the SWAN tool							
		Functionality		**Safety**		**Land use and supportive features**	**Appearance and maintenance**	**Social aspect**
		Street crossing	**Sidewalk**	**Traffic safety**	**Pedestrian safety**			
Extra tools/measures used for tool validation	SI (sidewalks)							
	Even		X		X			
	Well-Maintained		X		X		X	
	Surface Condition		X		X		X	
	Width		X					
	Intersection	X		X	X			
	HACE							
	Uneven Sidewalks		X		X			
	Easy To Use Sidewalks		X		X			
	Safe	X	X	X	X			
	Places To Rest							X
	Curb Ramps	X		X				
	Walk Score							
	Access to Amenities					X		

Result

Data collection is scheduled to conclude in the summer of 2024, involving over 80 eligible participants across four streams in pre-identified hotspots. The results are expected to be published in the winter of 2024.

Discussion

The adapted SWAN tool and its protocol, aim to advance our understanding of how built environment features impact the accessibility experiences of individuals with disabilities, particularly focusing on MAT users, people with vision, hearing, and mild cognitive disabilities. By broadening our perspective, we seek to identify areas in the built environment that need improvement to enhance accessibility and promote social participation. This expanded focus contributes to a more comprehensive understanding of the diverse needs within our community.

Our study's recruitment strategy is designed to encompass a broad spectrum of individuals with various disabilities, reflecting the diversity within the community. This inclusivity is evident not only in the tool domains but also in how we recruit participants. We have established connections with

municipalities, PWD-serving organizations, and individuals with lived experience through our interactive SWAN forum. These connections assist us in recruiting community members with different types of disabilities.
To enhance inclusivity, we acknowledge the limitations of relying solely on online advertising or word-of-mouth approaches, especially for populations such as older adults with dementia and people with vision impairment. Therefore, we supplement these methods with in-person recruitment efforts. This includes engaging with communities through presentations and attending resource fairs at community and seniors' centers. Our goal is to reach individuals who may be overlooked by conventional online recruitment methods.
In summary, this study demonstrates adaptability in tool design and a commitment to diverse and inclusive participant recruitment methods. This approach fosters a comprehensive exploration of the built environment needs across various populations, including those traditionally harder to reach. Data Collection Recognizing the diverse needs of our participants during data collection, we prioritize flexibility in administering the tool. For example, if a participant has difficulty holding the paper tool, an RA will verbally present the questions. To accommodate preferences for a quieter environment, we offer options for completing consent and demographic forms at home, away from potential distractions.

Conclusion

The study sheds light on the increasing challenges faced by individuals with sensory, cognitive, and mobility disabilities when navigating the built environment. Existing research has yet to fully capture the diverse experiences within these populations. The Stakeholders' Walkability/Wheelability Audit in Neighbourhoods (SWAN) tool emerges as a crucial solution, offering a user-led audit to capture nuanced perspectives at a micro-scale level.
The study aims to adapt the SWAN tool to include individuals with deafness or hard of hearing, vision disabilities, mild cognitive disabilities, and MAT users. Validation of the tool's effectiveness in identifying barriers within the built and social environment for persons with disabilities is the central focus. Ultimately, the study seeks to inform decision-making and policy changes while contributing evidence-based insights for municipalities and communities.
Looking ahead, the study's scope extends to include older adults from diverse ethnic groups without disabilities, broadening the tool's applicability. By providing a comprehensive understanding of the outdoor environment, the study advocates for enhanced accessibility and safety standards. The ultimate goal is to drive meaningful changes in the outdoor built environment, fostering inclusivity in local neighbourhoods and beyond. Through these efforts, the study aims to pave the way for accessible, safe, and inclusive neighbourhood spaces for individuals with diverse needs.

Declarations

Competing interests: None declared.

Acknowledgements: This research was made funded by Social Sciences and Humanities Research Council (SSHRC) funded Partnership Grant.

Data availability: The data set anticipated to be generated during this study will be available from the corresponding author upon reasonable request.

References

1. Arvanitakis, Z., & Bennett, D. A. (2019). What Is Dementia? *JAMA*, *322*(17), 1728. https://doi.org/10.1001/jama.2019.11653
2. Biglieri, S., & Hartt, M. (2021). *Aging People, Aging Places: Experiences, Opportunities, and Challenges of Growing Older in Canada*. Bristol University Press. https://muse.jhu.edu/pub/345/edited_volume/book/82815
3. Bigonnesse, C., Mahmood, A., Chaudhury, H., Mortenson, W. B., Miller, W. C., & Martin Ginis, K. A. (2018). The role of neighborhood physical environment on mobility and social participation among people using mobility assistive technology. *Disability & Society*, *33*(6), 866–893. https://doi.org/10.1080/09687599.2018.1453783
4. Cain, K. L., Millstein, R. A., & Geremia, C. M. (2012). Microscale audit of pedestrian streetscapes (MAPS): Data collection & scoring manual. *University California San Diego. Available for Download at: Http://Sallis. Ucsd. Edu/Documents/Measures_documents/MAPS % 20Manual_v1_010713. Pdf (Accessed 08.08. 13.)*.
5. Chan, Y. H. (2003). Biostatistics 104: Correlational analysis. *Singapore Medical Journal*, *44*(12), 614–619.
6. Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, *20*, 37–46. https://doi.org/10.1177/001316446002000104
7. Ferreira, M. A. G., & da Penha Sanches, S. (2007). Proposal of a Sidewalk Accessibility Index. *Journal of Urban and Environmental Engineering*, *1*(1), 1–9.
8. Gisev, N., Bell, J. S., & Chen, T. F. (2013). Interrater agreement and interrater reliability: Key concepts, approaches, and applications. *Research in Social and Administrative Pharmacy*, *9*(3), 330–338. https://doi.org/10.1016/j.sapharm.2012.04.004
9. Glanz, K., Handy, S. L., Henderson, K. E., Slater, S. J., Davis, E. L., & Powell, L. M. (2016). Built environment assessment: Multidisciplinary perspectives. *SSM - Population Health*, *2*, 24–31. https://doi.org/10.1016/j.ssmph.2016.02.002
10. Government of Canada, S. C. (2019a, May 8). *The Daily—Canadians with a Hearing Disability*. https://www150.statcan.gc.ca/n1/daily-quotidien/190508/dq190508b-eng.htm
11. Government of Canada, S. C. (2019b, December 3). *The Dynamics of Disability: Progressive, Recurrent or Fluctuating Limitations*. https://www150.statcan.gc.ca/n1/pub/89-654-x/89-654-x2019002-eng.htm
12. Hallgren, K. A. (2012). Computing Inter-Rater Reliability for Observational Data: An Overview and Tutorial. *Tutorials in Quantitative Methods for Psychology*, *8*(1), 23–34.
13. Ham, J., Towle, A., & Shyng, G. (2021). Deaf and hard of hearing awareness training: A mentor-led workshop. *The Clinical Teacher*, *18*(2), 180–185. https://doi.org/10.1111/tct.13304
14. Hugo, J., & Ganguli, M. (2014). Dementia and Cognitive Impairment: Epidemiology, Diagnosis, and Treatment. *Clinics in Geriatric Medicine*, *30*(3), 421–442. https://doi.org/10.1016/j.cger.2014.04.001
15. Kapsalis, E., Jaeger, N., & Hale, J. (2022). Disabled-by-design: Effects of inaccessible urban public spaces on users of mobility assistive devices – a systematic review. *Disability and Rehabilitation: Assistive Technology*, *0*(0), 1–19. https://doi.org/10.1080/17483107.2022.2111723
16. Keysor, J., Jette, A., & Haley, S. (2005). Development of the home and community environment (HACE) instrument. *Journal of Rehabilitation Medicine*, *37*(1), 37–44.
17. Mahmood, A., O'Dea, E., Bigonnesse, C., Labbe, D., Mahal, T., Qureshi, M., & Mortenson, W. (2019). Stakeholders Walkability/Wheelability Audit in Neighbourhoods (SWAN): User-led audit and photographic documentation in Canada. *Disability & Society*, *35*, 1–24.

https://doi.org/10.1080/09687599.2019.1649127

18. Mahmood, A., Labbe, D. (2021). Mobility and participation barriers and facilitators in the urban environment captured through user-led audits and photovoice by older adults with mobility disability. In M.D. Hartt, S. Biglieri, M. Rosenberg & S. Nelson (Eds.), Aging people aging places (pp. 27-44). Policy Press: Bristol, UK
19. McHugh, M. L. (2012). Interrater reliability: The kappa statistic. *Biochemia Medica*, 276–282. https://doi.org/10.11613/BM.2012.031
20. Naipal, S., & Rampersad, N. (2018). A review of visual impairment. *African Vision and Eye Health*, *77*(1), Article 1. https://doi.org/10.4102/aveh.v77i1.393
21. Prescott, M., Labbé, D., Miller, W. C., Borisoff, J., Feick, R., & Mortenson, W. B. (2020). Factors that affect the ability of people with disabilities to walk or wheel to destinations in their community: A scoping review. *Transport Reviews*, *40*(5), 646–669. https://doi.org/10.1080/01441647.2020.1748139
22. Rosso, A. L., Auchincloss, A. H., & Michael, Y. L. (2011). The Urban Built Environment and Mobility in Older Adults: A Comprehensive Review. *Journal of Aging Research*, *2011*, 1–10. https://doi.org/10.4061/2011/816106
23. Routhier, F., Mortenson, W. B., Demers, L., Mahmood, A., Chaudhury, H., Martin Ginis, K. A., & Miller, W. C. (2019). Mobility and Participation of People With Disabilities Using Mobility Assistive Technologies: Protocol for a Mixed-Methods Study. *JMIR Research Protocols*, *8*(4), e12089. https://doi.org/10.2196/12089
24. Sallis, J. F., Cain, K. L., Conway, T. L., Gavand, K. A., Millstein, R. A., Geremia, C. M., Frank, L. D., Saelens, B. E., Glanz, K., & King, A. C. (2015). Is Your Neighborhood Designed to Support Physical Activity? A Brief Streetscape Audit Tool. *Preventing Chronic Disease*, *12*, E141. https://doi.org/10.5888/pcd12.150098
25. Seetharaman, K., Mahmood, A., Rikhtehgaran, F., Akbarnejad, G., Chishtie, F., Prescott, M., Chung, A., & Mortenson, W. B. (2024). Influence of the built environment on community mobility of people living with visual disabilities: A scoping review. *Urban, Planning and Transport Research*, *12*(1), 2296891. https://doi.org/10.1080/21650020.2023.2296891
26. Tremblay, M.-C., Martin, D. H., McComber, A. M., McGregor, A., & Macaulay, A. C. (2018). Understanding community-based participatory research through a social movement framework: A case study of the Kahnawake Schools Diabetes Prevention Project. *BMC Public Health*, *18*(1), 487. https://doi.org/10.1186/s12889-018-5412-y