CANADIAN JOURNAL of
URBAN RESEARCH
REVUE CANADIENNE de RECHERCHE URBAINE

Evaluating street safety for women in Halifax

Natasha Juckes*
School of Planning, Dalhousie University

Mikiko Terashima
School of Planning, Department of Community Health and Epidemiology, Dalhousie University

Abstract
Factors that influence women's perceptions of safety, and how these factors are spatially distributed in Canadian cities, are understudied. This case study determined key factors that affect perception of safety in Halifax, Nova Scotia. A survey asked participants to choose from a list of factors identified in empirical literature those that most positively or negatively affected their perceptions of safety. *Media portrayal and stories from friends* was a significant negative factor on perceptions of safety; *presence of people on the street* was the most important positive factor. A weighted multi-criteria analysis (MCA) created a proxy for levels of perceived safety across streetscapes, showing which streets are most likely to be perceived as safe or unsafe by women. Findings suggest that women feel safer when the number of people on the street is increased, which can be achieved through mixed-use areas.

Keywords: street safety, women, perceived safety, multi-criteria analysis (MCA)

Résumé
Les facteurs qui influencent la perception de la sécurité par les femmes, et la façon dont ces facteurs sont distribués spatialement dans les villes canadiennes, sont peu étudiés. Cette étude a permis de déterminer les principaux facteurs qui influent la perception de la sécurité à Halifax, en Nouvelle-Écosse. Un sondage demandait aux participants de choisir, parmi une liste de facteurs identifiés dans la littérature empirique, ceux qui affectaient le plus positivement ou négativement leurs perceptions de la sécurité. *La représentation des médias et les histoires des amis* étaient un facteur négatif significatif sur les perceptions de la sécurité ; *la présence de personnes dans la rue* était le facteur positif le plus important. Une analyse multicritère (AMC) pondérée a permis de créer une approximation des niveaux de sécurité perçue dans les rues, montrant quelles rues sont les plus susceptibles d'être perçues comme sûres ou dangereuses par les femmes. Les résultats suggèrent que les femmes se sentent plus en sécurité lorsque le nombre de personnes dans la rue augmente, ce qui peut être réalisé par des zones à usage mixte.

Mots-clés : sécurité dans les rues, femmes, perception de la sécurité, analyse multicritère

*Correspondence to: Natasha Juckes, Faculty of Architecture and Planning, Dalhousie University, 5410 Spring Garden Road, P.O. Box 15000, Halifax, Nova Scotia, Canada B3H 4R2 (780) 492-1230 Email: natasha.juckes@dal.ca

Canadian Journal of Urban Research, Winter 2023, Volume 32, Issue 2, pages 1–13.

ISSN: 2371-0292

Introduction

Women often feel more vulnerable in public spaces—particularly in urban environments—than men (Gargiulo et al. 2020; Tandogan and Ilhan 2016). Feeling unsafe can limit women's behaviour as it can make women feel unwelcome in public spaces, leading them to avoid using some spaces (Bhattacharyya 2016; Tandogan and Ilhan 2016; Gargiulo et al. 2020). Women who feel unsafe in public spaces are less likely to participate in physical activity, such as walking and jogging (Gargiulo et al. 2020). Feeling unsafe can also prevent women from socializing with friends and participating in social activities such as attending public gatherings (Bhattacharyya 2016; Tandogan and Ilhan 2016). Therefore, perception of safety is an important factor for women's health and wellbeing. Women's rights advocates also posit that improving women's safety on streets helps improve safety for everyone and enhances the social sustainability of cities (Women in Cities International and Jagori 2010).

Traditionally, planning theories on improving perceptions of safety have mainly focused on crime prevention. Strategies for crime prevention on streets have been developed through different theoretical concepts about how to make public spaces feel and be safer. Jacobs (1961) posited that "natural surveillance"—having more eyes on the street from nearby residences or people walking on the street, improved safety. Newman proposed the "defensible space theory", claiming that well designed spaces give residents a sense of ownership and community which makes them more likely to protect their spaces (Newman 1972 and 1973, as cited in Cozens and Love 2015). These ideas later developed into the principles of Crime Prevention through Environmental Design (CPTED), promoting open space designs that maximize opportunities for natural surveillance, or "eyes on the street" to deter crime. An opposite design strategy, stemming from Newman's "defensible space theory", might be to make perpetrators feel like they are more likely to be caught by residents by putting up walls or fences, or demonstrating a sense of ownership of the place by the residents to demark their 'territory' (Cozens and Love 2015). Maintenance and management of infrastructure in spaces encourages a greater sense of ownership and guardianship of residents (National Crime Prevention Council 2003; Reynald 2011). In short, the principles of CPTED propose that the built environment can affect crime rates (Cozens and Love 2015).

Women may feel unsafe in a space even through there is little evidence of unsafe events occurring (Tandogan and Ilhan 2016). Therefore, an intervention that targets public spaces based on the objective evidence such as crime rates may miss important factors that hinder women from using a given space. A few recent studies have focused on identifying a multitude of factors that affect women's perceptions of safety to better understand how to improve women's safety through design or social interventions. In a survey conducted in India, Bhattacharyya (2016) asked 250 participant female respondents what factors and which places made them feel the most unsafe. Among the elements and qualities of streetscapes, 89% of the respondents chose crowded public transport, bus stops, or stations; lack of effective or visible policing; and potholed roads as negative factors on perceptions of safety. Streets were perceived as unsafe by 67% of respondents. Further, 99% of respondents reported being victims of verbal harassment (Bhattacharyya 2016). 85% of respondents also said that a "lack of respect for women from men" made them perceive certain places as unsafe (Bhattacharyya 2016, 318).

A study from Turkey (Tandogan and Ilhan 2016) also surveyed 250 women and found that 97.6 % of respondents experienced "fear of crime [that] restricts their freedom" (2016, parentheses added). The most chosen negative factors/situations on perceptions of safety were: walking alone in a deserted/quiet street or road during late night hours, chosen by 88% of respondents; being in a dark subway (85.6%); or being in a poorly lit street or place after dark (81.2%). Empty parks, abandoned buildings, and using public transit late at night were other negative factors on perceptions of safety.

Another study conducted in Barcelona, Spain (Gargiulo et al. 2020), which focused on trails, roads, and green spaces in a stream corridor, interviewed women and identified the following as factors that affect perceptions of safety: lighting, presence of streets, presence of discotheque, vegetation density visibility of residential areas, presence of truck drivers, presence of parking areas, presence of vandals, presence of abandoned areas, and user density.

It was found that high vegetation density negatively affects women's perceptions of safety as it can inhibit visibility of one's surroundings, while also creating dark areas where someone could hide. These findings are consistent with the CPTED principles.

To date, however, few studies have been conducted to assess how safe (or unsafe) women feel in public spaces in a Canadian context. Differences in patterns and layout of public spaces as well as sociocultural contexts likely influence what women consider important factors of perception of safety.

Objectives of the study

This study, therefore, attempts to shed some light on perceived safety for women in a Canadian context by asking what factors affect women's perceptions of safety. We focused on street safety because streets are a fundamental public space in cities, frequented by women daily, and everyone should have the right to feel safe in them. We asked the following questions:

- What are the factors that affect women's perceptions of street safety in the Halifax city centre?
- Where are example streets in the city centre that women participating in the survey felt safe or unsafe?
- How are the factors identified by survey participants spatially distributed in the city centre?

In addition, we attempted to examine whether the presence of factors identified in the survey in real spaces coalesce to predict the level of women's perceived safety on the streets based on the participant ratings.

Methods

This study employed a mixed-method approach including a survey, GIS mapping, and a multi-criteria analysis (MCA).

Women's safety survey

The survey was directed at anyone who self-identified as a woman, was 18 or over, and had experienced being on a street in Halifax (where pedestrians can legally walk) in the last five years. Since the survey asked their experience up to five years earlier, the participants could have been as young as 14 at the time of their experience interacting with a Halifax street. An experience at age 14 is reasonable to include in this study because it is around the age when women start high school and might start experiencing streets without their parents or guardians. Someone who lives in Halifax, or someone who has visited Halifax were both eligible to complete the survey. The survey was emailed to non-profit organizations that help women or care about women's issues, local universities, municipal and provincial organizations (such as Halifax's women's advisory committee, Downtown Halifax, and Develop Nova Scotia), and local politicians to share with their constituents through newsletters, Twitter, Instagram, and Facebook.

The survey asked respondents to identify a location on any street that they are familiar with and can think of as representative of safe or unsafe space. Respondents had the option of filling out the survey multiple times for different street blocks which would increase the number of points of observation. Our survey was open from December 15th, 2020, until March 1st, 2021.

The survey was conducted using an online GIS software (ArcGIS Online), which enabled each respondent to also identify a street block location (in latitude and longitude coordinate) in Halifax where they rated the level of safety they perceived at the location. The survey also asked the respondents to identify factors on the street elements in the chosen location that influenced their rating. The respondents chose the factors out of the predefined list of factors derived from empirical literature (Bhattacharyya 2016; Gargiulo et al. 2020). They included: time of day, season, lighting, surrounding land uses, vegetation, presence of people on the street, people participating in activities that made women feel uncomfortable (such as catcalling, drug use, etc.), and dark alleyways or dark building entrances.

In addition to the factors identified in empirical studies, we added media portrayal or stories from friends as a factor to determine if it affected perceptions of safety. Perceptions of safety often vary based on personal experiences but can also be impacted by stories from the media or from friends (Carli 2008; Intravia, et al. 2017). Media portrayal of crime, through traditional forms and social media, can misrepresent true crime rates (as only certain types of crimes may be reported) and can perpetuate existing stigmas of places or groups of people, negatively influencing people's perceptions of safety (Carli 2008; Intravia, et al. 2017). Table 1 shows the survey questionnaire.

The survey responses were summarized to describe the patterns. In addition, average scores of perceived safety were mapped at the street level, where three or more point locations were identified on the same street block in the survey. If there was only one or two locations identified on a street block, the score was further aggregated to several blocks radius to compose a group of three or more locations. Single ratings were never shown individually and only ever shown in an averaged format to prevent any response from being traced back to a specific person's experience. Averaging scores also ensured that the score for an entire street block was not based on only one response.

Table 1
Survey questions and possible answers

1. What street block are you rating?	(Add pin to map)
2. What time of day did you have this experience?* *'This experience' refers to the single experience (on a specific street) that you are basing your responses on.	Midnight, 1 am, 2 am, 3 am, 4 am, 5 am, 6 am, 7 am, 8 am, 9 am, 10 am, 11 am, noon, 1 pm, 2 pm, 3 pm, 4 pm, 5 pm, 6 pm, 7 pm, 8 pm, 9 pm, 10 pm, 11 pm
3. What month did you have this experience?	January, February, March, April, May, June, July, August, September, October, November, December
4. What year did you have this experience (must be within the last 5 years)?	2021, 2020, 2019, 2018, 2017
5. How safe did you feel on a scale of 1 to 5 (with 1 feeling very unsafe and 5 feeling very safe)?	1 (very unsafe), 2 (unsafe), 3 (neither safe nor unsafe), 4 (safe), 5 (very safe)
6. From the list provided, what factor do you feel most negatively affected your perception of safety at the location? *Note:* Adapted from Bhattacharyya, 2016; Gargiulo et al., 2020.	• Street lighting (e.g., lack of, poor placement, broken lights, etc.), • time of day, • season, • surrounding land uses (e.g., presence of bars, abandoned buildings, empty parking lots, empty parks), • dense vegetation that makes it hard to see the surrounding area, • lack of other people on the street, people participating in activities that made you feel uncomfortable (e.g., crime, catcalling, drunkenness, etc.), • dark alleyways or dark building entrances, and • media portrayal or stories from friends that portrayed the area as unsafe.
7. From the list provided, what factor do you feel most positively affected your perception of safety at the location? *Note:* Adapted from Bhattacharyya, 2016; Gargiulo et al., 2020.	• Street lighting, • time of day, • season, • surrounding land uses (e.g., residential or commercial areas, well-used parks), • presence of people on the street, • vegetation that makes the area feel welcoming, and • media portrayal or stories from friends that portrayed the area as safe.

Spatial distribution of perceived safety: Multi-Criteria Analysis (MCA)

Second, we assessed the spatial distribution of factors identified as influencing the perception of safety, identified by the survey respondents. Out of the eight positive and seven negative factors listed as potential factors in the survey, time of day and season were not included in the analysis as they uniformly affect the city, leaving six positive and five negative factors to compare. Of these, data were available for only three factors: presence of people, street lighting, and vegetation. We accessed the data collected by Halifax Regional Municipality (HRM) inventorying streetlights and trees. The density of lights and street trees were calculated by street block (per metre). We also used the population density (per smallest census population area) and locations of bus stops (per street) from the HRM Data as proxy for presence of people on the street. Land use data within urban core of Halifax are too coarse (with single zone and no comprehensive land use record at a granular level), and therefore, land use was not assessed.

The three factors (light density, vegetation, and presence of people) were combined to create a proxy measure for perceived safety at the street-level. The geographic layers containing each of the factors were combined in ArcGIS Pro, a GIS Software (Environmental Systems Research Institute (ESRI) 2021). A weighted Multi-criteria analysis (MCA) approach was applied to create a composite measure, based on the degree of importance for each factor from our survey responses.

Results

Factors that affect women's perceptions of safety in Halifax

We received 90 survey responses. Four of these responses showed locations in parks, trails, and parking lots in isolation, and not on a street, therefore excluded from mapping. However, they were included in our counts on factors that affect perceptions of safety in general.

A lack of people on the street and stories from friends or the media were major negative factors, chosen by 20 and 17 respondents respectively. The presence of people and the time of day were major positive factors, chosen by 35 and 27 respondents. Vegetation was not found to be a significant factor on perceptions of safety and was only chosen by one respondent as the most negative factor and by no respondents as the most positive factor.

The presence of people on the street was the most chosen positive factor on perceptions of safety with 35 responses. Even though the presence of people was the most chosen positive factor, street blocks where respondents chose this factor had an average perceived safety score of 2.5, meaning that the presence of people may be a strong positive factor, even though overall women still felt unsafe at these specific locations.

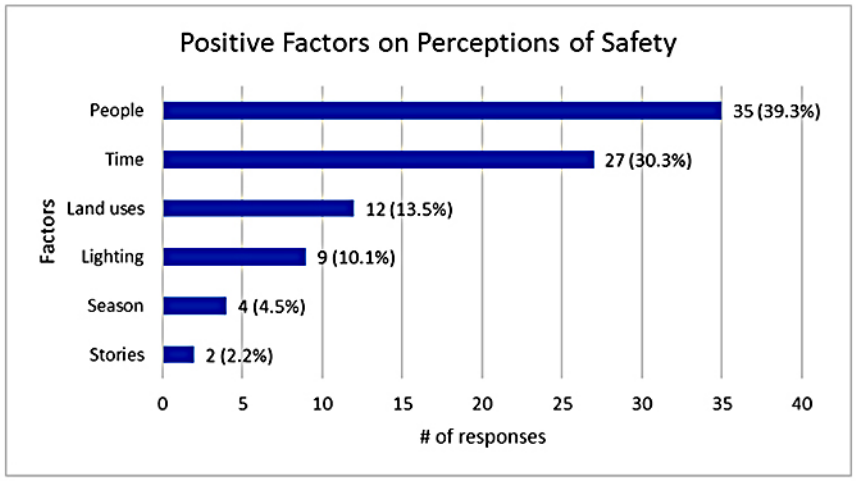
A lack of people on the street or the presence of people participating in activities that made the respondent feel uncomfortable were the most chosen negative factors (chosen by 20 respondents) and received a low average safety score of 2.3 (see Figure 1). Stories from the media and friends also seemed to be a strong negative factor on perceived safety. Dense vegetation was chosen in one response to be the most negative factor, but a high overall safety score was still given (4) which makes it seem like vegetation is not a strong negative factor.

The cross-tabulation of the safety scores and the time of rating revealed that the scores are overall greater during peak travel times, in the morning from 7 am to 9 am and in the afternoon from 3 pm to 5 pm (when people commute to and from work; Figure 2). This is not surprising as these times are when more people were present on the street, which was a strong factor on perceived safety according to our survey. There was no apparent difference in rating by season. Safety scores seem to be slightly increasing over the last five years.

Mapping the rated streets

Out of the 90 responses, 10 responses rated their location as very safe (score of 5), 11 rated their location as safe (4), 19 as neither safe nor unsafe (3), 33 as unsafe (2), and 17 as very unsafe (1). The average safety score from all responses was 2.6. Response rates were highest around streets in the Spring Garden Road and Barrington Street areas (see Figure 3).

The number of responses received per a street block ranged between 1 and 5. There were seven street blocks that received three or more responses. Where there were fewer than three responses on a street, these responses (locations) were further aggregated to a multiple block range, or to a broader neighbourhood range. The average scores at the street or multiple block-level ranged between 2 and 3.75. The average safety score for street blocks (where there were three or more responses) was 2.42. The average safety score for street blocks (that were aggregated by general area) was 2.47.



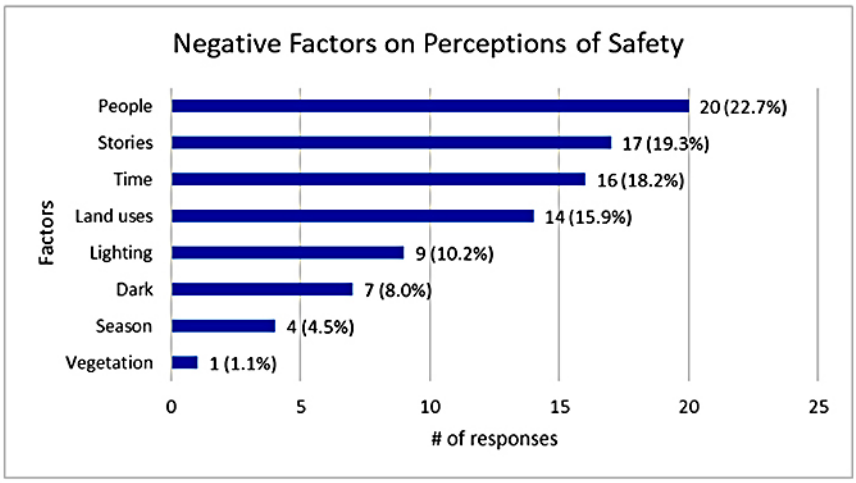


Figure 1
A breakdown of the number of responses and the factors that most negatively and positively affected perceptions of safety

Note: n = 88. Vegetation represents "dense vegetation that makes it hard to see the surrounding area". Season represents "season". Time represents "time of day". Lighting represents "street lighting". Dark represents "dark alleyways or dark building entrances". Stories represents "media portrayal or stories from friends that portrayed the area as unsafe". People represents the "lack of other people on the street, people participating in activities that made you feel uncomfortable (e.g., crime, catcalling, drunkenness, etc.)". Land uses represents "surrounding land uses (e.g., presence of bars, abandoned buildings, empty parking lots, empty parks)".

No easily discernable spatial patterns seem to exist on the average scores. High averages can occur right beside low averages. The general area averages are lower in the city centre where response rates were higher. Spring Garden Road and McFatridge Road were the only two streets to have two blocks on the same street that both received 3 or more responses. On McFatridge, these two blocks had the same average score of 2 and on Spring Garden one block had a score of 3.75 (the highest score of any block that received 3 or more responses) and the other a score of 2.2., showing that perceptions of safety can vary at a micro-scale between blocks on the same street.

Spatial distribution of perceived safety: Multi-Criteria Analysis (MCA) for the Halifax city centre

Using the available secondary data on density of people (population density and bus stop density), lighting, and vegetation, we created a composite score for the streets of Halifax city centre as proxy for perceived safety. The value

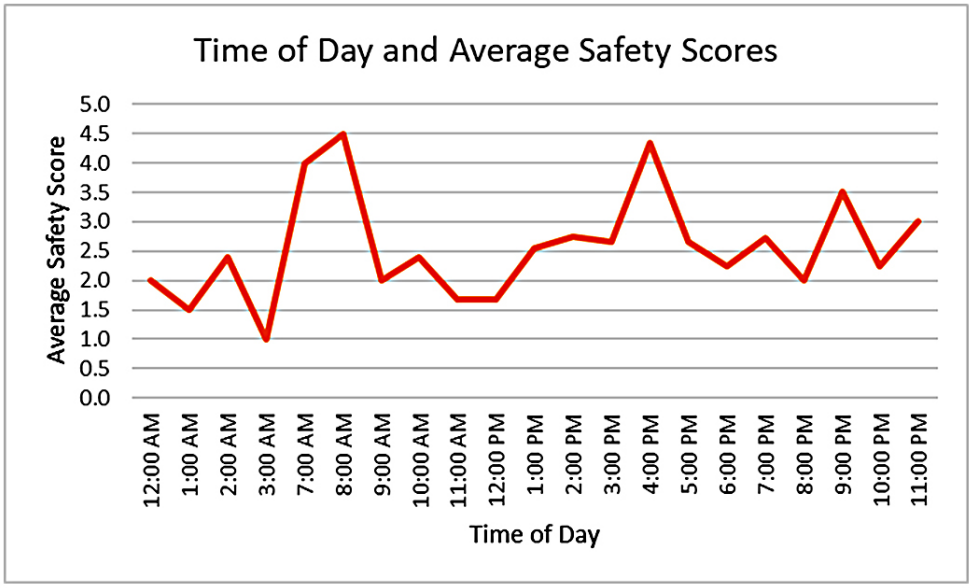


Figure 2
A breakdown of the number of responses (n=88) by time of day and the average safety scores

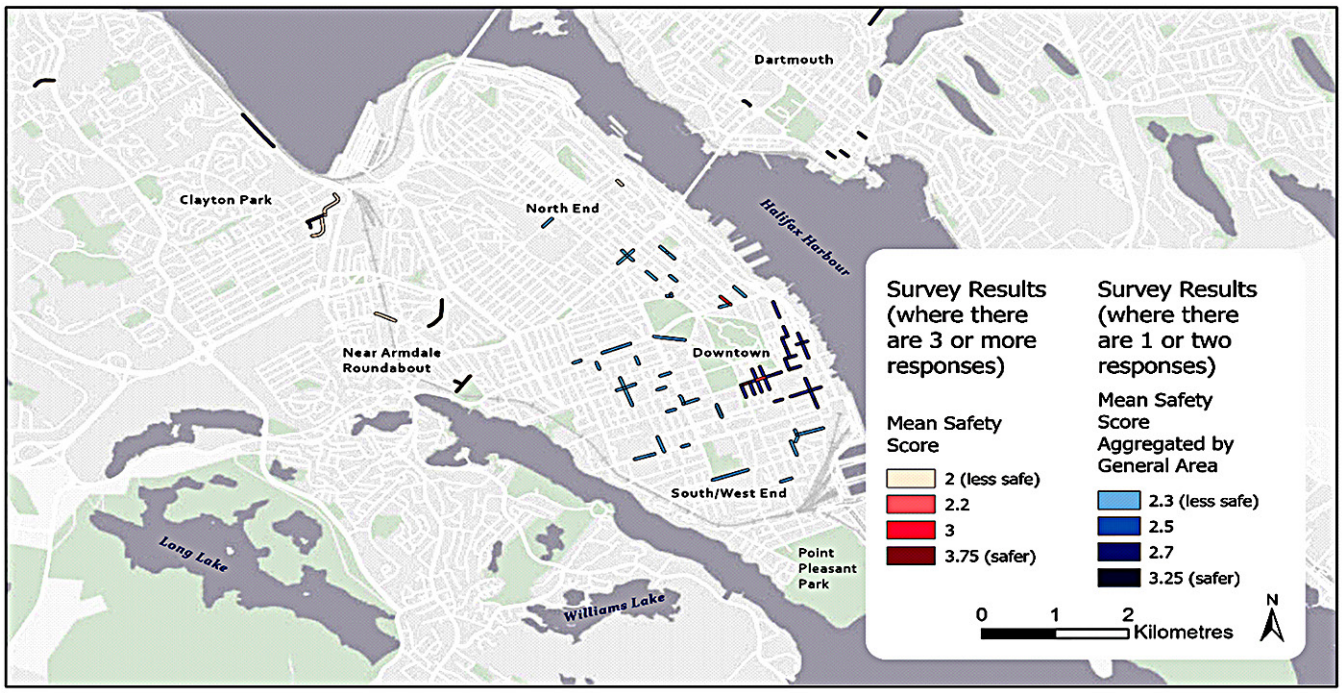


Figure 3
A summary of the aggregated survey results with averages shown for blocks with three or more responses (pink) and averages over the general area shown for blocks with fewer than three responses (blue)

Note: Data from HRM OpenData 2021c; ESRI 2021

of the factors calculated for each segment of the road in the Halifax City centre were classified and given a score on a scale of 1 to 5, shown in Table 2.

Then the respective scores were summarized with the weights assigned for each factor. The weights for each factor included in the MCA were determined by the survey results. As mentioned previously, the number of responses that identified people as the most important factor was 55 (positive if present [n=35], and negative if absent [n=20]). The lighting was identified as the most important by 18 responses (positive if adequate [n=9], and negative if poor

[n=9]). They represent 37.2% and 12.2% of 148 total responses including both positive and negative. Only 1 response (1%) listed dense vegetation as a negative factor and no responses listed it as a positive factor. Therefore, 0.372, 0.122, and 0.007 were used as the weights to aggregate the scores as follows:

> MCA Score = [(Bus score + Population score)/ 2 x 0.372] + [Lighting score x 0.122] + [Vegetation score x 0.007)]

For example, if a street segment had a bus density score of 4, population density score of 2, streetlight density score of 5, and vegetation score of 1, then:

> MCA Score = [(4+2)/2) x 0.372] + [5 x 0.122] + [1 x 0.007] = 1.733

Table 2 illustrates the MCA score breakdown based on the four major variables (density of bus stops, population density, density of streetlights, and density of street trees).

Table 2
A breakdown of the scores and weightings used for the MCA

	Perceived Safety Factor			
	Presence of People on the Street		Lighting	Vegetation
Score	**Density of Bus Stops** (number of bus stops/length of street block in metres)	**Population Density by Dissemination Block** (population/square km) Geometric Interval	**Density of Streetlights** (number of lights within 15 metres of the street centre line/length of street block in metres)	**Density of Street Trees** (number of trees within 15 metres of the street centre line/length of street block in metres)
1	No bus stops	≤50.7 people/km^2	No lights	>30 trees per 100 metres
2	>0 to ≤1 stop per 200 metres	>50.7 to ≤417.2 people/km^2	>0 to ≤1 light per 100 metres	>20 to ≤30 trees per 100 metres
3	>1 to ≤5 stops per 200 metres	>417.2 to ≤3068.7 people/km^2	>1 to ≤5 lights per 100 metres	>10 to ≤20 trees per 100 metres
4	>5 to ≤10 stops per 200 metres	>3068.7 to ≤22249.2 people/km^2	>5 to ≤10 lights per 100 metres	>0 to ≤10 trees per 100 metres
5	>10 stops per 200 metres	>22249.2 to ≤161000.0 people/km^2 (maximum value)	>10 lights per 100 metres	No trees
Weighting		0.372	0.122	0.007

Note: Lighting, vegetation, and the density of bus stops were categorized into intuitive classes, meaning that densities were calculated based on round distances (100 and 200 metres). Street blocks with no bus stops, lights, and trees were given their own category. Population density was categorized using a geometric interval, meaning that each class has approximately the same range and a similar number of street blocks in it. This interval type was chosen to show the vast range of population density values, while still showing the differences in lower values (which most blocks fall into).

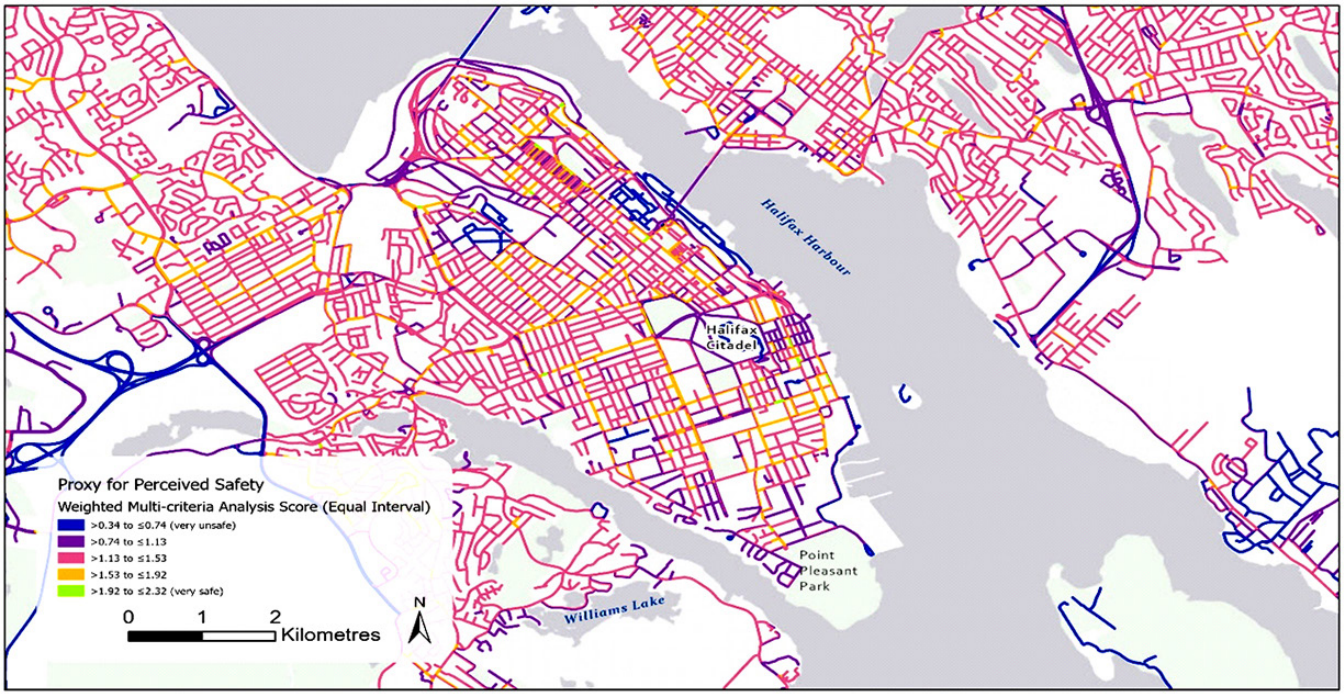


Figure 4
A map of the weighted MCA which combined the density of bus stops, population density, and the density of streetlights.

Note: Data from HRM 2021; HRM OpenData 2019, 2021a, 2021c; ESRI 2021.

Figure 4 shows the distribution of the perceived safety scores per street segment. After combining the scores for lighting, bus stops, vegetation, and population density in the weighted MCA, scores ranged from 0.343 to 2.319 and (the max possible score was 2.505 but was not achieved at any location). The mean score was 1.155 and the median was 1.145. The scores are normally distributed with most of the street segments scored around the mean. The scores were mapped using equal interval classification, meaning that each colour category is the same size (Figure 4).

Relationships between the survey rating and proxy of perceived safety

The areas with higher MCA scores should correlate with areas that were perceived as safer in our survey, but we did not have enough data points to run an accurate spatial regression to determine if this is the case. However, we could make some general observation by looking at the blocks around Spring Garden Road. The MCA scores these streets slightly higher than the survey results for the blocks aggregated by general area. This seems to suggest that MCA scores may be slightly higher in general than survey scores.

Having more people on the street was a strong positive factor on perceptions of safety, according to our survey, and therefore the areas with a higher bus stop density should be areas that also are perceived as safer. From a visual analysis, the density of bus stops did seem to match up with street blocks that received higher safety scores from the survey, but we did not have enough data points to determine statistical significance.

We conducted additional site observations on blocks found on Spring Garden Road, one of only two streets that had two blocks that both received 3 or more responses, with average scores of 3.75 and 2.2. One of the factors examined on Spring Garden was lighting. More lighting tended to be present on blocks of Spring Garden with more commercial uses. Both blocks rated were surrounded by mostly commercial uses, but had quite different average scores, suggesting that a factor other than lighting was at play. In general, blocks with more streetlights tended to occur in Halifax's downtown core. However, for survey responses for street blocks with 1 or 2 responses, the average score for the downtown was 2.5. Based on our survey results, increased lighting was a positive factor on perceptions of safety but was not as important as the presence of people on the street.

Discussion

Factors on women's perceptions of safety

In this study, we identified factors that affect perceptions of safety from relevant literature and conducted a geo-located survey on women's perceptions of safety in Halifax. The presence (or lack of) people on the street was the most chosen positive and negative factor on perceptions of safety. Media portrayal or stories from friends was found to be a significant negative factor on women's perceptions of safety in Halifax. Lighting was a significant factor on perceived safety, but it does not appear as significant as previous studies suggested. This could be because previous studies (Gargiulo et al. 2020; Tandogan and Ilhan 2016; Bhattacharyya 2016) examined were from different geographic contexts that might have had poorer lighting conditions. Halifax has switched to LED streetlights (Halifax 2019) which might be brighter than streetlights found in other cities. Having better lighting conditions might make people notice lighting less, making it seem like a less significant factor in Halifax. Vegetation was not listed by any response as a positive factor on perceptions of safety and was only listed once as a negative factor. This seems to contradict the principles of CPTED and the findings of Bhattacharyya (2016) and Gargiulo et al. (2020). A possible explanation for this finding could be that vegetation is not a strong factor on perceptions of safety in Halifax's geographic context. Much of our street vegetation is comprised of large trees with high canopies that do not significantly block one from seeing their surroundings.

The findings related to factors that affect perceptions of safety could be useful in the future planning and designing of public spaces. Creating spaces that encourage people to be present on the street (by creating a mix of uses surrounding the street or creating pedestrian attractions) can help improve perceptions of safety.

Incorporating women into the planning process through organizations, such as HRM's Women's Advisory Committee, can help create streets that are better designed to suit the needs of women, as planners may not always know what women need if women are not able to tell them. Gender mainstreaming, meaning the process of assessing policy changes for all genders, will help improve gender equality by ensuring that decisions are made to incorporate as many different perspectives as possible, but will also help to improve perceptions of safety (Women in Cities International and Jagori 2010).

Making women feel safer is about more than simply changes to the built environment and would require raising awareness about women's safety and trying to overcome or better understand the reasons behind feelings of fear. Stories from friends or the media may create preconceptions that are not always true and perpetuate existing stigmas about a place (Carli 2008). Changing how the media portrays a street is more difficult to change but understanding that these stories have a significant negative impact on people's perceptions might make planners and designers realize that the overall atmosphere of a street and what people will take from a space to go back and tell their friends is also important. Strategies to counter this would require positive messaging about places that are perceived as unsafe (based on old or false stories) to ensure that current contexts are represented. Strategies could include public engagement sessions to determine why women feel unsafe followed by promotional campaigns run by municipalities to re-brand neighbourhoods that have been unfairly stigmatized.

An additional strategy would be to raise awareness about women's safety to discourage violence against women and teach men to act more respectfully towards women (and people of all genders) in public spaces. This could be done through educational programs for the public to raise awareness about issues such as violence against women and gender dynamics (Women in Cities International and Jagori 2010). For example, other countries have used education programs to educate youth on how to treat women and how to be active bystanders (Women in Cities International and Jagori 2010). These programs have been focused on school aged youth and could be put on by municipalities, non-governmental organizations, or schools themselves. Changes would need to occur at a behavioural or cultural level, which would take time.

Limitations

This study has a few important weaknesses. First, we only examined a small number of factors mentioned in empirical studies. More factors may exist but we relied on the few existing studies to pre-identify these factors for the survey. Future studies asking women what makes streets feel safe or unsafe will likely reveal more factors. Second, our survey sample size was small compared with the geographic area covered, and there were very few street segments that received multiple ratings. Therefore, it was not possible to generalize the ratings or spatial patterns observed with any measure of reliability. Third, the formulation of proxy for perceived safety was limited by the availability and

quality of the secondary data. Streetlight data included all known locations of municipally owned streetlights, but some of these streetlights could be out of order. Neither did we include other lighting sources (such as restaurants and signs) as no data were available. Likewise, inaccuracy in bus stop locations in the data required manual corrections. During the process, some points could have been missed, or misrepresented. Population data used to approximate the likelihood of people present on the street was of residential population density. Therefore, the proxy created using these data is a coarse estimate based on a limited number of known factors.

In general, the average safety scores from the survey results and the MCA do not seem to correspond to each other, which suggests that future research needs to enhance the survey sample size, while finding ways to overcome the data limitation to formulate a better measure of perceived safety factors across the streets in the area. Nevertheless, it appears that perception of safety may be more subjective than we initially anticipated, based on the inconsistency between their rating of street segments chosen, what they think are important influences on their perceptions, and what are present—as far as people and lighting are concerned.

Conducting an online survey limited whom the survey could reach. Women who did not have access to the internet (e.g., women experiencing homelessness, women who live rurally, etc.) were not able to complete the survey. Due to the COVID-19 pandemic, it was safer to conduct the survey online. Asking women to rate how safe they felt on streets in Halifax during the pandemic (2020 and 2021) may have also altered our results as the number of people on the streets was probably generally decreased as many workplaces, universities, and schools were operating online or remotely. The areas where there are more people present might have given different impressions for the survey participants who chose to rate a street based on their experience in the last year.

Areas for future research

Our study did not examine any identity factors of our survey respondents. Things like age, sexual orientation, or race might also affect safety and should be examined in future research. For example, being younger or identifying as persons of Aboriginal origin are factors that increase a woman's risk of being a victim of violence against women (Sinha 2013).

Media portrayal or stories from friends was a significant factor on perceived safety identified by the survey participants in our study and should be included in future studies to see if it is a significant factor in other locations. The presence of people on the street was the most frequently identified significant factor on perceived safety, which matches with what the literature said in general, and supports Jane Jacobs original theory of 'eyes on the street' (Jacobs 1961). Bus stop density and residential population density may be poor proxy for gauging presence of people on the street. Where data is available for other factors that might affect the number of people on a street, such as the number of pedestrians who use a street, it should be incorporated into future studies.

Lighting and vegetation were identified in the literature as significant factors on perceived safety, but they do not appear to be as influential in Halifax as the literature suggests, with lighting being a relatively unsignificant factor and vegetation seeming to not be a factor at all. It may simply be that lighting is adequate across the area, and there is little difference in the amount of vegetation across the city centre. Some comparative analysis with other, similar size Canadian cities might be helpful in clarifying the role of lighting and vegetation.

In the future, it would be helpful to conduct the study longitudinally to see if the factors that affect perceptions of safety change over time. If overall perceived safety scores improved and the main factors from this study were not found to be significant in the future, one could hypothesize that changes in other components of the built form (such as more mixed-use developments) or changes in the society (such as a greater gender equality) may have contributed to improved perceptions of safety.

Conclusion

This study was largely exploratory in the ways to assess the factors influencing women's perception of safety on the street, providing a basis for future studies in Halifax and elsewhere. The survey used identified factors in literature, both positive and negative, that affect women's perceptions of safety in Halifax. The MCA created a proxy for perceived safety (how safe or unsafe women may feel) across Halifax by measuring the actual presence of factors identified in the survey. Such a measure could be further developed and tested in the future to determine if it does correlate with women's perceptions of safety. Increasing the number of people present on the street seems to be paramount

to improving perceived safety in Halifax and policy changes to encourage a mix of uses, especially commercial uses, would help improve perceptions of safety. Having a mix of residential and commercial uses ensures that people are present at all times of day. Strategies to incorporate women into the planning process to help improve the built form may also help improve perceived safety.

Literature references

Bhattacharyya, R. 2016. Street violence against women in India: Mapping prevention strategies. *Asian Social Work and Policy Review* 10 (3): 311–325. https://doi.org/10.1111/aswp.12099.

Carli, V. 2008, December. *The media, crime prevention and urban safety: A brief discussion on media influence and areas for further exploration* [Report]. Public Safety Canada. https://www.publicsafety.gc.ca/lbrr/archives/cnmcs-plcng/cn000043672798-eng.pdf.

Cozens, P., and T. Love. 2015. A review and current status of crime prevention through environmental design (CPTED). *Journal of Planning Literature* 30 (4): 393–412. https://doi.org/10.1177%2F0885412215595440.

Gargiulo, I., X. Garcia, M. Benages-Albert, J. Martinez, K. Pfeffer, and P. Vall-Casas. 2020. Women's safety perception assessment in an urban stream corridor: Developing a safety map based on qualitative GIS. *Landscape and Urban Planning* 198, Article 103779. https://doi.org/10.1016/j.landurbplan.2020.103779.

Halifax. 2019, February 25. *Issues with new LED streetlights* [Halifax Regional Council Information Report]. https://www.halifax.ca/sites/default/files/documents/city-hall/regional-council/190326rci01.pdf.

Intravia, J., K. T. Wolff, R. Paez, and B. R. Gibbs. 2017. Investigating the relationship between social media consumption and fear of crime: A partial analysis of mostly young adults. *Computers in Human Behavior* 77: 158–168. https://doi.org/10.1016/j.chb.2017.08.047.

Jacobs, J. 1961. *The death and life of great American cities* (50th Anniversary ed.). Modern Library.

Mata, F., M. Torres-Ruiz, G. Guzman, R. Quintero, R. Zagal-Flores, M. Moreno-Ibarra, and National Crime Prevention Council. 2003, October. *Crime prevention through Environmental Design guidebook* [Guidebook]. https://rems.ed.gov/docs/Mobile_docs/CPTED-Guidebook.pdf.

Sinha, M. 2013. *Measuring violence against women: Statistical trends*. Component of Statistics Canada catalogue no. 85-002-X Juristat. Retrieved from: http://www.statcan.gc.ca/pub/85-002-x/2013001/article/11766-eng.pdf.

Reynald, D. M. 2011. Translating CPTED into crime preventive action: A critical examination of CPTED as a tool for active guardianship. *European Journal on Criminal Policy and Research* 17: 69–81. https://doi.org/10.1007/s10610-010-9135-6.

Tandogan, O., and B. Ilhan. 2016. Fear of crime in public spaces: From the view of women living in cities. *Procedia Engineering* 161: 2011–2018. https://doi.org/10.1016/j.proeng.2016.08.795.

Viswanath, K., and A. Basu. 2015. SafetiPin: An innovative mobile app to collect data on women's safety in Indian cities. *Gender & Development* 23(1): 45–60. https://doi.org/10.1080/13552074.2015.1013669.

Women in Cities International and Jagori. 2010. *Conference background paper, Third International Conference on Women's Safety*. 22–24. Retrieved from http://www.safedelhi.in/sites/default/files/reports/Final%20Conference%20Background.pdf.

Data references

Environmental Systems Research Institute (ESRI). 2021. *ArcGIS Pro* [Computer software] (Version 2.7.0). https://www.esri.com/en-us/arcgis/products/arcgis-pro/overview.

———. 2021. *Light Gray Canvas* [Datafile]. Retrieved from ArcGIS website: https://www.arcgis.com/home/item.html?id=8a2cba3b0ebf4140b7c0dc5ee149549a.

Halifax Regional Municipality Open Data (HRM OpenData). 2019. *Census 2016 Dissemination Blocks* [Datafile]. https://catalogue-hrm.opendata.arcgis.com/datasets/5cc881bc60b741d88fab3fc4a5f2e7e8_0?geometry=-64.288%2C43.907%2C-59.619%2C45.276.

———. 2021a. *Bus Stops* [Datafile]. https://catalogue-hrm.opendata.arcgis.com/datasets/29de9d04a3454e11a1e0a-1f78a27bc07_0?geometry=-64.141%2C44.564%2C-62.973%2C44.905.

———. 2021b. *Public Trees* [Datafile]. https://catalogue-hrm.opendata.arcgis.com/datasets/33a4e9b6c7e9439abcd-2b20ac50c5a4d_0?geometry=-63.673%2C44.627%2C-63.527%2C44.670.

———. 2021c. *Street Centrelines* [Datafile]. https://catalogue-hrm.opendata.arcgis.com/datasets/560fec412dd044b08ae52a8575a215d4_0?geometry=-64.304%2C44.517%2C-61.969%2C45.198.