Community Case Report

Inequalities in travel time, cost, risk as cause of persistent social and health inequalities

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Abstract

Background: inequalities in travel time, travel cost, and travel risk (ITTRC) can consistently affect access to primary care and social services for disadvantaged and marginalized patients. At the same time, the most disadvantaged patients may face the highest travel time, travel cost, and travel risk due to pre-existing disability, poverty, or other intersectional marginalization.

Case Report: to study ITTRC as a confounder which reinforces social and health inequalities, key-informants in the World Health Organization Healthy Cities program, Age-Friendly Cities program, and global EcoCities research initiatives (n=5) were engaged to validate a city planning model towards minimizing ITTRC. A case review of Vancouver, Canada, shows developments which help minimize ITTRC have increased over the last decade, but are not financially-accessible for disadvantaged and marginalized patients.

Conclusion: ITTRC can be reduced through city planning, but underlying classism and capitalism must be acknowledged and addressed towards equitable physical access to life opportunities.

Keywords: City Planning; Diversity, Equity, Inclusion; Health Inequalities; Health Services Accessibility; Transportation of Patients.

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Introduction

The World Health Organization's framework on Social Determinants of Health, initially starting with research on hierarchy and autonomy in work settings (1), have quickly expanded to include evidence on an income-gradient in health (2) as well as increasing recognition of a multitude of social factors that lead to inequitable health outcomes (3). In the original 2005 volume by Marmot and Wilkinson, a chapter is dedicated to transport and health, noting specifically the impacts of transportation on heart disease, mental health, respiratory disease, and vehicular accidents (4). With this expanded acknowledgement of social determinants, growing research suggests a linkage between travel and transportation as factors impacting health at a population level. A review of 114 international policy documents published between 2011 and 2013 illustrated that the concept of urban livability (5) has significant overlaps with the social determinants of health framework. Despite these overlaps between urban transportation research and health, there is a lack of interventions to tackle inequitable travel time, risk, and cost, (hereon noted as ITTRC) as social determinants of health. In 2013, a systematic review on access to health care identified 61 studies, and provided a direct

link between transportation barriers and "rescheduled or missed appointments, delayed care, and missed or delayed medication use…poorer management of chronic illness and thus poorer health outcomes" (6). Seven years later, another systematic review conducted on transportation interventions to improve equitable access to health care identified only eight studies that met inclusion criteria, due to "most [studies being] rated as low quality" (7). This research gap suggests that while the overlap between transportation and health has led to significant multidisciplinary scholarship, the actual act of reducing travel time, travel risk, and travel cost is yet to be documented by the literature at a comparable level.

ITTRC Impacts on Daily Life

Most notably, inequitable travel time, risk, and cost (ITTRC) does not simply impact physical access to healthcare, but also access to various opportunities and resources linked to the social determinants of health. As an example, access to education is noted in the literature to be impacted by travel cost (8); additionally, availability of schools alone has not guaranteed equitable access to education for highly-disadvantaged families (9,10). The resulting impact is that akin to the income gradient in health, an education gradient in health has also been observed in the literature (11). This education gradient can create a cyclical compounding in which poor health leads to poor access to education, which in turn leads to poverty to exacerbate illness (12). Beyond education, access to employment is also affected by ITTRC (13). ITTRC plays a role in determining length of unemployment as well as level of wages (14). Job accessibility as an outcome of transportation equalities is considered to be a "crucial social equity indicator" (15). Transportation and car-ownership are important factors which can lead to job-education mismatch in which individuals are forced to accept lower-paying positions (16). Entire neighborhoods can be described as "job poor" (17), causing individuals to face higher levels of ITTRC in search of adequate employment. Research also suggests that job-access can be severely impacted by travel concerns, to the point that ITTRC overrides racial disparities in well-known racialized communities (18).

As ITTRC impacts access to a diverse gamut of services, opportunities, and amenities, research on ITTRC can be fragmented. Unlike education and employment as concepts falling within clean disciplinary boundaries, social services and amenities research in relation to ITTRC is not only fragmented by sub-themes but also by geographic locations. Still, a vast number of studies can be found to demonstrate the collective impacts of ITTRC. As an example, access to childcare (19) is noted to be affected by ITTRC, and reliable access to childcare is also noted as an essential component of sustainable employment for mothers. Access to childcare is therefore also a strong predictor of gender-based equality in employment, suggesting the gendered impacts of ITTRC (20). Another aspect of access to resources with a notable body of research is access to healthy foods. Affordability of food is compounded by driving time and driving costs (21), and a number of studies have identified "food deserts" as causes of population-level obesity and cardiovascular disease (22).

Beyond access to education, employment, childcare, and food, ITTRC also impacts access to human-connection. Access to a supportive network of friends and family, either when an individual needs informal care or simply socializing can strongly impact both mental and physical health (23,24). ITTRC thus can play a significant role in leading to social isolation or social exclusion, with studies linking "transport disadvantage" to lack of wellbeing (25–27). In turn, having mobility to overcome ITTRC is studied as an economic asset in

existing scholarship (28). With regards to specific subpopulations who already experience greater health needs – like people living with disabilities – ITTRC and resulting social exclusion can be exacerbated by existing illness (29). Although access to informal supports (ie. visiting a friend) can be difficult to quantify in empirical research, the impact of loneliness is nonetheless tied to all-cause mortality in existing studies (30–32).

Significant attention and funding on the linkage between health and transportation has been centered on active transportation (33), which aims to promote walking and cycling as transport-based physical activity. The act of making cities more walkable and cyclable may help to reduce ITTRC; however, without changes in the built environment, behavior-based interventions aiming to promote walking and cycling can marginalize high-needs populations such as seniors; individuals living with existing chronic health conditions; people living with disabilities; and young children without family capital. As a result, ITTRC remains an under-investigated topic which may lead to persisting health inequalities due to its intersections with gender, race, income, age, and existing illness.

Case Report

To demonstrate the layered impacts of ITTRC, qualitative data collected by a non-profit serving people living with disabilities is presented below. All identifying details are anonymized following a composite case study approach (34). The geographic context of the study is a North American municipality without notable poverty nor notable incidence of illness. The municipality is part of a larger metropolitan region with a well-established public transportation system. Natural geography involves a non-coastal waterfront, and associated changes in elevation throughout the region.

Case Report 1. Individual is a man who has survived a childhood health condition resulting in multiple amputations. Due to this physical condition, he relies on an electric wheelchair for daily mobility needs. He could not have access to high school and postsecondary education until later in his life when online education became increasingly formalized. Through his dedication to integrate himself into society, the man secures his first employment as an intern in his mid-thirties. He relies exclusively on public transit and his electric wheelchair to travel to work as he has limited ability to drive. One day, on his trip home from his internship, the battery in his electric wheelchair dies and the electric wheelchair comes to a full stop on a sloped road. He is strapped in his electric wheelchair through safety belts, and tumbles down the street completely strapped in. This incident causes significant blunt-force trauma to his head, as well as injuries to two other pedestrians. Wishing not to lose his employment, the man puts in tremendous effort to recover from the head injury. Although the incident leaves permanent blindness in his right eye, the man is allowed to leave the hospital after eight days. He leaves the hospital but realizes that damages to his electric wheelchair will prevent him accessing work according to his contract. The local government funding scheme which provides a wheelchair replacement every eight years refuses his request for a new chair in year three. The man ends up losing his internship and is unable to obtain a letter of reference for future employment.

Case Report 2. Individual is a single-father who has a son four years of age and a daughter five years of age. Both children live with a visible health condition that subjects them to harassment from other children. The mother has left the family due to significant financial stress of the children's health conditions. The father has access to well-paying employment and is dedicated to not surrendering his two children to the foster care system. During work hours, his two children are placed in the same daycare. The daycare is willing to

manage the children's special health needs but only through a special arrangement. The father is required to arrive at the daycare within fifteen minutes of receiving a call – when the daycare workers are unable to provide adequate health-related support, or, unable to protect the children from bullying. The father meets these conditions, even though this occasionally involves driving over the speed limit to reach the daycare center. During one of his trips, the man is involved in a minor vehicle collision which results in his license being revoked. After the incident, he is no longer able to meet the demands of the daycare as public transit does not grant fifteen-minute access. As he fails to find another daycare center willing to accommodate the health needs of his children, he resigns from his job to a lower-paying position near the daycare center. After switching to the new job, he is eventually fired by his employer for leaving the job to rush to the daycare center every other week.

Case Report 3. The non-profit begins to target poverty-reduction in an attempt to address health inequalities. A successful output of these efforts is the development of free therapy programs, delivered through partnerships with medical professors interested in providing their students with internship opportunities. After the establishment of the cost-free therapy program - intended to benefit young children early in their lives to avoid costly health procedures in later years - many families access the program with positive results. After a year into the program, it slowly becomes evident that the same cohort of families were accessing the free program. More importantly, every single family accessing the free therapy had notable income (ie. with combined incomes of over 90,000 US dollars). This was a piece of evidence that the non-profit chooses to avoid discussing at first due to the private nature of personal earnings. Eventually, the non-profit prepares to engage in analysis of why families in poverty did not access free therapy. Preliminary qualitative results show that while accessing the therapy was free, travel was not. The families with the highest needs experienced numerous barriers related to travel time, travel risk, and travel cost. For example, families who could not afford to live in the city needed to drive over two hours to access the free program. Families whose children with more severe disabilities could not take advantage of regular public transportation, and needed to book costly wheelchair-accessible vehicles from the local transit authority. Most importantly, a parent or guardian would need to take the child to the program, which meant at least two hours of lost employment as opportunity cost. This was a significant barrier for families with a single-parent, or, families in which both parents needed to work - potentially multiple jobs - in order to cover all health and living expenses of the children. In summary, families with the most severe disabilities, the lowest-incomes, and the greatest combination of intersectional marginalizations also had to face the highest travel time, travel risk, and travel cost – ultimately allowing the free therapy program to exclusively benefit more privileged families.

ITTRC Impacts on Validity of Research

After Case 3, the non-profit became aware that intentional strategies to address (ITTRC) are critical to ensuring equality in health outcomes. The first step taken was to research the capacity of the non-profit in providing its own wheelchair-accessible van-service – so the highest-needs families can access free therapy. The concept of social entrepreneurship was explored, in which a sliding scale would charge a fee for higher-income families, and generate revenue that helps cover costs for highest-needs families. Additionally, the hiring of a driver was strategized to provide potential employment for families facing financial barriers. Research was also deemed to be necessary to ensure sustainability of the accessible-van program. The program would need to be

used at a sufficient frequency to cover initial capital investment of a wheelchair-accessible vehicle. Scheduling was another significant challenge, as with only one vehicle, families could not logistically arrive at the same time. All group-based services and programs had to be restructured. A participatory action research approach was employed to answer key questions such as who can operate the vehicle (ie. it would not be financially-feasible to hire an individual on full-time standby); who can access the transportation-service and at what times; and how a schedule can be optimized to ensure that the wheelchair-accessible van can create tangible benefits for high-needs families.

Unfortunately, in parallel to the situation of inequitable access to the free therapy program, only highest-income families expressed interest in research participation. Online engagement of families in severe poverty was attempted, but did not grant these families the same level of power and the access-to-discourse that high-income families had. Gathering all families together for a collaborative discussion was seen as a worthwhile goal to enhance robustness of the participatory research project, and funding was sought to cover the travel expenses of high-needs families. Funding bodies were contacted to cover the travel expenses for families with insufficient resources to overcome travel time, travel cost, and travel risk. All funders were willing to consider travel expenses for researchers only - especially for conference-related travel - but in-project travel expenses for participants were deemed out of scope. As a result, the participatory action research project failed to reflect the unique circumstances and perspectives of the highest-needs families.

Totality of ITTRC Impacts

In combination, these case studies illustrate that ITTRC can create a multitude of unexpected impacts at a personal level. Addressing ITTRC as a whole is challenging, but necessary given how ITTRC impacts both organizations and individuals to severely reinforce existing inequalities. From the perspective of health and social service organizations, ITTRC is a consistent barrier that can impact the entire service planning and delivery process. For families, ITTRC can affect equitable access to a multitude of opportunities, including employment, education and training, health care, governmental services, social networking, as well as appropriate food and other amenities needed to support a healthy lifestyle. ITTRC discriminates against families through the fact that the highest-needs families tend to bear the highest travel time (eg. due to inability to live in the urban center); highest travel risks (eg. due to lack of health or physical capacity to protect oneself from weather, potential crime, and other risk factors); as well as highest travel costs (eg. requiring specialized vehicles for wheelchairs as opposed to general public transit). ITTRC also leads to opportunity costs for lost employment hours, which can be significant barriers for families struggling to pay health-related bills. Without intentional strategizing, ITTRC leads to greater inequalities after successful delivery of physical services and programs, as these will tend to benefit the most privileged families who have capacity to overcome travel time, risk, and cost required for access. There is a lack of research targeted at understanding the collective, day-to-day impacts of ITTRC that a high-needs family accumulates over their entire life course. With regards to conducting research to overcome ITTRC, the case study also suggests that equitable research participation can be hindered by ITTRC, allowing privileged families to easily dominate the research discourse.

Urban Solutions to Reduce ITTRC

Reduction of ITTRC is often associated with the concept of universal design for disability-access. However, two key gaps

remain: first, universal design principles have not resulted in significant built environment changes at the urban or city-level, but rather emphasize architectural, building-level interventions (35) such as wheelchair ramps (36). An international review of best practices in universal design produced a list of disability-specific modifications to buildings (37); these interventions are much needed, but cannot be expected to address the macro-level barriers of time, risk and cost arising from a commute. Secondly, societal discourse on universal design often is limited to asking the question of whether a location is wheel-chair-accessible. The concept of ITTRC highlights scenarios in which a family needing to access a specific location - even after universal design has made it accessible - cannot logistically perform the commute due to time, risk, and/or cost. It is worth noting that this behavior of not accessing the location should not be considered as a choice, but rather, a forced situation when ITTRC cannot be overcome.

While attempting to equalize travel time, risk, and/or cost across the population may be futile, it is possible to consider influencing ITTRC via a single macro leverage point: minimizing travel distance. Travel time, risk, and cost can at first appear to be disparate, fragmented issues that pose unique challenges to different subpopulations and geographic locations of interest – but all three are intrinsically tied to overall travel distance. Towards the reduction or minimization of travel distance, a number of urban planning principles can be applied. Most importantly, these principles often overlap with existing urban policy initiatives, particularly with the rapidly-growing sustainable city initiatives co-led by UN-HABITAT and UNEP (38) and its relevant counterparts such as green cities (39), eco-cities (40), and smart cities (41). Three specific principles towards sustainable city planning are discussed below, to illustrate a concrete example of an urban model which minimizes ITTRC (see Figure 1).

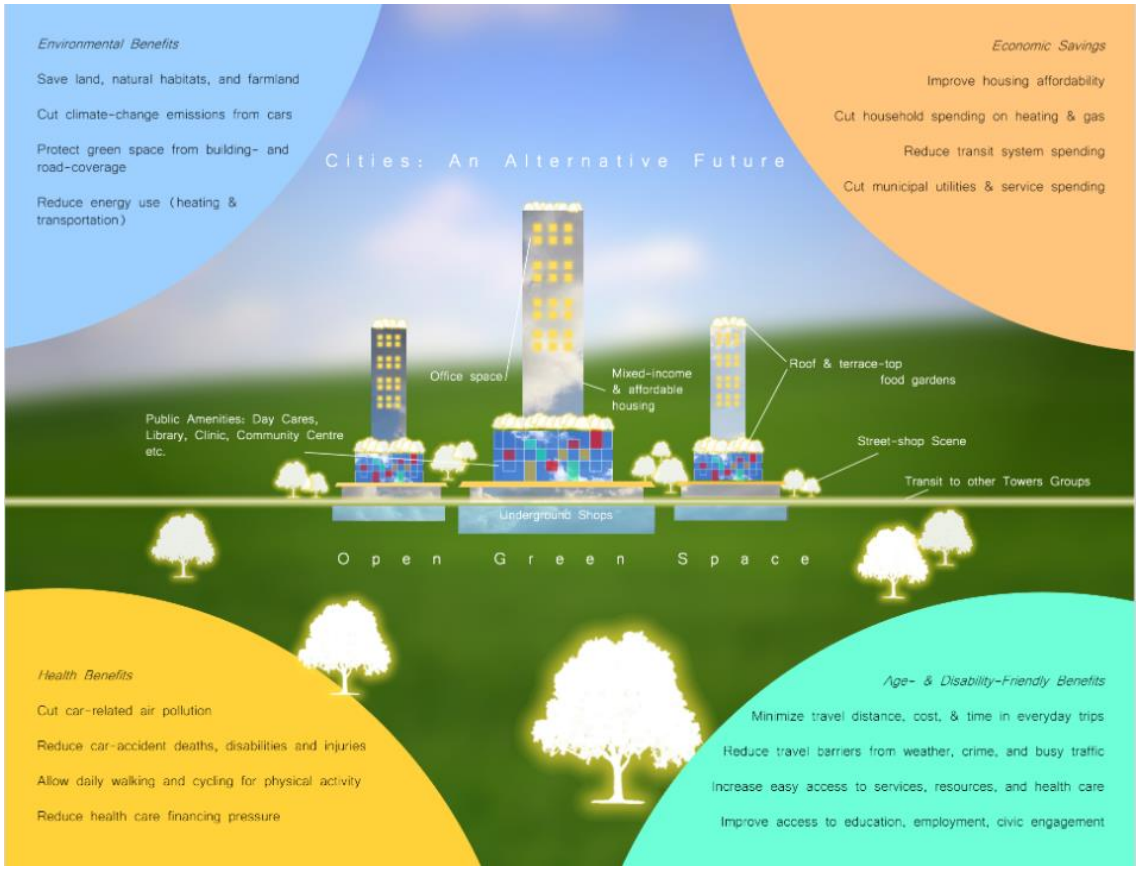

Figure 1. Urban Planning Model for Minimization of ITTRC

Vertical City (42). Developed primarily as a response to growing urban populations, the vertical city concept uses the skyscraper model to provide housing within limited land resources. More importantly, the vertical city attempts to integrate various elements of the city within the same building structure. In other words, beyond residential units, different floors of the skyscraper could be dedicated towards business and commercial offices offering both services and employment opportunities, as well as the integration of public amenities such as health clinics, libraries, daycares, among others. Modern building technology has advanced to accommodate even farms and other agricultural spaces within a vertical city design (43). Although access to a farm within the same building is arguably not relevant to reducing ITTRC for highest-needs families, the significance of integrating agricultural space within a vertical city is that significant land outside of the footprint of the building can be left untouched by human activity, thus preserving natural habitats and minimizing ecosystem disruption. The critical implication of a vertical city as a design principle is that the elevator, in combination with walking indoors, grants a degree of access to essential services and employment opportunities as a safety net. The purpose of this is not to trap individuals within a skyscraper building, but rather, drastically reduce travel distance, which in turns helps to reduce travel time, travel risk, and travel cost associated with urban sprawl (44). The vertical city can paradoxically increase access to green space due to either the installment of indoor parks (45), or, through massively preserving greenspace around the skyscraper due to compacting the city footprint (46).

Mixed-Use Development (47–49). As a design principle, mixed-use development can be as simple as a conjunction of residences with a cafe (50) at the ground floor, or, a more comprehensive integration of different urban locations within walking distance. The vertical city in itself can be considered a form of intense mixed-use development, and this intensity can raise concerns surrounding feasibility and quality-of-life. Firstly, it should be noted that not all urban locations need to be compacted into a singular building. Multiple vertical-cities can be combined within walking-distance in a cluster, thus reducing the need for excess height of vertical cities. Secondly, mixed-use principles can be selectively applied, as there is limited rationale in forcefully integrating elements such as warehouses and light industrial zones into every single vertical-city structure. In other words, refined and intentional application of mixed-use development principles can help minimize ITTRC while reducing quality-of-life and feasibility concerns. The expansion of singular vertical-city buildings into integrated, mixed-use communities of diverse vertical-city buildings can further provide space for public plazas, town squares (52), or urban gardens to benefit public health (53).

Transit-oriented development (54–56). Positioning vertical cities into small, mixed-use clusters or communities may create an undesirable sense of crowding. To address overcrowding, these communities can be positioned with ample greenspace in between, and connected by public transportation such as light rail (57). Use of underground subways or elevated transit lines (58) may also be considered to reduce impacts on the natural ecosystem and greenspace. Strategizing mixed-use, vertical-city development along existing or proposed transportation nodes can help grant highly-disadvantaged families access to public transit - which, in the European context, is mobilized to provide access even beyond national borders (59). Within the concept of transit-oriented development, one key principle stands to improve both feasibility and social equality: value capture (60). Development of public transportation stations or nodes-of-connection will inevitably lead to increase in surrounding

land value. In many cases, private owners, or even private investors are the sole beneficiaries of this increase. Value capture proposes that governments can elect to purchase land in direct vicinity of future transit stations for development, resale, and reinvestment of subsequent revenue into public projects. With regards to the development of vertical cities to minimize ITTRC, value capture can significantly improve financial feasibility of projects in low-resource settings (61).

Key-informant Interview validation

Beyond these three principles, a number of urban initiatives in the literature may also contribute to the goal of minimizing impacts of ITTRC on health and social inequalities. Existing scholarship documents movements such as: car-free cities (62), new urbanism (63), garden cities (64), complete communities (65), smart cities (66), livable cities (67), and 15-minute cities (68) among others. Each of these urban initiatives can be applied with varying intensities and in combination, resulting in a wide spectrum of designs that raise the critical question of what defines valid eco-city planning.

To tackle validity, the three key principles identified: vertical city, mixed-use development, and transit-oriented development were combined into a single model (see Figure 1). After receiving ethics approval from the University of Manitoba, Canada, a qualitative (69) pilot was initiated with the objective of investigating validity through key-informant interviews (n=5). Key informants served in policy or research roles related to sustainable cities, the World Health Organization Healthy Cities Program (70), or the World Health Organization Age-Friendly Cities Program (71). Convenience and snowball sampling were employed, ensuring that all three policy initiatives are represented in the final sample. Interviews were conducted over online audio connections due to global spread of the key informants, and followed a semi-structured schedule (72). Data was recorded and transcribed for open coding (73) and subsequent analysis, with the overarching objective of validating an urban model which minimizes ITTRC.

Results

Key-informants described specific concerns which could be addressed towards greater validity. Firstly, achieving structural-stability of vertical towers was noted to be a resource-intensive process which requires assessing the costs throughout the construction process. This remains the most significant financial barrier to the model. Secondly, glass-curtain design of modern skyscrapers is noted to require higher energy for heating in cold climates, unless triple-pane glass is utilized. An alternative is active incorporation of greenery in the building facade through balconies and vertical gardens, which helps to moderate energy and heat transfer.

Another major concern was focused on the impacts of interior architecture. For example, key-informants noted that the indoor walking environment should be well-lit and well-populated - yet without overcrowding - to ensure a safe traveling environment. In other words, the application of the three key design principles can serve to reduce ITTRC at the macro-level, but micro-level considerations with regards to the interior travel environment should also be taken into consideration for future research.

Beyond these concerns, key-informants provided comments on the positive aspects of the model. Most significantly, key-informants suggest that there are already a number of successful developments in South America and Asia which are similar to the model. This may be due to higher population densities, which in turn allows municipalities to rationalize compact urban designs. Overall, key-informants unanimously agreed that the model is neither too aggressive nor unfeasible when an international lens is applied.

One specific European case was highlighted by a key-informant to discuss financial feasibility as a political construct. The European municipality named stands in stark contrast to North American cases as over half of its population lived in housing provided by the government. Social housing was not conceptualized as housing of the poor, but as default housing available to everyone as a safety net. Individuals interested in a greater choice of housing options can elect to access housing from private developers, but are not barred from accessing basic housing that the government considers a human right. Within this political model of urban development, the government is actively financing housing projects which share massive similarities with the model proposed in Figure 1. Public amenities, health services, and social services are intentionally combined with residential units as there is limited rationale to purchase additional, separate land. In essence, the fact that most governments already need to purchase land and develop health- and social-amenities means that residential units can be added on vertically without serious financial barriers. Financial feasibility, therefore, is a notion linked to a government's interest in supporting a private market of development. With regards to accurately assessing financial feasibility, key-informants also emphasized the hidden costs of urban sprawl. As residents are forced to drive through expansive road networks in a low-density, disconnected urban development model, governments face immense road construction and maintenance costs. These costs are also linked to government spendings dedicated to addressing air pollution and greenhouse gas emissions due to sprawling travel distances.

In relation to car-dependency, a key-informant pointed out the importance of the model in completely excluding parking space. It was noted that co-developing a model with car-oriented policies inevitably leads to crowded "concrete jungles" in which communities are surrounded by tall towers and persistent traffic congestion. The concrete-jungle development was described as key historical context which led to population-level preference for urban sprawl as the alternative. Developing residences far away from congested tower-clusters appeared to improve quality-of-life, but over time, more travel time, risk, and cost needed to be committed in order to facilitate everyday access. These sentiments were echoed by another key-informant, who stressed that cities should not demand car-ownership from its citizens if long-term equality is to be achieved.

Urban sprawl is noted to generate not just higher costs for citizens, but also for municipalities. A key-informant raised the example of various rural municipalities struggling with massive infrastructure costs just to maintain everyday transport for residents. This struggle is also exacerbated over time due to social processes such as population-aging: as working-age families are pressured into seeking better economic opportunities in urban centers, rural ageing forces municipalities to address ITTRC for senior residents – a challenging task given the sprawling, low-density nature of most rural settings. Key-informants described that the proposed urban model should therefore not be viewed as "progressive", but simply "cognizant" of emerging social issues.

With regards to accessibility for seniors, key-informants discussed how reducing ITTRC can benefit both mobility of seniors and mobility of potential visitors and caregivers. In relation to reduction of social isolation, mixed-use principles in general can allow seniors to feel more integrated with their communities. As a specific example, the integration of senior centers with daycares for children is described to bring positive health impacts for seniors. Supported by scholarly evidence (74), key-informant responses suggest that what appears to be an urban design reducing

ITTRC can also lead to positive health outcomes in itself.

Lastly, key-informants discussed the concept of housing affordability, which is noted to be strongly linked to transportation-affordability. A common issue with the model in Figure 1 is that it can be priced as a luxury apartment, leading to classist gentrification. However, key-informants suggested that price is not a function of the physical form of housing - but supply and demand. In other words, the higher pricing of the proposed model is not necessarily due to higher construction costs; instead, the fact that developments represented by the proposed model can be overpriced indicates high demand arising from lack of similar developments on the market. To address the issue of affordability, similar developments should not be prohibited but actively encouraged, which in turn increases market supply to stabilize prices in a capitalist economy. As evidence, key-informants pointed to many highly-populated Asian cities in which apartment housing is the norm, while single-floor housing is instead the unaffordable luxury. Beyond discussions on supply and demand, housing affordability was also described as inseparable from convenience of location. Location, as a prime indicator of real estate value, can essentially be reconfigured through the proposed model. In other words, what defines a "convenient location" to warrant higher real estate prices can be rewritten, if governments actively choose to employ existing design strategies that can equalize convenience across urban locations.

Discussion

The following sections outline ITTRC considerations of a theoretical nature, organized into key themes emerging in the literature.

Oil/Petroleum/Fuel Prices. ITTRC will likely increase over time due to depletion of oil as a finite resource. In multiple countries, the price of oil has been researched as a factor directly influencing poverty (75–79). As poverty is linked to poor health outcomes (80), rising oil prices can further exacerbate poverty via ITTRC as a mechanism. Financial cost may be cited as the reason why society cannot develop towards an urban model that minimizes ITTRC. However, cost-benefit analysis should consider the financial burden of oil across the population. There exist additional societal- level concerns of oil, as household transportation does not constitute the entirety of demand. Transportation of goods to maintain economic activity can be impacted by rising oil prices, leading to significant population-level changes related to employment, income, and poverty. As a specific example, access to food has been noted as a growing health challenge in midst of rising oil prices (82). In summary, decreasing society's demand on oil from household transportation can help maintain sufficient oil for transport of goods in the economy, including goods required in the healthcare system. This decrease in oil used in household transportation, arguably, is already happening, but is primarily forced upon the poor to great detriment.

Synergies with Health Objectives. Revisiting the World Health Organization's early social determinants of health framework on transportation and health (4), an urban model that reduces ITTRC will inevitably also lead to other health benefits. The most direct connection is the reduction of air pollution (83) through minimizing the need for car-travel at a population level. As air pollution is linked to respiratory illness (84), cardiovascular illness (85), and all-cause mortality (86), reduction of air-pollution through minimizing ITTRC can generate considerable public health benefit. For individuals choosing to employ healthy transportation methods such as walking and cycling, existing literature suggests that these choices can in fact lead to poorer health due to air-pollution exposure (87).

Obesity and cardiovascular disease have been heavily studied in relation to healthy urban form. Existing research on active transportation has linked walking and cycling to multiple positive health outcomes (33,88–90), and the massive economic cost of obesity (91,92) justifies built-environment interventions in addition to diet-based health promotion. During walking or cycling, an urban model that minimizes ITTRC can become ever important. In addition to helping reduce exposure to air pollution, consistent noise pollution from traffic can have multiple impacts on health of vulnerable populations (93). Additionally, for certain age-groups, vehicular-related accidents constitute the leading cause of death or lifelong disability (94). An urban planning model which simply promotes walking and cycling without considering car-free design, as noted during the key-informant interviews, can result in additional health risks. Employing a model to minimize ITTRC can effectively replace car-travel with a combination of elevator-access, indoor-walking, and public transportation, which in turn creates a safe environment for daily physical activity. Beyond noise-pollution, air-pollution, and traffic-accidents, mental health is also linked to urban form via accessibility of green space and nature (95,96). Active transportation by walking or cycling to school or work can facilitate this access to green space - if the urban street environment is not dominated by car-traffic.

Lastly, in relation to green space and oil, climate change and its impacts on health can also be mitigated through urban planning. Green space can reduce the urban heat island effect (97), which in turn can help reduce impacts from severe heat dome incidents (98). Reducing transport-related emissions to prevent serious climate change impacts on health has been a heavily-debated topic. Even without in-depth discussion of all the existing health-related evidence on climate change, precautionary reduction of climate-disasters such as flooding (99) will contribute to financial sustainability of health care systems. Additionally, while “global warming” has been conceptualized as a distant risk in the future, extreme heat events have already become increasingly fatal - especially for vulnerable populations such as seniors (100).

These concerns do not represent all potential health benefits from the World Health Organization’s conceptualization of healthy city planning. Through improving environmental sustainability, additional health benefits may be generated at the population level due to the interconnectedness of human beings with the natural ecosystem. Initiatives like EcoHealth and One Health (101) highlight the indirect benefits to public health when environmental sustainability is prioritized by society. In combination, the health impacts of an urban model intending to minimize ITTRC can be diverse, and are currently captured in various bodies of multidisciplinary literature.

This diversity, however, has not always been beneficial to the advancement of urban developments which minimize ITTRC. The reality is that any of these aforementioned synergies can potentially overshadow ITTRC as a legitimate concern: for example, emphasis on active transportation can lead to construction of bike lanes, which do not reduce everyday travel time, cost, nor risk for people living with disabilities. Reduction of ITTRC requires a significant degree of re-orienting the urban planning process, and this reorientation does not always serve to maximize the profits of the real estate nor automobile industries (102). The multitude of synergistic health impacts which are easier to accomplish as low-hanging fruit can create a sense of success which decreases the perceived need to reduce ITTRC. As a result, ITTRC remains as a significant determinant of health for highly-disadvantaged individuals who already experience chronic health conditions and/or

disabilities. The fact that ITTRC is multifaceted by nature leads to multiple action-items that can benefit the upper-middle classes, while the most marginalized populations continue to struggle with things as simple as everyday commutes.

Feasibility. Development of an urban model to minimize ITTRC can easily be seen as utopian, financially-unfeasible, or even undesirable for buyers in a housing market. These concerns are not unique to urban models which minimize ITTRC, but rather, public discourse on sustainable cities, healthy cities, and age-friendly cities have historically generated resistance from the private sector and some members of the general public.

Here, it is useful to apply a case study of Vancouver as a city with sufficient peer-reviewed literature on relevant issues. Vancouver is unique in its positionality towards urban initiatives: it has simultaneously self-initiated policy efforts to become "the greenest city on earth" (103) while also being the center of notable health inequality (104) - and one of the most inequitable neighborhoods in the nation (105). This disparity is not due to Vancouver prioritizing environmental sustainability over health-equity policies. Contrarily, Vancouver has also officially adopted the healthy city initiative (106), and has been a collaborating city with the World Health Organization in the age-friendly city movement (107). Amidst all the official support for new modes of urban development, Vancouver has paradoxically resisted changes to its urban environment in the lens of preventing gentrification (108).

Existing policy and research documents from Vancouver may suggest many reasons why an urban model minimizing ITTRC is too utopian, financially-unfeasible, or undesirable. However, these scholarly and political concerns are not reflected by on-the-ground reality of Vancouver's actual housing market. Over the past decade in the Greater Vancouver Regional District, models which reduce ITTRC have been developed, including models which explicitly integrate the three principles of vertical city, mixed-use development, and transit-oriented development. As one example, the Surrey City Centre development combines a major public transit station, residences, municipal services, a shopping center, and multiple employment opportunities in the form of government offices within the same interconnected structure (109). Likewise, the Metrotown regional town center (110) and Lougheed Town Centre neighborhood (111) also combine the exact same functions around a major public transit station to ensure commute-convenience for its residents. Among existing developments like the Woodwards Building and Brentwood Town Centre, new developments such as Vancouver-Oakridge (112) and Broadway Centre (113) are also being constructed towards the same level of ITTRC reduction.

The first implication of these developments is that urban models which minimize ITTRC are financially feasible to construct. Public-private financing is capable of producing vertical cities in which indoor walking allows a basic level of access to essential services. Moreover, via integration with a public transit station, these vertical cities are also all linked to one another to facilitate even greater access-to-the-city for highly-disadvantaged families. The concerns that urban development to minimize ITTRC would be undesirable is also assuaged by the fact that many of Vancouver's vertical cities have experienced massive increases in real estate value.

Secondly, developing an urban model to minimize ITTRC does not require significant changes nor intense demolition to the existing city. By nature, vertical-city design principles lead to a small building footprint, which allows almost all existing public transit stations to be vertically extended towards providing residential and

commercial space. The model proposed in Figure 1 can therefore be easily mapped onto existing urban structures, and can generate financial savings for development projects since no additional land needs to be purchased. As a notable deviation from Figure 1, not all cities will have the level of greenspace depicted in the figure, but this lack of greenspace does not defeat the purpose of minimizing ITTRC. Greenspace can also be slowly re-developed over time (46,114), or reclaimed once the necessity of car-travel declines (115).

Arising from literature on gentrification, developments which minimize ITTRC has faced criticism for displacing and evicting original residents who can no longer afford to live in original locations. Regarding this concern, it is useful to apply data gathered from the key-informant interviews. Gentrification does not necessarily happen because of new urban planning, but rather from insufficient levels of new urban planning. Urban developments which minimize ITTRC can be easily be utilized by the upper-middle class for everyday convenience, thus driving up demand and real estate prices. This in turn displaces lower-income families, which suggests that the population-level demand is much higher in comparison to existing supply. Without increasing the supply of urban developments that minimize ITTRC, displacement will only continue to happen within in capitalist economy. Therefore, increasing the supply of such developments should not be inhibited by the label of gentrification – if equality and housing-affordability are actual concerns.

Capitalism and Classism. Displacement and gentrification illustrate a critical challenge with urban developments that minimize ITTRC: after successful development, highest-needs families whose health hinges upon equitable access are often financially-excluded. Minimization of ITTRC is not impossible through intentional urban planning, but rather, it has already been achieved - for those who can afford it. High-needs families who would benefit the most from these urban models are not prioritized in a free real estate market. As a result, the act of minimizing ITTRC becomes trivialized as merely providing convenience for the upper-middle class, which inevitably undermines discourse on tackling ITTRC via urban development.

The real estate market in Vancouver experienced a massive surge in prices all across the board. In other words, models which minimize ITTRC were not the only types of development which resulted in pricing-out, evictions, or displacement of higher-needs families. The general increase in real estate prices served regardless as context for sellers to up the price of urban developments which minimize ITTRC, effectively eliminating the potential of these models to assist those in need. For years, increase in real estate prices was linked to increased immigration in Vancouver (116–118), and it is only recently that more evidence has emerged regarding other capitalistic factors such as money laundering as documented by local government (119).

Profit and capitalism are often censored in scholarly research (120), and thus are given space to persist and create "wicked problems" with no apparent solutions (121). On the other hand, existing research also positions global capitalism as a determinant of health (122). In order to address capitalism as a determinant of health, capitalism should not be excluded but targeted in health research. In relation to capitalist influence over urban development, eviction and displacement of highly-disadvantaged families are worthy concerns, yet these concerns may only emerge when urban development which minimize ITTRC infringe upon automobile, oil, and other corporate profits. This phenomenon suggests rationale in universal, widespread urban development to minimize ITTRC across an entire region: if all urban locations have been re-oriented

to provide reduced levels of travel time, travel risk, and travel cost, wherever highly-disadvantaged families become displaced to would still present a safety net in terms of access to health care, employment, life opportunities, and essential services.

Here it is useful to consider classism and privilege as causes for ITTRC, as retrospective analysis shows that society often leans towards moderate interventions. Applying urban development to minimize ITTRC at a regional level will strongly benefit quality-of-life and health outcomes of displaced families; yet, this action seems unnecessary when there are already existing victories in cycling infrastructure or other sustainability solutions like car-share and electric vehicles. These perspectives effectively eliminate representation of high-needs families who cannot cycle due to a disability, or, cannot operate a regular vehicle that has not been modified for wheelchair access. The perspectives of the privileged class continue to influence public discourse to reposition ITTRC as not a fundamental, everyday issue, but an overly-radical or progressive issue. Privilege is also present in discourse criticizing urban developments that minimize ITTRC because of reduced opportunities to drive or cycle. Replacing driving and cycling with a combination of elevator-access, indoor walking, and public transportation is worded as a violation of personal freedoms. The reality is that a model which minimizes ITTRC can still accommodate space for recreational cycling and car-maneuvering. The creation of vertical-cities in transit-oriented, mixed-use clusters does not eliminate all prospects of cycling or driving; in fact, minimizing travel distance inherently leads to minimized land use, which results in more land that can be used to accommodate recreational cycling and car-maneuvering. However, classist discourse protects cyclists and drivers from becoming a population which needs to be "accommodated" by society. The direct result is that highest-needs families and individuals – seniors, people living with disabilities and chronic health conditions, and families living with intersectional marginalization from race, gender, and income – are confined as the population that mainstream society needs to accommodate instead. Accommodating the recreational needs of drivers and cyclists through an urban model minimizing ITTRC is much more easily-accomplished, especially when compared to the immense challenge of accommodating all transportation barriers of highest-needs families within the existing urban structure. If indeed the latter is easier to accommodate than the former, the time to accommodate transportation needs of highest-needs families is now.

Conclusion

ITTRC, in combination, affects daily access to health care, employment, essential services, food, social participation, and a range of other opportunities that are not accessible through an online or virtual environment. ITTRC also affects interventions intended to decrease health inequalities, as travel time, cost, and risk can naturally select privileged individuals as the only recipients who can access these interventions and their benefits. By consistently benefiting the privileged, existing health and social interventions may result in greater health-equity gaps within the population. Additionally, ITTRC impacts equitable participation in research, suggesting that the existing research discourse may be largely driven by privileged voices.

Minimizing ITTRC at the individual or familial level can require a multitude of highly-specific, personalized, and multi-faceted interventions as demonstrated by the three case studies. Contrarily, addressing ITTRC through urban development can create a universal solution at the population level through strategic minimization of travel distances. This reduction of ITTRC aligns with existing global policy initiatives such as the WHO

Healthy Cities Program, WHO Age-Friendly Cities Program, and the UNEP-UN HABITAT Sustainable Cities Program. The alignment is beyond policy and theory, as multiple on-the-ground developments have been established in the past decade to manifest the reduction of ITTRC.

Despite these successful developments, capitalist and classist influences do not allow highest-needs families to access these developments due to pricing and a tragic lack of supply. Instead of providing critical reductions to travel time, cost, and risk for highly-disadvantaged families, these urban developments are mobilized by society to provide mere convenience for the privileged. Addressing ITTRC can be as simple as placing highest-needs families in these existing urban developments through mechanisms such as social housing or rental subsidies. The solution towards providing a safety net of reduced travel time, risk, and cost is therefore within reach. Acknowledging capitalism and classism can easily become "unwelcome" in research (123); yet, the combined, continued impact on public health - particularly on health inequalities - suggest value in further scholarly investigation. Existing evidence suggests that ITTRC impacts a multitude of inequitable health and social outcomes, and that urban planning solutions to reduce ITTRC have already been realized. The choice is whether as a society we choose to grant this solution to the high-needs families in our midst.

Conflict of interest

The author declares no conflict of interest

Ethics approval and informed consent

All key-informants provided informed consent; ethics approval was received through the University of Manitoba

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