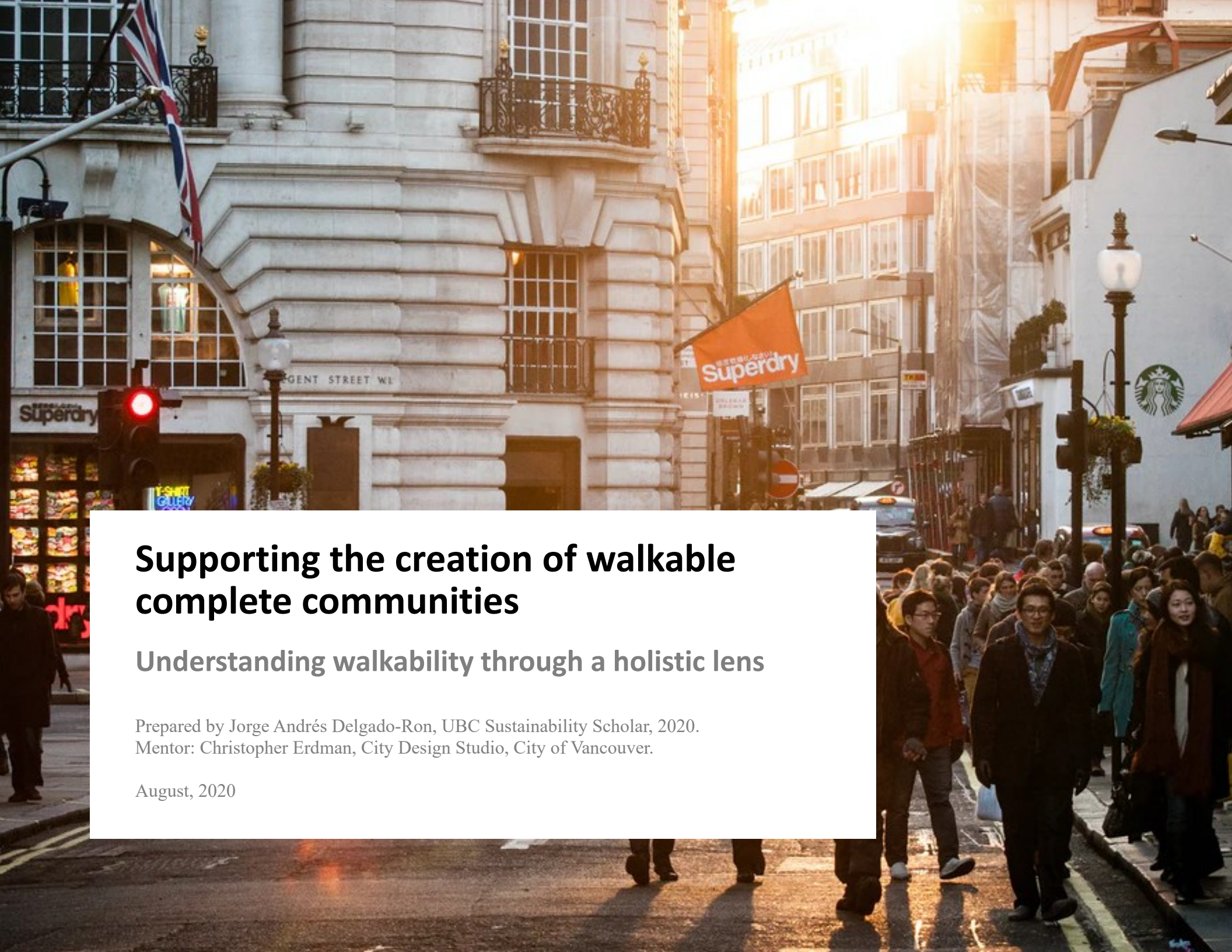

Supporting the creation of walkable complete communities

Understanding walkability through a holistic lens

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August, 2020

This report was produced as part of the Greenest City Scholars (GCS) Program, a partnership between the City of Vancouver and The University of British Columbia, in support of the Greenest City Action Plan.

This GCS project was conducted under the mentorship of City staff. The opinions and recommendations in this report, and any errors, are those of the author, and do not necessarily reflect the views of the City of Vancouver or The University of British Columbia.

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Introduction

Walkability is a set of features that allow sequential steps. It is also multidimensional criteria to build cities. It can refer to environments, policies, and even societies. The reason for such variability is that "walkable" (a word first printed around 1736) became an umbrella term for many other activities that involve both active transportation and the communities that emerge around them. What lies ahead of you is a holistic approach to the term. We will start with this simple formula:

$$Walkability = Walkable\ Space + Walker$$

I am telling you this upfront because our report will follow a similar structure. We will start talking about the built environment and slowly transition towards the human element of walkability. It is also worth stressing that for this review, we will consider the World Health Organization's definition for pedestrian:

> Any person who is travelling by walking for at least part of his or her journey. In addition to the ordinary form of walking, a pedestrian may be using various modifications and aids to walking such as wheelchairs, motorized scooters, walkers, canes, skateboards, and roller blades. The person may carry items of varying quantities, held in hands, strapped on the back, placed on the head, balanced on shoulders, or pushed/pulled along. A person is also considered a pedestrian when running, jogging, hiking, or when sitting or lying down in the roadway (World Health Organization, 2013, p. 3).

Besides, we will supplement our review with literature relative to other forms of active transportation, such as biking.

To facilitate our learning, I have chosen four guiding questions. They will allow us to characterize the different layers of walkability while keeping a coherent narrative between the walkable and the walker. A lot of the existing research on walkability focuses on specific outcomes associated with walking, like weight reduction or mental health. We do not. Instead, we will explore what makes a place walkable irrespective of what people would achieve by traversing it. These guiding questions are also sequential, meaning one has to answer the first question before moving to the second, and the second before moving to the third. You cannot do it the other way around as each item increases in complexity.

1. **"*Can* we walk there?"** refers to the *physical* features that allow walking or moving around.
2. **"*Should* we walk there?"** considers the *biological* and *psychological* needs of the walker. While investigating the theme of safety, we start by questioning environmental hazards, such as asking if a person can walk the path injury-free and then advance towards a sense of security and comfort, including perceived safety and threats.
3. **"*Will* we walk there?"** considers rival modes of transportation (and also competing activities). It also focuses on personal preferences tilting the balance towards walking instead of something else.
4. **"Who is *we*?"** emphasizes the "we" of the previous questions. Specific populations have varied mechanical, psychological, and social needs, and only by recognizing this fact, we can aim for equitable walkability.

By exploring these four guiding questions, we aim to provide policymakers with a general framework about how to approach walkability. Such a framework does not intend to be exhaustive (exploring every aspect of the question posed above). Instead, it is meant as a guideline that can accommodate different users and perspectives. We conclude by providing examples based on current research on walkability to demonstrate how future research should inform our guiding principles and practical framework.

So, without further ado, let's ask ourselves...

Can we walk there?

When toddlers threaten their first steps, families know exactly what to do in a matter of seconds. First, they identify *a flat terrain* suitable for small baby steps. Then, they calculate how long their child should walk. It should be *enough distance* to allow for the trudge but not as far as to deter the impetus. After padding all sharp corners, they double-check for any potential security hazard. Once *it is safe*, they release the toddler's hands and call from afar. The uncontained joy builds up to the moment. Slowly, the baby takes her first unassisted steps. She is walking. Partly because it was time for her to achieve such a milestone and partly because her parents created a "walkable" space.

At the most basic level, walkability encompasses three things (emphasized above): traversability, compactness, and safety. In other words, you need (1) a nearly flat surface without obstacles from origin to destination, (2) proximity between the origin and destination—closeness makes walking either the default or preferred way of moving—, and (3) being free from danger: you must survive the path without injury. These three elements are all required, but not sufficient on themselves, to make a place walkable.

Let's think through the complementary aspect of these concepts quickly. Imagine you are dropped in the middle of Salar de Uyuni, the world's largest salt flat located at the Bolivian Altiplano during a winter morning at 6 am. This place is nothing but traversable. However, it is far from everything else. If you start walking to the closest city, the sun will set, and you will likely die of hypothermia (the temperature at night reaches below zero temperatures). So, there you have it—flatness on its glory, not sufficient to be equated with walkable.

Now let's imagine that we have a fully charged satellite phone that happens to point in the direction of the closest city. Our App tells us that we only need to walk eight hours at a steady pace to reach our destination before 2 pm. It is safe *and* traversable. Yet, it is hard to affirm this trek is walkable. You could make the case, of course, but literally, any other option sounds better—a bus, a motorcycle, a bicycle, or even riding a donkey. If you prefer anything but walking, this is not a walkable place.

Similarly, closeness is meaningless if there is not a relatively flat, traversable terrain between two points. As an example, Figure 1 shows a well-known landmark where walking from point A to point B could take months, irrespective of them being meters apart from each other. Closeness sadly does not mean walkable either.

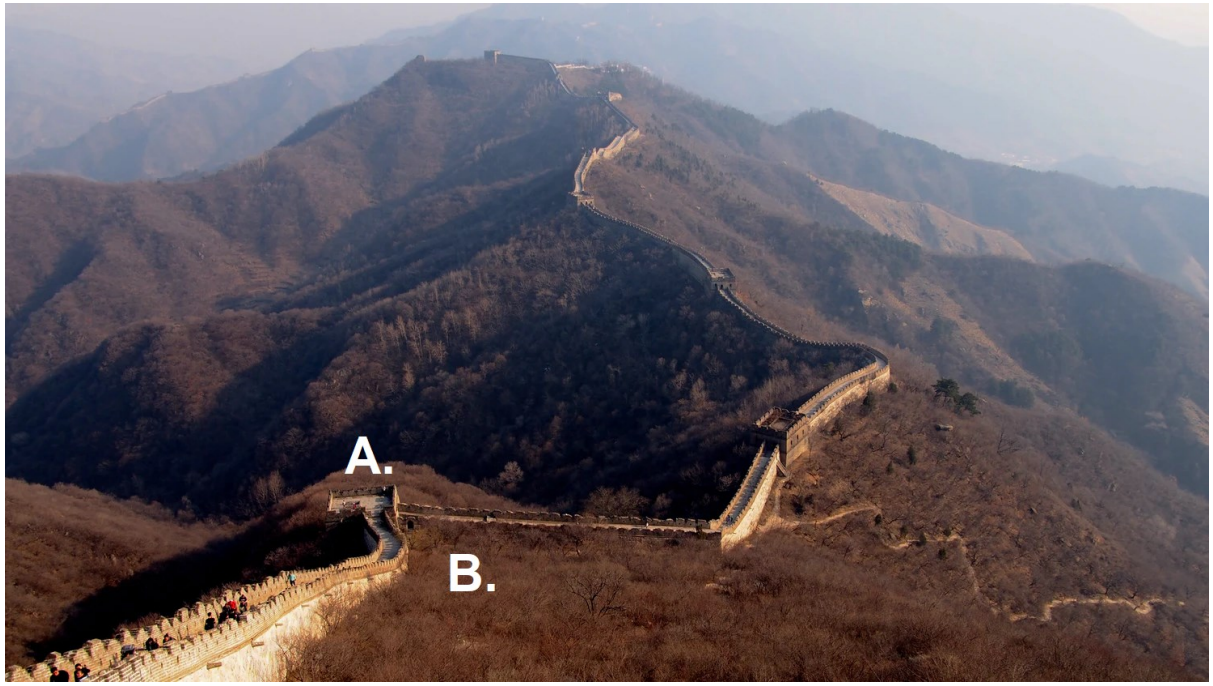

Figure 1. A Ming Section of the Great Wall of China (photo by Rita Chou)

Finally, safety is paramount, irrespective of traversability or closeness. An example better illustrated by the concept war of “no man’s land;” the space between two trench systems of opposing bands. People at both extremes literally try to kill whoever walks there. It is not walkable if you cannot survive it.

So, *we can walk there* if it is traversable, close, and safe. We need these three things at the same time. However, traversability and closeness evolve relatively slowly, matching the rate of change in our cities. The city has the ability to make land-use changes which guide what types of uses can be located where, this is a major possibility for reshaping cities to allow for more proximate locations of living, jobs, amenities, shops, services and other daily needs; however, cities change over the course of years. Additionally, we have

decided to create a separate question regarding safety ("Should we walk there?") and dedicate this section to the physical aspects of walkability (traversability and proximity).

Measuring the built environment

There are many tools out there claiming to measure walkability. Dr. Ann Forsyth, Professor of Urban Planning at Harvard, wrote a thorough review of the topic (Forsyth, 2015). In this review, we will mention only some of them, when they become relevant to the topic at hand. Walkability scales come on many forms and shapes. However, most can be classified into two broad categories: macro- and micro-scales. The former uses satellite-like vision to discover urban features while the latter usually requires a pair of eyes near ground level.

As you can imagine, it is hard to judge traversability with an aerial view. Measures of traversability consider slope, available area, and integrity. As such, street audits tend to be more useful to detect even small imperfections. The Microscale Audit of Pedestrian Streetscapes (MAPS), for instance, asks about the wide and continuity of sidewalks, the presence of heaves, misalignments or cracks, slope, and obstacles (Millstein et al., 2013). In the case of crossroads, it accounts for the presence of pre- and post-crossing curbs and tactile paving. Traversability research is still in development but proliferating due to autonomous robots making their way into the market (Kümmerle, Ruhnke, Steder, Stachniss, & Burgard, 2015). But until robots use high heel shoes or walk using canes, there will always be a need to understand how terrain affects our human affairs.

Proximity or compactness has been measured in many ways. At the macroscale, land-use and city zoning practices have assisted planners in quantifying "land-use mix." Others count the number of destinations from an individual's household or workplace and call that "accessibility," although this is not exclusive to walking. The walkability measurement tool that most prominently features compactness is Walk Score™, which assigns a higher score to places in close proximity (400 meters) to a high number of varied destinations (Carr, Dunsiger, & Marcus, 2010). An alternative that measures time instead of distance is the pedestrian shed, which accounts for the area covered by, let's say, a 5-minute walk (Vale, 2015). At the micro-scale level, accessibility can be measured by looking at the number of shortcuts, the presence of stores, kiosks, and plazas and other non-residential destinations.

Accessibility is also relative to the person. Again, let us imagine you just moved to a new city. Due to the high cost of changing your residence, you were left with only a few dollars in your pocket. However, you forgot to bring your cutlery, and now you are forced to eat out for a couple of days. You take your smartphone out of your pocket and open your favourite App. It turns out there are dozens of restaurants around you (walk-and-eat score of 100!). But with a limited budget, you soon realize there are only one or two options you can afford. Similarly, you can have access to many cultural places or religious buildings, but only a few will be relevant to your personal needs. While most scores do account for types of destinations, ultimately, accessibility is also a personal thing.

Should we walk there?

Out of the three main characteristics of physical walkability, safety is probably the most complex. People make judgements on their travel safety considering actual threats (like high-speed cars in a busy intersection), and perceived threats; this is the tricky part. So, let us break down both concepts using examples for our daily life.

Planners design for "injury-free walking" using features of the built environment. They minimize the chances of collisions and deaths. Speed bumps, traffic signals, wider crossing areas, reduced number of cars all aid to keep our bodies safe. But we are more than bodies, and that is why WHO's *Pedestrian safety: a road safety manual for decision-makers and practitioners* defines safe walking using dimensions that also consider mental health: "less crime and fear of crime," "inclusive mobility," "spaces and places for people," and "a culture of walking," among other things (World Health Organization, 2013, p. 36).

So, perceived threats in this context relate less to the built environment and more the social characteristics of the space. For instance, an LGBTQ2S couple holding hands will feel safer while walking on Vancouver Davie's Village (Walk Score: 64) compared to doing the same is Singapore (where their public displays of affection would be considered illegal- Walk Score: 98). Only when a walker does not fear the street, due to *both* its built environment characteristics and its social characteristics, you have truly safe walkability.

Assessing the social dimension of safety is hard, and it might be impossible to reduce both actual and perceived threats for every pedestrian. For instance, certain interventions might increase the presence of male pedestrians in a certain area. At the same time, solely the presence of men might increase female pedestrians' insecurity, as shown by recent research in Brasilia (Souza, Bittencourt, & Taco, 2018). Another example of the same environment producing dissonant responses can be seen in Figure 2. A poorly lit and lonely street, with its walls full of graffiti and fenced structures, would make some change routes. However, these are the exact characteristics that attracted one of my best friends during his undergrad years; he wanted to avoid police presence and peacefully smoke some pot in the corner of a dark alley. Fear of authority can be common people experiencing homelessness or those involved in sex work too. After all, perceived threats are modelled after past experiences, and social structures impact people in different ways.

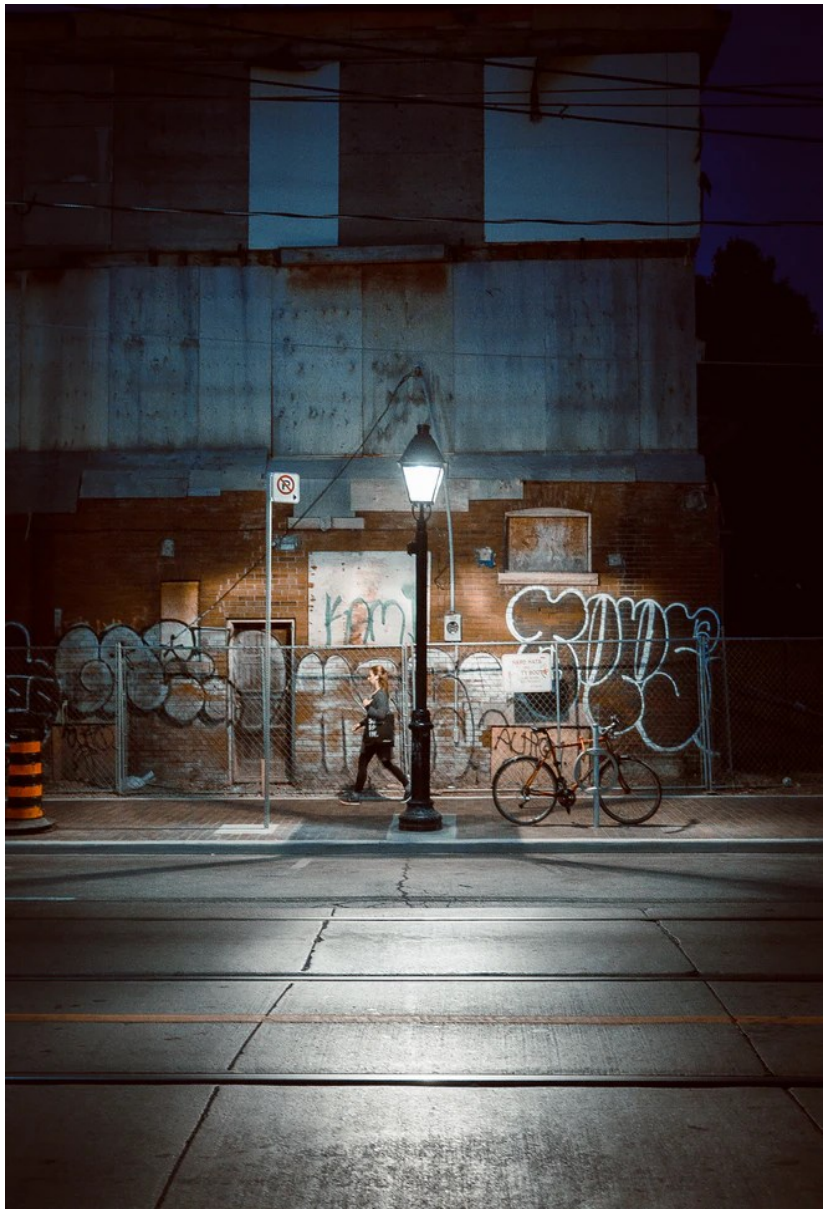

Figure 2. Features classically associated with unsafe spaces: poor illumination, graffiti, lack of a buffer area, a high-traffic zone, and the absence of people on the street and inside the surrounding buildings (photo by Filip Mroz).

Measuring safety

Safety metrics are tricky because they depend on individual perception and not solely on facts or statistics. Unlike traversability and compactness, safety is not always considered as part of composite walkability measures. This exclusion is particularly common for macro-scale measures like those of Walk Score™ or Dr. Lawrence Frank's Walkability Index (Frank et al., 2010). Understandably, both left safety out of their equations due to the challenges related to quantifying using mostly a satellite (metaphorically speaking).

On the other side of the spectrum, you can find Holly Crambeck's *The Global Walkability Index*, which includes eight safety indicators. These include both objective (i.e. enough time for an elderly to cross or the number of fatalities per crossing) and subjective measurements (i.e. the perception of security from crime or accidents). The MAPS tool resorted to proxy indicators that rely solely on the built environment. Driveways and car-sized alleys are markers of hazard, whereas traffic-calming structures and signalization, buffer zones, streetlights, and good overall maintenance signal the opposite. Other measures like human presence relate more closely to the social dimension of safety,

countered by general disorder, the presence and extent of graffiti or broken windows. Similarly, other tools measure the percentage of a route which is visible from street level dwellings or businesses.

If we take this approach a step further, we can go beyond "stress-free walking." *Physically enticing* environments can produce pleasure-inducing walking. In her walkability review, Ann Forsyth remarked the following quote from the City of Geelong: "an environment that invites people to get around on foot, not because they have to but because they will feel like they are missing out if they don't."

However, as explained above, not a single feature of the built environment makes *everybody* feel safe or invited. Instead, we should aim to understand the impact of urban and social interventions in the threat model (and preferences!) of diverse populations.

Will we walk there?

Walkability depends on a walkable space as much as it depends on people deciding to walk. In previous sections, we explored elements that make people want to walk more. However, they still need to choose walking over *other* transportation alternatives. Cycling, Transit, Car-pooling, taking a cab and using private vehicles impact walking in different and unique ways. We also need to understand whether such alternatives behave as competitors or complements of walking.

In order to analyze the relationship between travel modes, we must ask ourselves a question that views walkability not as an end but as a means: Why walkability? Every person or agency assessing walkable spaces and people will need to address this question in order to make an honest evaluation. For example, we started this framework to advance Vancouver's Greenest City Action Plan, Healthy City Strategy, and Climate Emergency Response. Hence, we will evaluate the relationship between walking and other travel modes based on the premise that we want to foster human health and sustainable environments. Under these circumstances, biking and walking are considered natural allies; both are active forms of transportation that reduce greenhouse gas emissions, sedentarism, obesity and its associated chronic diseases.

Public Transportation (trams, trains, light rail, ferries, buses) is considered a complementary alternative to active transportation. After all, very few people live right next to a transit stop. Hence, using public transport often involves walking to them. A meta-analysis of studies published from 2002 to 2012 found that using public transport associated with 8 to 33 minutes of additional physical activity (Rissel, Curac, Greenaway, & Bauman, 2012). A finding replicated over time in different cities. Well-designed bike lanes also increase pedestrian safety (DiGioia, Watkins, Xu, Rodgers, & Guensler, 2017). Although bikeability places more emphasis on infrastructure and topography and less on land-use and density (Muhs & Clifton, 2015), it is still considered part of the "walkability" pack by some researchers

Ride-hailing is a competitor for public transit, which in turn would result in less associated walking. Ride-hailing also reduces walking directly, as shown by a study conducted in Denver, where walking was the second-best option for 12% of ride hailers (add to that the extra 22% that would have used public transit). Moreover, ride-hailing increases the number of vehicle-miles travelled by an extra 83.5%, with an associated impact on pollution and other traffic-related issues (Henao & Marshall, 2019).

Taxis are neither private vehicles nor public transportation (although researchers and policymakers tend to group them with the former in most countries). While taxis are an important means of transport for people who experience mobility issues and people who do not own a car (sometimes when other forms are unavailable), they still compete with public transit and walking in a similar fashion to ride-hailing (Cosby, 1992).

Private vehicles do not get along with other forms of transportation. If you own a car, you are very likely to use it as your main form of transport, unless there are significant barriers (Spears, Houston, & Boarnet, 2013). If we analyze the use of private vehicles and compare them with other forms of transportation, we see a clear pattern. As car usage increases, other forms of travel lose terrain. Figure 3 shows this tendency in the United Kingdom, but the same happens virtually in every country.

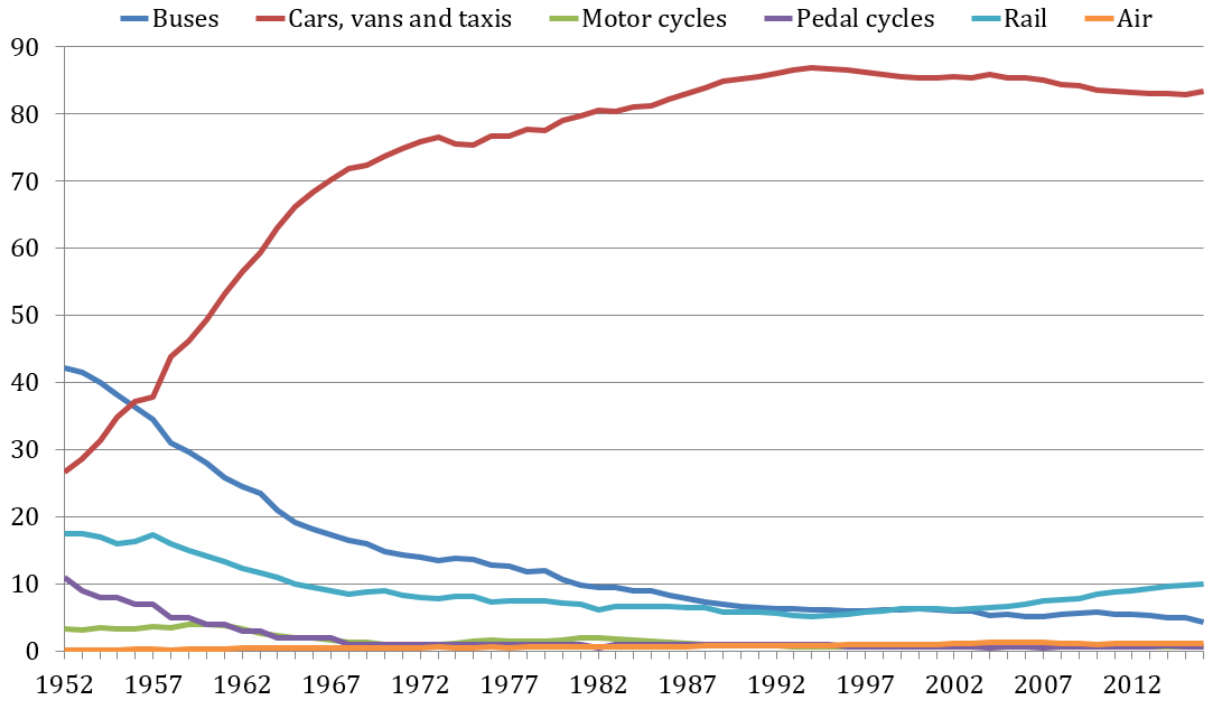

Figure 3. United Kingdom transport modal share from 1952 to 2014, Department for Transport. Image under CC BY-SA 4.0 License

Access to transport modes and their associated facilities influence people's behaviour. A study conducted in Antwerp (Belgium), in 2013, showed that nearly half of participants who biked thought about bicycle storage or parking at their destination. If they thought their goods might get stolen, they would consider an alternative transport mode. They also enjoyed bike-sharing programs around the city as it gave them "easy access to transportation." Similarly, proximity to bus stops played a role in their decision to use public transportation (Simons et al., 2013).

Measuring walkability-related modal share

Reviewing walkability-focused modal share transportation is out of the scope of this document. The intersection between urban and transportation planning deserves detailed attention from a transdisciplinary team. Suffice to say that such measurements would need to consider multi-modal routes while focusing on maximizing (a) mode shift away from private vehicles into public transport, and (b) the integration of pedestrians and bikers into public transportation.

Who is “we”?

At the end of the last century, the legal definition of “pedestrian” stopped referring to the average walker: an abled adult who uses both of his legs to move around. It started to include those using mobility aids (Lo, 2009). In some places, like Washington State, it also includes skateboarders and roller skaters. Similarly, the definition of “walker” in modern research comprehends trips by skateboard, roller-skates, and sometimes even bicycle as forms of active/non-motorized transportation (Greenberg & Renne, 2005). An honest approach to walkability must take this diversity into account and comprehend that humans are also unique in their reaction to the built, natural, and social environments. A cross-cultural study in Uganda and Seattle, for example, showed that people in Uganda slowed down when walking in groups, likely because they use the activity to socialize. A similar effect could be observed when children were part of a group (Bouterse & Wall-Scheffler, 2018).

Planning for walkability—be it at its most basic level or engaging in more complex definitions—require us to understand that unique human qualities will translate into different requirements for walkability. Much like our clothes, walkability must consider our anatomy and preferences, our abilities and even our purchasing power. Beyond this simplistic metaphor, walkability needs to reflect on historical structures of oppression towards the disadvantaged and find a way to create belonging.

An intersectional approach to integrating equity into walkability assessment

Inclusive walkability refers to societal and built environment features that maximize the diversity of people who are both comfortable with and able to walk. It mirrors the principles adopted by the World Health Organization (WHO) in 1948 when its States Parties declared that every human being should enjoy the “highest attainable standard of health” irrespective of their race, religion, political belief, economic or social condition. WHO further clarified that “happiness, harmonious relations and security of all peoples [depends on]

complete physical, mental, and social well-being."[1] By adding this equity layer, we are truly maximizing our holistic understanding of walkability.

Intersectionality refers to using more than one of these categories to understand the lived experiences of our potential walkers. Andrea, my wife, is a woman, an adult, a mother, an immigrant, a self-defined mestiza recognized in Vancouver as a visible minority; a person who speaks Spanish at home and that very often carries a stroller with her. While the following paragraphs explore different dimensions of human nature, we want to remind the reader the intersection of those dimensions creates unique backgrounds that should not be missed in more prominent categories. We start by exploring age, disability, gender, income, and race. But, much like pieces of a puzzle, the readers will need to see how and if they fit together. Only by placing them next to each other, the reader will be able to see the bigger picture.

[1] Preamble to the Constitution of WHO as adopted by the International Health Conference, New York, 19 June- 22 July 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of WHO, no. 2, p. 100)

Age and walkability: a timeline of human mobility

Newborns and toddlers

I used to verbalize a mantra before leaving my house: "cell phone, wallet, keys." Over time, many things changed in my life, but this mandatory checklist. That is until I became a parent. My five-syllable list became 25 rows of items after my first child was born: diapers, wipes, rash cream, a bag for dirty stuff, baby food, burp cloth, blanket, the emergency kit, among many others.

So, "cell phone, wallet, keys," baby bag, and—last but not least—baby Alice. The idyllic image of carrying a nursling in your arms is soon replaced by the realization that holding a baby for long periods is exhausting. Hence, I had to add a new item: a stroller, which is both good and bad. It's good because its wheels help carry all the weight, but it is bad because it is sizable. Back then, I lived in a hilly place, and the sidewalks were constantly interrupted by steps. So, I could walk, but I had to share the street with cars if I wanted to. Taking the bus was challenging in the absence of ramps, and public transportation was regularly packed, with little space for carry-ons and zero time for anything right after you sit down, that is, if you are quick enough. If I needed to go somewhere, I had two options, driving or taking a cab; there were no other options available.

The Institute of Transport Studies, along with the Department of Transport in Melbourne (Australia) has conducted several studies during the last three years about travel mode choice among people like me, parents and families with children aged 0-5. Their findings mirror my parts of my experience. Their systematic review found that "the majority of factors influencing mode choice among families with young children tend to facilitate car use." When they asked parents about their reasons to choose a car over transit or walking, they found that caregiving status—and not gender—was associated with car use (McCarthy, Delbosc, Currie, & Molloy, 2017, 2019a).

Development milestones are tremendously important too. During early childhood, some parents will plan their trips to accommodate sleeping schedules. Later, they will do the same to transition out of the diapers. Finally, a child's mobility and comfort with its surrounding physical environment will determine the length of trips in each travel mode. Parental characteristics also play an important role in switching travel mode: leaving and returning to the workforce and moving houses signalled major changes. Hence, researchers have developed tailored policy recommendations considering age, gender, income, employment, car ownership, among other things (McCarthy, Delbosc, Currie, & Molloy, 2019b, p. 112).

As kids slowly transition from toddlers to preschoolers, their activities diversity (playgrounds, museums, and other destinations are now part of their map), which also influences their family's travel behaviour, especially among those of low-income or without a car. At this age, things as basic as the surface material, pathway form, and open areas impact the amount of a child's physical activity (Cosco, Moore, & Islam, 2010). If children go to daycare, planners should consider both optimal density and distance. For example, a study in China found an optimal walking distance of 4 blocks or less and a density of 1 in 1,500 households (Lee, Dong, & Cho, 2013). Of course, these factors should be calculated according to each city's unique characteristics. Other factors like gender and perceived safety are relevant even at this age. Parents are less likely to leave their children out if they feel it is unsafe, but even less likely if their children are female (Hinkley, Salmon, Okely, Hesketh, & Crawford, 2012; J F Sallis et al., 1993; Tucker, 2008). On the other side, a higher street density seems to correlate with increased physical activity at ages 3 to 5 (Lovasi et al., 2013).

School-aged children

School-age marks the beginning of structured activities in people's life. For kids, that means going to school for 5 to 9.5 hours per day (depending on the country) five days a week. Walking gets divided into *transport* and *leisure* walking, and so does research. Health geography had researchers inquiring about the relationship between the built environment and whether it associates with the threshold of minimal physical activity recommended by the WHO, and to what extent.

Some correlates of physical activity are access to schools, recreational facilities, and other destinations; sidewalks and protected crossroads; owning a dog, and access to public transportation. The types of neighbourhoods where kids wander the most were single-family housing, densely built-up residential areas and big buildings. On the contrary, high street density, high traffic density, high speed, crime and local deprivation correlate negatively with physical activity. Parental perception of traffic has been, by far, a more reliable indicator of a child's mobility compared to other objective measurements of the built environment. Because researchers require big sample sizes to detect such effects, quantitative research has rarely found differences among children due to ethnicity, age, or income. In terms of gender, neighbourhood design, and bike ownership were particularly important for girls (Davison & Lawson, 2006; Marzi, Demetriou, & Reimers, 2018).

Kids at this age start to position themselves in relation to other people and the world, which includes their relationship to public space. When children were asked about a redevelopment project in Boulder (Colorado), they were particularly interested in integrating nature

into their activities, "spaces for active play, water interaction, and a sanitation station for the homeless." This initiative also helped kids to feel they were heard by the local authorities, and took an active role in shaping their communities, likely fostering a high sense of belonging (Derr & Tarantini, 2016). Creating child-friendly cities has become more common during the last decade, and because of that, we have also gained insight into what kids want around the world. As explained by Tim Gill, an expert in child-friendly urban planning, children consistently "value safety and free movement, and want green spaces and places to meet their peers. They dislike litter, heavy traffic and lack of choice about places for playing and socializing."[2]

Shaping urbanization for children: A handbook on child-responsive urban planning offers a thorough review of both principles and practical steps to design cities that promote children's rights (Askew, 2019). Among them, you will find the use of Child Impact Assessment (CIA) processes, which is a multidimensional assessment of a given project on children. CIA exemplifies how to both assess the impact and integrate people, in this case, children, when developing urban projects. Because there is considerable variability across geographies and cultures (and due to the high stakes of implementing such a tool), there is not a set of unified indicators to evaluate the impact of development on children. However, numerous examples can be found listed under 'Resources' at UNICEF's Child-Friendly Cities Initiative website.[3] Similarly, Victoria Derr, Louise Chawla, and Mara Mintzer compiled numerous case studies and success stories in *Placemaking with children and youth: participatory practices for planning sustainable communities* (Derr, Chawla, & Mintzer, 2018). The book also offers advice regarding engaging strategies using both art and interviewing techniques.

Teenagers

The transition from childhood to adolescence marks the beginning of a steady decline in physical activity. As they age, teenagers reduce their daily step count along with other types of physical activity (Tudor-Locke et al., 2011). They start spending less time with their parents and more times, both with their peers and independently (Feldman & Gehring, 1988). Therefore, understanding motivators and deterrents for walking during this period is critical as their travel mode will likely remain the same over the course of several years.

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[2] Gill, Tim. "Building the case for child-friendly urban planning." https://www.wcmt.org.uk/fellows/reports/building-case-child-friendly-urban-planning

[3] UNICEF. "Resources." Child Friendly Cities Initiative, UNICEF, 4 Apr. 2018, https://www.childfriendlycities.org/resources/

A team of researchers produced a thorough review of environmental factors that influence active travel in youth in 2008 (Panter, Jones, & van Sluijs, 2008). Social cohesion came on top, with both male and female teenagers increasing their walking and biking activities due to the presence of peers in the neighbourhood. Next was road safety, where parental influence determined whether their kids travelled on foot or not. Travel length was, unsurprisingly, associated with active transportation. The overall findings of the review were summarized in a conceptual framework (Figure 4).

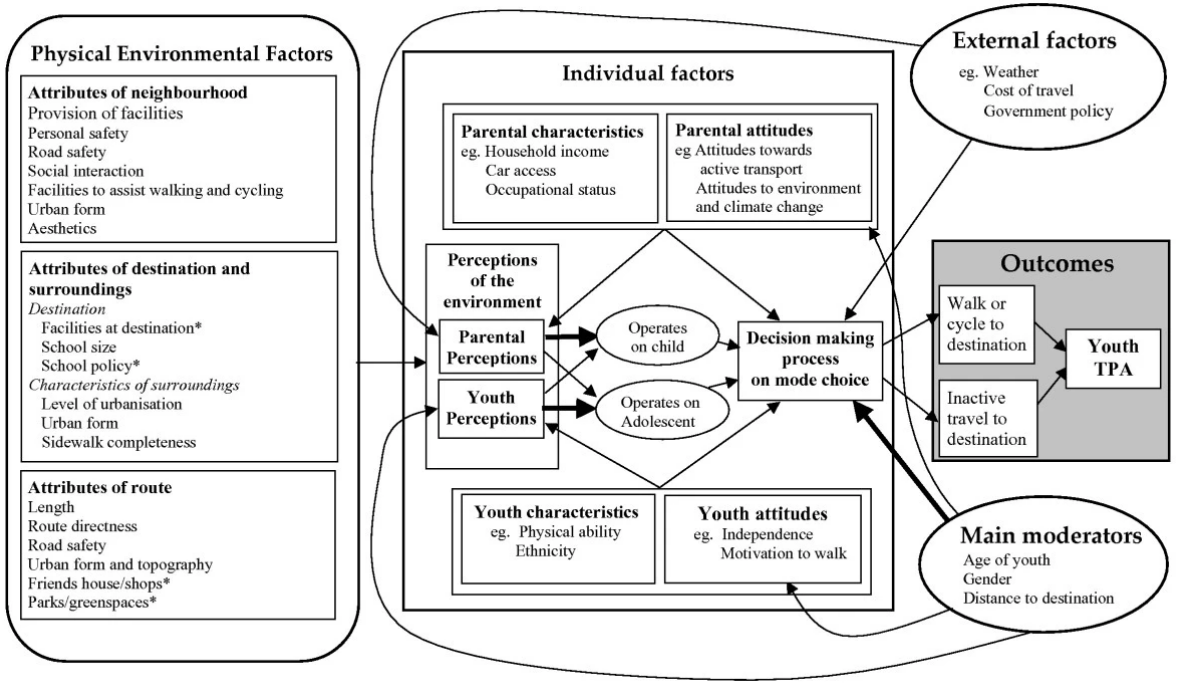

Figure 4. A conceptual framework for the environmental determinants of active travel in children. Arrows indicate a hypothesized direct relationship. Larger thicker lines indicate a stronger hypothesized direct relationship. Image by Jenna R Panter, Andrew P Jones & Esther MF van Sluijs under a CC BY 2.0 License

Built environment characteristics have produced mixed results (Panter et al., 2008). Positive findings linking walking and features of the built environment (e.g. green spaces, recreational facilities, land-use mix, or traffic safety) are less common when you study adolescents (ages 13-18) compared to children (ages 3-12); a difference that is further exacerbated by the use of objective measurement (Ding, Sallis, Kerr, Lee, & Rosenberg, 2011). In other words, the built environment concedes some terrain to social and psychological aspects as we age. Reasonably, adolescents' search for autonomy and peer interaction heavily influences their travel mode choice (Simons et al., 2013), which is why planners should not overlook this when assessing walkability for people at this age. Finally, they also should consider that adolescents most likely will depend on their parents' income, something which heavily influences their decision to walk, bike, or be driven. Girls are more likely to be driven (instead of walking or taking transit) compared to boys. Ironically, mothers are twice as likely as parents to act as a chauffeur when driving teenagers (National Academies of Sciences Engineering and Medicine, 2011, pp. 203–212).

Young adults

The reason young adults deserve their own category is mainly twofold. Firstly, a large proportion of young adults still live with their parents and, even when they don't, they still need to gain financial autonomy. Secondly, young adults are less likely to have a family and their mobility needs mainly relate to other forms or social interactions, school and work. Hence, we will address both circumstances when discussing income and walkability.

Older adults

Did you know that our walking speed predicts accelerated ageing, brain integrity, and, to a certain extent, death? A fast pace associates with a 20% reduction for all-cause and cardiovascular mortality, especially when you are 50 years or older (Rasmussen et al., 2019; Stamatakis et al., 2018). Walking is extremely important at this stage of life and one of the few low-impact exercises readily available for those with fragile bones and worn-out joints. It can literally both extend and improve older adults' lives at zero-cost.

Understandably, many public health experts and sustainability enthusiasts recommend walking, for everybody. But seniors do not experience walking in the same way young people do. Starting at age 50, the cornea starts losing elasticity, and you cannot focus on nearby objects without the assistance of glasses, no matter how hard you try. Your night vision impairs and, to make things worse, your reflexes slow down. On average, ageing is also associated with increased weight gain, muscle mass loss, and bone fragility. Put all those factors together, coupled with increased mental fragility, and you get a very different ability to traverse terrain, to find your way from

point A to point B and to react to both perceived and real threats. According to WHO's report on disability, the prevalence rate of disability among adults aged less than 50 is 8.9%. However, the rate increases to 38.1% for those 60 and older (WHO, 2011).

At age 65 or older, 1 in 10 adults won't be able to walk while carrying an object 15% their body weight; a similar proportion won't be able to identify and avoid small obstacles at night. Once we reach the age of 75, 1 in 4 adults could not perform such tasks. Moreover, we start seeing people who cannot walk and talk at the same time or walk and pick up and object. At age 85, only half of the adults can sustain a 400-metres walk (Shumway-Cook et al., 2007).

While age impairs our overall ability to walk, it also impacts our ability to use other travel modes. After a certain age, adults are faced with barriers to driving and using public transit. These and other considerations should be considered when assessing the impact of urban development in this age group.

Feeling like an *old*, *old* walker*

Imagine yourself arriving in a different city. You are trying to get from the bus station to your new place with nothing but a cellphone. Due to a narrow schedule, you did not choose a route beforehand. There is no public transport. You walk. You have no idea what it is out there. Yet, you hope an App will guide you through the city.

Once you are out, you realize that the cars drive at twice the speed of your hometown and that the number of lanes doubles in most streets. To make matters worse, you do not get extra time to cross the intersection. (*I am accelerating the rhythm of the city, but in practice, age slows us down*).

Your App requires you to use headphones because technology is somehow imposing nowadays. Once you put them in your ears, a high pitch resonates in your left ear and loud music bangs on your right one. (*Like living in a constant hangover, the elderly struggle to handle more than one source of sound at the time. Listening to music while hearing others converse can give them headaches*).

Annoyed by the sound, but still decided to reach your destination, you start following the route on the phone, trying to understand how to position your phone in order to make sense of your own steps. As you cross the street, you listen to a car accelerating. You try running but feel restrained by the weight of your luggage! (*As we age, our bodies respond in a slower manner and our muscles lose strength. We need longer time to recover and risk a fracture on every fall*).

Panic! As you reach the opposite side of the corner, you see the broken screen of your crushed phone amid the street. You have no idea where your destination is or how to get there. (*Loss of memory is common as we age, sometimes this is coupled with a lack of orientation*). You don't know it, but you are just two blocks away from your new home. It doesn't really matter. You are lost. Desperate, you try to reach out to others. Sadly, they don't understand what you are saying. (*Sometimes it is a matter of a generational gap, sometimes it is your dental prosthesis getting on the way*).

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* Note: Among older adults, those 75 years and older face significant bigger challenges compared to the other groups. Sometimes they are referred to as the 'old, old').

Disability

Talking about age, income, gender, or race will inevitably lead to a conversation about disability. Each of these factors—being old, female, poor, or indigenous—increases the risk of living with impairments, activity limitations, or participation restrictions (WHO, 2011). It is not only physical disability but also mental disabilities that worry public health experts. As the population grows older (as is the case in most developing countries), it is more common to see people living with arthritis, heart disease, chronic pain, or dementia during much of their lives (Jetha, Besen, & Smith, 2016).

While cities generally mandate improved accessibility for people living with disabilities since decades ago—mainly because of war veterans coming back in big numbers—, such accommodations apply mainly to indoor spaces and have rarely reached the public space. On top of that, despite their big absolute numbers, people with disabilities make a small proportion of the population sampled for walkability study, leading to a poor understanding of their specific needs (Stafford & Baldwin, 2017).

Unlike abled people, those using mobility devices are particularly sensitive to the traversability and accessibility of sidewalks, the safety of construction detours, and harsh weather conditions. Mobility speed among people living with disabilities changes a lot with age, and as such, resting points become very relevant. They also might benefit from being able to use bike lanes and to know about their right to do so (depending on the local legislation) (Parent, 2018). On the other side of the spectrum, people with dementia establish a special relationship with their built environment that helps them set limits as well as provide opportunities to compensate for their limitations, not also in terms of mobility but also regarding their sense of self and identity (Ward et al., 2018).

There are no firm evidence-based recommendations to increase the walkability of people living with disabilities, mainly due to the lack of specific research. Cities could help society overcome this obstacle by supporting research and by using participatory methods in their assessments (Stafford & Baldwin, 2017). Particular recommendations for people using wheelchairs can be found in a recent doctoral dissertation by Dr. Laurence Parent (2018).

Repurposing the term ‘safe space’: A conversation about gender and walkability

During my first stay in Vancouver, I often met with other first-year students from Latin America to feel “at home.” It struck me how consistently women emphasized missing their home countries, “but here I can walk freely.” The sentence echoed in so many conversations until it made me realize not only how patriarchal and oppressive public spaces can be, but also how hard it was to notice

from a position of privilege. As mentioned in previous sections, people might feed threatened as a result of their gender or sexual preference (Souza et al., 2018). In fact, scholarship on the topic suggests that the lived experience of LGBTQ2S people plays a higher role than age or income in building our relationship with public spaces (Sanschagrin, 2011). While a more walkable environment relates to a higher proportion of women walking (likely due to an increased sense of safety), there is still a need to research the impact of complete streets on the LGBTQ2S community (Jensen, Stump, Brown, Werner, & Smith, 2017). Past reports indicate aggression as a significant contributing factor in changing route or travel mode and specific calls to improve reporting and management of hate crimes, assault, harassment, and microaggressions (Roberton, 2016; Weintrob, 2018).

Gender also influences house roles; in turn, they associate with specific activities. A systematic review published by researchers from Durham University found that child-care and running household errands might play a role in the higher levels of leisure walking of women (compared to men) while it was more common for men to "be active" by playing sports or exercising (Sanschagrin, 2011). The latter finding is consistent with a more recent systematic review that also explored gendered differences but focused on chronic disease risk (Valson & Kutty, 2018). Studies in Canada and Texas also point to a lower level of mobility independence as parents usually protect more their of daughters than their sons (McMillan, Day, Boarnet, Alfonzo, & Anderson, 2006; Stone, Faulkner, Mitra, & Buliung, 2014), mirroring adult women's perception of public space. Women are more likely to perceive their neighbourhood as unsafe, while men tend to identify more often opportunities for leisure physical activity (Bengoechea, Spence, & McGannon, 2005; Hidayati, Tan, & Yamu, 2020).

Feminist scholars recommend using women's safety audits to understand the feminine perspective better and to increase a sense of space ownership and public participation. We propose the use of such tools for women and all genders as means to achieve equitable spaces (Whitzman, Shaw, Andrew, & Travers, 2009). Similarly, others have developed a Women's Walkability Index finding striking contrasts with standard measures of walkability, like Walk Score™ (Golan, Henderson, Lee, & Weverka, 2019).

Walkability and wealth

How does walkability relate to income? We can approach this question by looking at the two main components of walkability: place and person.

First, having less money for rent limits your housing options. Highly walkable neighbourhoods not only correlate with higher housing values but also with fewer foreclosures and lower crime rates (let's remember the importance of perceived safety in walkability). People

with high income are likely living in rich neighbourhoods, more often than not they are surrounded by a built environment that promotes physical activity—with more recreational facilities and better aesthetics—and feel safer than those living in poor neighbourhoods (Gilderbloom, Riggs, & Meares, 2015; James F Sallis et al., 2011).

A 2017 review that characterized walkability based on social context found that socioeconomically disadvantaged groups "walked more in unsupportive built environments," likely because they *must* walk to move around (Adkins, Makarewicz, Scanze, Ingram, & Luhr, 2017). As explained in previous sections, not owning a car is a significant contributor to increased levels of physical activity, mainly through commuting (Marzi et al., 2018; McCarthy et al., 2019b). Finally, low-rent housing might be associated with longer commutes in some cities, although more research is required on this topic (Snyder, 2014). It is essential to mention that although walkability studies rarely occur outside high-income countries, cross-country comparisons with low-income countries revealed similar relationships between neighbourhood environment and physical activity (CERIN et al., 2014).

The interaction between income and walkability is complex and beyond the scope of this document. Interventions to improve walkability might end up increasing house prices and displacing disadvantaged populations. On the other hand, low-income people who sometimes end up experiencing homelessness are represented in walkability-related research mainly as a perceived threat to others (as is the case with the Women's Walkability Index mentioned above). It is critical that our understanding of walkability improves over the next years to better integrate those systematically excluded from planning practices due to the nature of the extant research available.

Walkability: Pathways to Reconciliation

While exploring the relationship between income and walkability in San Francisco, a doctoral student from the University of California, Berkeley, ran into a different pattern. It was not low-income, but ethnicity what correlated with living in less walkable neighbourhoods. He explored whether affordability or cultural factors mediated this relationship. In-depth interviews confirmed that affordability played a predominant role in displacing people towards these pockets of low walkability. Moreover, more affordable places were sometimes perceived as less safe, further exacerbating the issue. Black people clearly resented the situation as they were "forced out" of their neighbourhood due to rising costs. The qualitative study revealed that some linkages are not immediately evident in quantitative analysis, race associated with less relative income, and it was indeed causing changes in walkable space (Riggs, 2011).

The case for reparations by Ta-Nehisi Coates (2014) clearly outlines the history of institutionalized racism American housing policy and discrimination against low-income and minority neighbourhoods. Further displacing minorities towards low walkable areas exacerbates their existing risk of chronic diseases and adds to that the risk of pedestrian injury (Adkins et al., 2017).

Ethnic minorities often face racially or culturally motivated aggression in public spaces. In the wake of the 9/11 attacks, Muslims struggled against racism in the streets (Chon & Arzt, 2005). Similarly, the political discourse that followed the global COVID-19 pandemic in 2020 motivated hate crimes against East Asian people (Hager, 2020). Racial profiling and police violence also gave birth to the term "walking while black." Just like in the same expression used for driving, walking while black represents the disproportionate enforcement of traffic violations and civil codes against African-American people. What is telling about this story is that experts concluded that no amount of enforcement would reduce violations, but instead recommended to increase pedestrian-friendly infrastructure. In other words, urban planning can and should be used as a tool to fight racial injustice (Sanders, Rabinowitz, & Conarck, 2017).

Summary

Walkability is an umbrella term that encompasses several definitions, from technical standards to policy goals. Hence, integrating walkability into policymaking can be challenging. In order to ease the process—and to maximize our holistic understanding of the term—we stratified walkability into four layers:

1. Requirements for a walkable space: Traversability and Compactness.
2. Requirements from a walker's perspective: Safety and Security.
3. Walking desirability: Travel Mode.
4. Inclusive walkability: Equity.

The order of the layers reflects usual considerations in planning and policymaking, which usually start with the physical features of the built environment and have a universal design as the archetype of successful design. Concordantly, each layer adds complexity to the previous one. We integrated key findings from the scientific literature to each of these concepts. In addition, we attached guiding questions and measurement tools. Below, we present a table that summarizes the key elements of our equity framework.

While the framework allows for flexible measurement—e.g. you could measure only physical characteristics of walkability—, a truly equitable assessment requires the use of all four guiding questions and the participation of a diverse population into planning, monitoring, and implementation. However, the tool was designed in modules as policymaking usually depends on limited financial and human resources. Each component was supplemented with research and documentation from the existing literature.

Walkability

Guiding questions, areas, tools, and equity considerations for a person-centered walkability.

Guiding Questions	Areas	Measurement	Equity analysis
Can I walk there?	Traversability	Street audits	Age and disability. Occupation and family roles (carried items)
	Proximity	Walk score Land-use mix # of destinations Access to daily needs	Person-specific destinations. Average velocity and physical needs.
Should I walk there?	Physical Safety	Crime rates Accident rates Street audits	Special needs for toddlers, children, older people and those who experience disabilities.
	Psychological Safety	Perceived safety	Cultural relationship to walking. Inclusive spaces. Full equity analysis related to sense of belonging and well-being (Example: Child Impact Assessment; women's safety audits)
	Enjoyment	Leisure vs. Transport walking	
Will I walk there?	Car usage prevention	Costs associated with owning and operating a car Environmental and health consciousness	Age and its relationship with travel mode. Family roles and car usage Generational effect of climate awareness. Income-specific options for mobility Disability.
	Travel mode shifting strategies	Percentage of people using more than one travel mode. Travel mode over time	Accommodation in public transit for all pedestrians. Group-specific shifting strategies.

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