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Generating stronger evidence to inform policy and practice: natural experiments on built environments, health behaviours and chronic diseases

Guest Editors: Stephanie A. Prince and Gavin R. McCormack

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Invited editorial

Natural experiments in the built environment: evaluating impacts on health

Adrian Bauman, MD, PhD, Dr.Med (h.c.) (1); Melanie Crane, MPH, PhD (1,2)

Our understanding of how the built environment affects health outcomes has improved in recent decades through the use of natural experiments. Natural experiments are observational studies of naturally occurring phenomena or events that show variation, in which exposure to different levels or types of exposure are assessed in relation to defined health outcomes.[1,2] Natural experiment methods are particularly useful for evaluating the effects of built environment changes.

Natural experiments can be new policies, infrastructure or interventions that researchers may neither be able to, or should (for ethical or practical reasons), control or manipulate.[1] This means that there is generally no input into the intervention design a priori. The agencies or actors implementing such interventions can be governments, municipalities or non-governmental organizations. Natural experiments can also be naturally occurring events such as catastrophic weather events, major economic downturns or societal changes such as the COVID-19 pandemic.[3] Published natural experiment interventions are typically characterized by changes in policies or regulations related to the environment or in health service provision, which cannot easily be evaluated using traditional evidence-generating research designs.[4]

Natural experiments are important in evaluating community-level interventions that are relevant to population health and well-being. A broader strength of natural experiments is their ability to assess complex interventions at scale, including obesity-prevention policies such as food labelling and restricting advertising of or taxing unhealthy products, among other examples.[5] Natural experiments are useful where controlled trial designs are not amenable, such as the effects of alcohol policies or fluoridation of water.[6,7]

Many built environment interventions are outside of the control of health researchers, which results in limited evidence on their health outcomes.[8] Natural experiments enable health researchers to work alongside planners, transportation and other city sectors to investigate the effects of planned or unplanned urban interventions. A recent systematic evaluation of natural experiments provides valuable evidence in summarizing the effects of the built environment.[9] Still, natural experiments cannot always provide strong causal evidence, given the complexities of built environment interventions. This means that there is a risk of bias in study designs;[10] however, this is outweighed by the flexibility natural experiments provide in complex evaluations.

There have been several iterations of best practice guidelines for natural experiments. In the most recent, in 2025, researchers with the United Kingdom's National Institute for Health and Care Research and the Medical Research Council developed a framework for quality evidence in natural experiment design.[1] The starting point for natural experiments is to determine if methods can be applied to usefully understand or explain the changes induced by the naturally occurring phenomenon.[11] Natural experiment evaluations utilize diverse methods, including quantitative designs, qualitative research, economic evaluations and routinely collected health or social indicator data.[1] The most frequently used quantitative research designs use repeat cross-sectional surveys, quasi-experimental designs, interrupted timeseries designs and difference-in-difference methods.[1] Qualitative methods may assist in understanding the intervention context and the actors, partners and affected groups involved and in explaining potential mechanisms of change. It is usual for natural experiments to require complex system evaluation methods as multiple components of interventions are often delivered across diverse settings.[4]

Given the intersectoral nature of built environment interventions, it is often necessary to use natural experiment methods in their evaluations. Examples include assessing the effects of introducing healthy city policies or housing redevelopment policies within an urban area on community well-being, dietary habits or physical activity.[12,13] Sometimes natural experiments can assess interventions across communities, such as in the evaluation of the 19 rural communities in the Alberta Healthy Communities Approach by Gillies et al.,[14] which showed positive effects of built environment changes and support for healthy eating and physical activity programs. Not all natural experiments show positive results, as Belon and colleagues' study of urban infrastructure regeneration planning in Alberta demonstrates.[15] This study highlights the challenges of defining exposure, determining when data are collected, where study

Author references:

1. Prevention Research Collaboration, Sydney School of Public Health, Charles Perkins Centre, The University of Sydney, Camperdown, New South Wales, Australia
2. Health Promotion, Centre for Population Health, Western Sydney Local Health District, Cumberland Hospital Campus, North Parramatta, New South Wales, Australia

Correspondence: Dr. Melanie Crane, Prevention Research Collaboration, Sydney School of Public Health, The University of Sydney, Camperdown, NSW 2006, Australia; Email: melanie.crane@sydney.edu.au

participants are selected and the difficulty of finding representative comparison groups. Sometimes evaluation methods from both implementation science and from scale-up evaluation[16] are useful to assess the reach, adoption and adaptation of community-wide interventions.

Another Canadian study looked at cycling infrastructure in Montréal, Quebec, and evaluated the intervention using biennial national population health surveys and geographical information systems data. Prince et al. showed that decreased distance to and increased length of bike paths were related to increased usage over time.[17] Similarly, natural experiments evaluating public open spaces revealed that access to open spaces was partly responsible for maintaining social connections during the COVID-19 pandemic lockdown.[18] Many studies that examined park design improvements and outdoor exercise facilities have included serial time series measurements and compared differences to parks that had not undergone changes as controls, and demonstrated increased usage and increased diversity of park users.[19] More broadly, a systematic review of natural experiments of real-world built environment interventions across Canada conducted by Prince et al. revealed positive effects of walkable community interventions, cycling–pedestrian infrastructure and bike-share schemes; however, less evidence was apparent from school or daycare infrastructure improvements or new bus route interventions.[9]

These recent examples demonstrate the kinds of interventions that require natural experiments for their evaluation. Future opportunities related to the built environment could include contributions from citizen science and individual wearable-technology data, using geographic information systems and movement cameras. Opportunities should also be taken to strengthen networks between public health research, practice and policy, particularly across city sectors driving health outcomes.[20] Opposition may come from the research community, guided by the biomedical hierarchy of evidence, which may consider the evidence from natural experiments as not "reasonable causal evidence." This opposition has necessitated several attempts to define the attributes of good quality natural experiment research,[1,4] and it is hoped that policy-makers will appreciate when natural experiment have been rigorous enough to provide policy relevant advice.

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Original mixed methods research

Shaping healthier futures: community-level impact of the Alberta Healthy Communities Approach

Christina Gillies, PhD (1,2); Lisa K. Allen-Scott, PhD (1,3,4); Courtney Baay, MA (1); Nicole Frenette, MSW (1); Jacky Ka Kei Liu, MSW (1,5); Stephanie Patterson, MHSc (1)

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Abstract

Introduction: Built environment initiatives that change the physical places in which people live, work and play offer an approach to preventing cancer and chronic diseases. The purpose of this study was to evaluate the effectiveness of the Alberta Healthy Communities Approach Phase II (AHCA II), a community-based approach to creating healthy environments within and across rural communities and addressing modifiable health behaviours to prevent and reduce cancer and chronic disease.

Methods: Nineteen rural communities participated in AHCA II. Data collected with and by community members included two pre- and postimplementation assessment tools and postimplementation focus groups and surveys. Qualitative and quantitative data sources were triangulated to determine community-level outcomes and impacts.

Results: The evaluation found three key outcomes and impacts of the AHCA: supportive (built) environments for health; community wellness culture; and community capacity. These intersecting categories demonstrate the positive effects of healthy community initiatives on improving the built environment and supporting health behaviours such as healthy eating, physical activity, ultraviolet radiation protection and tobacco reduction.

Conclusion: In addition to improving supportive environments for health, the AHCA facilitated cultural changes and improved community capacity within and across rural communities in Alberta. Each of these components is required to support long-term behaviour changes that promote health and prevent cancer and chronic disease. While these results are encouraging, time and additional evaluations are required to determine whether behavioural changes are sustained and result in reduced rates of cancer and chronic disease.

Keywords: *built environment, chronic disease, primary prevention, evaluation, Healthy Communities Approach*

Highlights

- The Alberta Healthy Communities Approach (AHCA) addresses multiple environmental factors and modifiable health behaviours to reduce cancer and chronic disease risks in rural communities.
- Multisectoral teams improved built environments for health through physical changes to community environments and programming to support healthy eating, physical activity, sun protection and tobacco reduction.
- The AHCA created a novel health and wellness culture within communities, which increased community engagement and participation in health-promoting initiatives.
- Communities increased their capacity to collectively promote health by identifying the determinants of health, improving multisectoral partnerships and leveraging community resources.

Introduction

In Canada, the high prevalence of cancer, cardiovascular disease, diabetes and other chronic diseases[1] challenge policy-makers, public health practitioners and communities to improve supportive environments for health. While interconnected environmental features and mediating factors influence individual health behaviours, rates of cancer and other chronic diseases may be improved by changing the physical environment to support healthy behaviours. For instance, clean, safe, walkable neighbourhoods with access to green spaces and affordable food outlets can encourage physical activity, healthy food choices and a sense of community belonging.[2,3]

As features of the built environment are not available equally within and across all

Author references:

1. Public Health Evidence & Innovation, Primary Care Alberta, Calgary, Alberta, Canada
2. School of Public Health, University of Alberta, Edmonton, Alberta, Canada
3. Department of Community Health Sciences, University of Calgary, Calgary, Alberta, Canada
4. Department of Oncology, University of Calgary, Calgary, Alberta, Canada
5. Faculty of Social Work, University of Calgary, Calgary, Alberta, Canada

Correspondence: Christina Gillies, 10030 107 St. NW, Edmonton, AB T5J 3E4; Tel: 587-598-6503; Email: christina.gillies@primarycarealberta.ca

communities, the built environment (broadly defined as the places and spaces in which people live, work and play on a daily basis[2,4]) can foster or exacerbate inequities in health outcomes.[3,4] Although patterns differ based on health indicators, people living in rural areas experience health disadvantages and generally have worse health outcomes than their urban counterparts.[5-8] For example, risk for obesity, cardiovascular disease and lung cancer are higher in rural areas.[8-10] Marked variations across the urban–rural continuum influence prevalence of health risk factors, including demographic characteristics (e.g. age, income, education), health behaviours (e.g. smoking, healthy eating) and social and structural determinants of health (e.g. income, air pollution, and distribution of resources).[5-7,11-13] At the same time, rural communities benefit from having more opportunities to form close social relationships, increased availability of social support and greater senses of belonging.[8,11] Efforts to improve the built environment that recognize the unique characteristics and diversity of rural communities can help to improve rural health and reduce inequities in cancer and chronic disease.

The Healthy Communities Approach offers a community- and settings-based approach to building and promoting supportive environments for health as well as cancer and chronic disease prevention.[14] The movement addresses multiple determinants of health, including the built environment, through community engagement and multisectoral partnerships. In Canada, the Healthy Communities Approach has been implemented in smaller communities and large cities and towns alike through community-focused health initiatives.[14,15] The movement prioritizes developing a community's existing capacity to improve health and well-being and facilitating collaborative action to address issues of local relevance and significance.[15]

The Healthy Communities Approach in Canada has been adopted by partners in the public, non-profit and private sectors in several provinces and has persisted for more than 30 years.[15] However, there are gaps in our knowledge concerning the healthy community initiatives that have been developed. There have also been few evaluations of the effectiveness of the approach in improving the built environment, health behaviours and health outcomes, or else evaluation findings are not freely accessible.[16] In addition, less is known about initiatives to improve the built environment in rural communities than in urban contexts. Barriers to evaluation and knowledge-sharing exist both within and outside communities (e.g. lack of human and financial resources). However, determining the effectiveness of community-focused health initiatives in different contexts is important for informing preventive health programs and policies and for disseminating this information.

The Healthy Communities Approach has been adapted for rural communities in Alberta and established as the evidence-based Alberta Healthy Communities Approach (AHCA).[17] Intended for addressing multiple determinants of health, the AHCA has the potential to improve social, economic and environmental factors within and across communities, as well as modifiable health behaviours, in order to reduce cancer and chronic disease rates in the province. The purpose of this study was to evaluate the community-level outcomes and impacts of the AHCA.

Methods

Intervention

The AHCA was co-designed and developed by the Communities Team in Cancer Prevention and Screening Innovation (CPSI), Primary Care Alberta (formerly Alberta Health Services) and collaborating partners who adapted the Healthy Communities Approach to the context of rural communities in Alberta in Phase I (2015–2019) and Phase II (2019–2023). Adaptations were based on the capacity and assets in rural contexts and were designed to support initiatives that address the determinants of health associated with cancer and chronic disease prevention, for example, built environments that promote physical activity and ultraviolet radiation (UVR) protection.

The process of adapting and piloting the AHCA in Phase I has been described elsewhere.[17] In this article, we report on AHCA Phase II (AHCA II), the aim of which was to determine the effectiveness and efficiency of the AHCA to inform sustainability and scaling.

Participating communities followed the AHCA process (Figure 1), which comprises five iterative steps: (1) engage and create connections; (2) understand your community; (3) prioritize and plan; (4) implement and evaluate; and (5) sustain, improve and share.[18] Throughout the process, communities received implementation support in the form of mentoring by a CPSI health promotion facilitator (HPF); evidence-based tools and resources; and learning and sharing opportunities. Many resources are available online on the Alberta Healthy Communities Hub.[18] Communities also received seed funding of CAD 20 000 to develop and implement comprehensive efforts directed toward increasing community control over the determinants of health (i.e. healthy community initiatives), thereby creating supportive environments for health and cancer and chronic disease prevention.

Study design

In this natural experiment study we utilized a multimethod design and process and a summative (i.e. outcome and impact) evaluation to determine the effectiveness of AHCA II. We used the RE-AIM evaluation framework[19] to select indicators for the evaluation and to determine and synthesize project outcomes and impacts. In this paper we focus on effectiveness, but information on the other important evaluation findings (i.e. reach, adoption, implementation, maintenance) are available from the authors upon request.

As this was an evaluation study, approval from an ethics committee was not sought. However, the ARECCI (A Project Ethics Community Consensus Initiative) Ethics Screening Tool[20] was used to ensure minimal risks. The tool determined that the project posed "somewhat more than minimal risk" due to inexperienced project leads. A second opinion was sought (through virtual consultation), and the research team made sure that project leads were supported by experienced community-based evaluators to minimize risks to participants.

Setting and participants

The populations of interest were rural communities in Alberta with a concentrated population of 15 000 or less in non-urban centres. Recruitment involved a call-out campaign from the CPSI Community Team to encourage eligible communities to submit a letter of intent to share their community's story and motive for participating in the AHCA. After receipt of a letter of intent from a community, an HPF conducted an interview with the applicant(s) that focused on dimensions of

FIGURE 1
The AHCA iterative five-step process

Source: Primary Care Alberta.[18]

Abbreviation: AHCA, Alberta Healthy Communities Approach.

AHCA readiness (e.g. existing supports, resources and collaborative practices). CPSI team members and partners then discussed each community's application and the interviews, any prior experiences with the community, the communities' existing capacity and how to make sure that the communities selected would be geographically diverse.

AHCA II involved 19 rural communities that ranged in size from 522 to 14 436 people (average size = 3767; median size = 2918) based on population counts from the 2021 Census of Population.[21] In each community, multisectoral teams (MSTs) were formed and members collectively implemented the AHCA and participated in evaluation activities. The teams included members from diverse settings, including the community at large, community facilities and organizations, health care, schools and workplaces. MSTs included 4 to 30 individuals in the community, with a total of 258 individual MST members participating in the project.

Data collection and analysis

Both qualitative and quantitative data were collected with and from members of community MSTs. All MST members in AHCA II received a booklet that outlined the purpose of the project and provided detailed information on evaluation activities, the individual and community-level data collected, the risks and benefits of participating as a volunteer, privacy and confidentiality, and data management. All MST members were required to sign an informed consent form agreeing to the use of anonymized individual-level data for the purposes of knowledge translation (e.g. publications). After all the MST members had read the booklet and had had the opportunity to ask questions, a representative signed an informed consent form on behalf of the MSTs agreeing to the dissemination of community-level data.

The sources of data used in this study were Community Capacity Assessment Tool (CCAT) results; Healthy Places Action Tool (HPAT) results; focus group transcripts; and results from a follow-up survey.

Community Capacity Assessment Tool

The CCAT is an evidence-informed assessment and planning tool that facilitates intentional in-depth consensus-building conversations concerning community capacity (i.e. the ability to address collective priorities).[22] The MSTs discussed each of the questions across 11 domains (Table 1) and answered them using a five-point Likert scale from "haven't started" to "we're there" with corresponding scores of 1 to 5. A research associate [NF] then generated a report with the pre- and post-implementation scores for each CCAT domain for each MST.

Healthy Places Action Tool

The HPAT is an evidence-informed planning and assessment tool that is used to identify and understand community settings and environments while focusing on established modifiable health behaviours for cancer and chronic disease (i.e. focus areas) (Table 2). It is used to identify community strengths and areas for improvement across various health domains as well as to prioritize areas for action to support community health and well-being. As with the CCAT, MSTs discussed and answered each of the corresponding questions using a five-point Likert scale to rank answers from "haven't started" to "we're there" from 1 to 5. A research associate [NF] then generated a report with the pre- and postimplementation scores for each HPAT setting, environment and focus area.

To evaluate effectiveness, an evaluation associate [JKKL] conducted inferential analyses on the pre- and postimplementation CCAT and HPAT data using paired sample *t* tests with effect size Cohen *d* scores to determine whether differences between before and after the completion of AHCA II were statistically significant.

Focus groups

Of the 19 MSTs, 18 participated in endpoint impact focus groups; one MST had dissolved by the time the focus groups were conducted, and the members could not be contacted. The focus groups were conducted online via Microsoft Teams (Microsoft Corp., Redmond, WA, US) by one evaluation associate [JKKL] using a semistructured guide, between May 2023 and January 2024. One focus group was attended by only one MST member and was conducted as a semistructured interview. The largest focus group comprised 10 participants. A total of 86 MST members participated in 18 focus groups.

Participants were asked about the AHCA's impact in their community (example

TABLE 1
Community Capacity Assessment Tool domains that together indicate a community's ability to address collective priorities

Domain	Description
1. Sense of community	Feelings of belonging and trust among community members.
2. Communication	Opportunities for people to share their ideas, knowledge and perspectives with others in order to bridge gaps, resolve conflicts and create effective ways of working together.
3. Partnerships, linkages and networks	The ability to form connections with diverse groups, organizations and individuals who share similar interests and goals.
4. Participation	Active and intentional engagement of community members, organizations and other partners throughout the initiative.
5. Resources	People, infrastructure, funding and time that can be leveraged to ensure the success and sustainability of community initiatives.
6. Skills and knowledge development	Opportunities to identify existing skills and gain new knowledge.
7. Asking why	Identifying the root causes of community concerns to design comprehensive solutions.
8. Learning from experience	Reflecting on and seeking feedback to understand what is working well and what can be improved upon to inform future action.
9. Shared vision	A detailed, realistic picture of the community that members strive to reach in the future.
10. Shared community leadership	Bringing together formal leaders and other people (or groups) for shared leadership.
11. Sustainability	Lasting benefits in a community through ongoing community action.

questions were as follows: "What was your vision of change for your community?"; "Did the AHCA help you achieve your vision?"; "What are the most significant changes you have seen in your community?"); community experience (e.g. "What tools and resources did you find most and least beneficial in achieving your vision?"); and sustainability plans (e.g. "How will you sustain and build on changes in your community?").

Transcripts were verified for accuracy and anonymized. A research associate [CB] analysed the focus group transcripts using a "codebook" thematic analysis approach[23] and NVivo qualitative analysis software version 12 (QSR International Pty Ltd., Melbourne, AU). A second researcher [CG] supervised the analysis process to ensure that interpretations reflected the dataset as a whole (i.e. peer debriefing).

Survey of support partners

After project completion, a survey was sent to support partners to ask about the impact and sustainability of the AHCA. Support partners were those in the MST who facilitated the AHCA process as employees or volunteers with community-level organizations (e.g. the recreation coordinator) and by working closely with a CPSI HPF. The online survey consisted of eight dichotomous (yes/no) and branching qualitative open-ended questions that focused on the sustainability of the MST (i.e. whether collaboration had been sustained and contributing factors); sustainability of healthy community initiatives (i.e. whether the initiatives had been sustained, whether new initiatives had been developed, and the contributing factors); and collective impact (i.e. whether the support partners had witnessed beneficial or harmful changes in the community since participating in the AHCA).

A link to the survey was emailed to the support partners by CPSI HPFs 6 months after communities completed the AHCA II. The survey responses were anonymous and collected via REDcap (Vanderbilt University, Nashville, TN, US). Upon receiving the survey link, support partners had 2 weeks to complete the survey; a follow-up email was sent if the survey was not completed within that time. The

TABLE 2
Healthy Places Action Tool domains identifying community strengths and prioritizing community action

Setting	Environment	Focus area
Communities at large: The foundation for understanding the entire community.	Social: How people connect within the community, their cultures and their shared values.	Physical activity
Community facilities and organizations: The environments within community facilities, such as parks, libraries and community centres.	Physical: The community's built and natural surroundings including the availability of walking paths, bike lanes and green spaces to encourage physical activity and access to nature.	Healthy eating
Health care: Hospitals, clinics and community health centres.	Economic: The affordability of health-related resources in the community.	Alcohol reduction
Workplaces: The environments in which people work, e.g. offices and factories.	Policy: The protocols and rules in place to support health and wellness.	Tobacco reduction
Schools: The environments that provide early, primary, secondary and postsecondary education.	n/a	UVR protection
n/a	n/a	Cancer screening

Abbreviations: n/a, not applicable; UVR, ultraviolet radiation.

survey was sent to 18 support partners in 16 participating communities; a total of 15 surveys were completed by support partners in 12 communities (response rate 83.3%). Conventional content analysis[24] and NVivo 12 qualitative analysis software were used by a research associate [CB] to analyze the qualitative survey data. A second researcher [CG] supervised the analysis process and functioned as a peer debriefer.

Data synthesis and reporting

To determine the effectiveness of the AHCA, the four data sources (CCAT, HPAT, focus groups and follow-up survey) were reviewed and analyzed (i.e. triangulated) by a researcher [CG], a research associate [CB] and an evaluation associate [JKKL] involved in data collection and analysis. The team found that quantitative findings from the HPAT and CCAT results were contextualized by results from the qualitative focus groups and surveys, which provided additional perspectives concerning the effectiveness of the AHCA. The results were thus combined in a narrative synthesis to provide a comprehensive understanding of the summative outcomes and impacts of the AHCA. Identifiers accompanying illustrative quotations indicate that the participant is a support partner (SP) or community member (CM) who sat on an MST, along with the rural community they represented.

Results

The evaluation results addressed three key outcomes and impacts of the AHCA in rural Alberta communities: improvements to supportive (built) environments for health; community wellness culture; and community capacity.

Supportive (built) environments for health

Of the 19 MSTs who completed a pre-HPAT assessment, 16 conducted a post-HPAT assessment. Nine MSTs completed a post-HPAT in full, and seven completed the post-HPAT for the focus areas identified as priorities for their communities. All six focus areas showed an overall improvement, from a mean preassessment rating (standard deviation [SD]) of 1.95 (0.43) to 2.70 (0.56) for the postassessment rating ($t(15) = 4.45$, $p < 0.001$, Cohen $d = 1.11$). The largest improvement was in "UVR protection," from 1.43 (0.26) to 2.33 (0.83) on the rating scale ($t(10) = 3.64$, $p < 0.01$, Cohen $d = 1.10$). "Physical activity" grew from 2.53 (0.65) to 3.11 (0.64) ($t(14) = 3.56$, $p < 0.05$, Cohen $d = 0.92$), and "healthy eating" from 1.71 (0.44) to 2.25 (1.00) ($t(15) = 2.38$, $p < 0.05$, Cohen $d = 0.60$). "Tobacco reduction" changed from 2.27 (0.89) to 3.11 (1.30) ($t(9) = 2.53$, $p < 0.05$, Cohen $d = 0.80$). No statistically significant changes were found for "alcohol reduction" (2.37 [0.63]–2.89 [0.74]; $t(10) = 1.56$, nonsignificant [ns], Cohen $d = 0.49$) or "cancer screening" (1.93 [0.74]–2.03 [0.54], $t(9) = 0.39$, ns, Cohen $d = 0.13$) (see Figure 2).

To encourage physical activity, communities implemented changes to the built environment by building sledding areas, walking, cycling and cross-country skiing trails, disc golf courses and outdoor crokicurl and skating rinks; installing bike racks; and developing or enhancing parks and other outdoor play spaces including multisport, pickleball and basketball courts, skateboard and bike parks, and playgrounds. To support UVR protection, sunscreen stations and sun shelters were installed, shade trees were planted and signs about sun safety were posted. Communities promoted healthy eating by installing water filling stations, establishing community and youth gardens, making healthy food and water available in facilities and community spaces, and partnering with grocery stores to provide and promote healthy food options.

All but one of the communities (which focused only on physical activity) implemented initiatives that addressed more than one focus area; for example, one community installed a water filling station, enhanced an outdoor walking trail and built a gazebo for shade near the trail, while another established a community garden, installed bike racks, enhanced a playground and built sun shelters.

One participant explained that the community garden implemented as part of the AHCA had led to changes that support physical and social health and well-being: "it's expanded to more than just feeding our community … the space is quite beautiful and with the sun shelters that are there, it's become a meeting spot" [CM1, Wembley]. Another explained that a natural outdoor play space that included a garden, sunscreen stations and fruit and shade trees was encouraging healthy eating, physical activity, UVR protection and social connection:

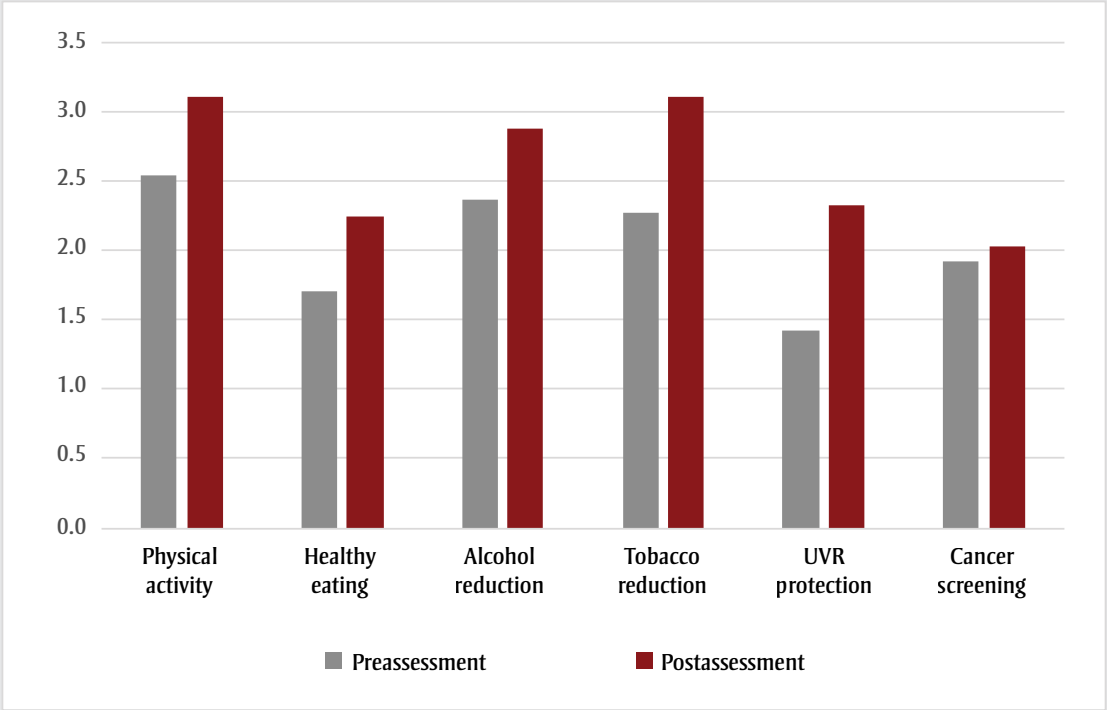
> The outdoor play space is being used much more than when it was just a green space. The school, daycare and [family and community support services] have added dedicated times to be outside in the space. This has brought about more gross motor, fine motor, risky and imaginative play to those that use the space. It has also produced fruit and vegetables that some of the families have never tasted before, so they were able to try new things. Plus, the increase in fresh air, sunshine, sunscreen usage and socializing as the families/individuals gather [SP3, Raymond].

The positive effects of supportive built environments were reported in other communities, particularly for the focus area of physical activity. One participant described their walking trail as well-used, which led "to an increase in physical activity and community connectedness" [SP6, Provost]. Another explained that their MST had established "[a] fitness trail […] to go along [with the] existing walking trail" [SP3, Bonnyville], which in turn promoted physical activity.

Alongside the physical changes to the built environment, communities created programming aimed at improving accessibility of health supports. For instance, communities implemented lending library programs that offered sports and physical activity equipment, health products, on-demand classes and cooking equipment that local residents could borrow. These programs also inspired community workshops and events such as cooking and preserving classes, seed exchanges and gardening events. One participant explained that the program "has been able to address several barriers that the community members face including not having access to equipment due to transportation issues, lack of funds and lack of exposure to opportunities" [SP11, New Sarepta]. Another stated that they had seen an "increase in outdoor recreation due to the [lending] library having items available to borrow instead of [having to purchase them]" [SP3, Raymond].

All but one of the support partners (n = 14; 93%) said that the AHCA initiatives continued to be maintained for 6 months after the project ended. One mentioned that

FIGURE 2
Mean assessment rating results for HPAT focus areas before and after implementation of AHCA II (n = 16)



Abbreviations: AHCA II, Alberta Healthy Communities Approach Phase II; HPAT, Healthy Places Action Tool; UVR, ultraviolet radiation.

their town had maintained and expanded their outdoor skating rink "by adding seating, fire bowls, firewood and special event nights" [SP3, Raymond]. Another stated that "our community has continued on with building community connection by hosting different events/workshops promoting wellness" [SP13, Crossfield]. Other ways in which AHCA initiatives were built upon included purchasing new sporting equipment, expanding walking trails, building outdoor benches, planting trees and adding shade structures to existing parks. Communities also continued to implement programming within the wellness infrastructure developed through the AHCA, such as snowshoeing groups and drop-in sport programs.

Community wellness culture

Alongside changes to the built environment, AHCA II caused cultural shifts within communities that promoted both individual behaviour change and community health and well-being. When asked about the AHCA's impact, participants said that the AHCA process had had the broader effect of creating a novel health and wellness culture within their respective communities. For example, one participant said that the AHCA process "created a stage for people [in the community] to champion mental health and well-being" [CM1, Valleyview]. Another stated that the AHCA had "created a wellness culture in the community. Community residents now seem to understand and participate in wellness-related activities" [SP2, Millet]. Yet another said that "many people still want to engage with the concept of healthy communities" [SP10, Grande Cache], indicating that the values-based approach had been accepted by and instilled in the culture of their rural community. One participant further noted that "there has been more open discussion about health and wellness" [SP13, Crossfield].

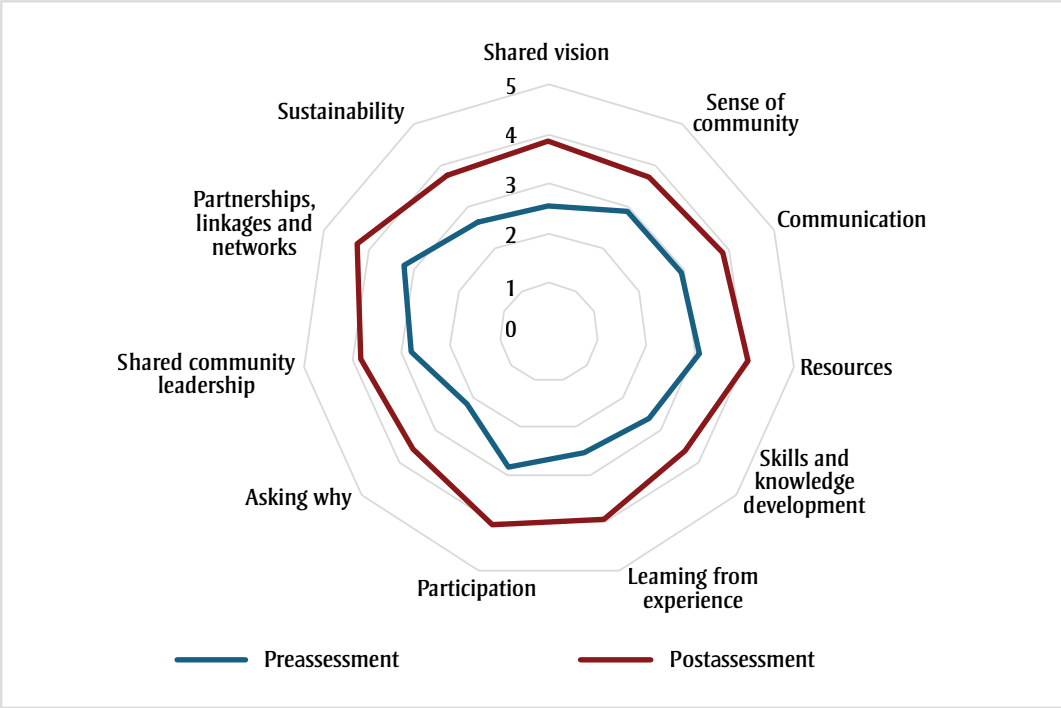
Alongside the collective sense of appreciation for and understanding of wellness, participants noted that community members were more engaged in healthy community initiatives. One participant said that the AHCA had "sparked interest in community wellness, [and] over time this has grown into community wellness events [such as mental health] initiatives, food security initiatives [and] overall community well-being" [SP2, Millet].

Modifications to the built environment had also led to new family activities and traditions and indicated changes to community ways of life. As one participant said, "skates are just flying off the shelves this year, and families are borrowing items all year long. One family lives along the walking path where the frisbee golf course is, so they borrow that set in order to play, especially when grandkids come over" [SP3, Raymond].

Community capacity

Communities increased their capacity to address collective priorities and promote the health and well-being of their respective communities. After the implementation stage, 17 of the 18 MSTs who completed the CCAT preassessment also completed a postassessment; all 17 communities saw a significant increase in all 11 domains of community capacity on a scale of 1 to 5, from a mean (SD) preassessment rating of 2.76 (0.65) to 3.89 (0.56) for the postassessment rating ($t(16) = 5.19$, $p < 0.001$, Cohen $d = 1.26$) (Figure 3). The three top-rated domains were "partnerships, linkages and networks," from 3.21 (1.08) to 4.27 (0.56) ($t(16) = 3.42$, $p < 0.01$, Cohen $d = 0.83$); "resources," from 3.08 (1.07) to 4.08 (0.80) ($t(16) = 3.49$, $p < 0.01$, Cohen $d = 0.85$); and "participation," from

FIGURE 3
Mean CCAT results before and after participating in AHCA II (n = 17)



Abbreviations: AHCA II, Alberta Healthy Communities Approach Phase II; CCAT, Community Capacity Assessment Tool.

2.82 (1.03) to 4.05 (0.57) ($t(16) = 3.99$, $p = 0.001$, Cohen $d = 0.97$). Improvements were also observed in "asking why," from 2.19 (0.81) to 3.61 (0.89) ($t(16) = 4.57$, $p < 0.001$, Cohen $d = 1.11$), with an emphasis on critical thinking and questioning in community capacity-building. "Learning from experience" showed a significant improvement, from 2.55 (0.82) to 3.95 (0.68) ($t(16) = 4.86$, $p < 0.001$, Cohen $d = 1.18$), as did "shared vision," from 2.56 (1.12) to 3.87 (0.63) ($t(16) = 3.42$, $p < 0.01$, Cohen $d = 1.25$).

In line with the CCAT results, participants said that the AHCA had established and/or strengthened multisectoral collaborations and partnerships, improved community participation and increased resources. One participant explained that the AHCA had facilitated access to resources as well as "ways to meet other people and get partnered up with things" [CM1, Hanna], while another said, "I think the knowing of individuals and organizations and pulling them all together into the same room has been hugely beneficial" [CM1, Langdon]. Another participant explained that "so many different groups came together, people representing different areas came together and are working together to push together to make change, rather than everybody working on separate projects" [CM2, Brooks]. Participants also noted that the AHCA had helped to strengthen relationships across communities in rural Alberta. As one participant noted, "the connections inside [our community], which I've seen from throughout this committee, are, I would say, the most valuable, but also as a secondary, getting connections with other communities as well" [CM3, Raymond].

Participants also recognized the positive impact of the AHCA on encouraging community participation. The process of community engagement resulted in meaningful participation of individuals and groups within the community, which helped to establish and maintain changes to the built environment. For instance, participants noted that their communities had more residents volunteering their time. One participant stated that "over the course of the last 4 years, I think [community members'] participation on the community team has skyrocketed" [CM1, Jasper].

As an example of community participation, another participant mentioned that "families help plant the gardens in the spring and harvest them in the fall.… Community members are donating items to the lending library," and that their community specifically engages youth in an outdoor play space "by creating signage, decor and stepping stones, and helping with cleanup and maintenance" (SP3, Raymond). By actively engaging community members, organizations and other partners, communities were enabled to lead initiatives. One participant reflected that

> … there's almost a courage in the community … community members now are taking their ownership and their own leadership, and they've built a strength to be able to do it on their own [CM7, Millet].

Communities also reflected that the AHCA had increased their ability to identify and leverage existing resources, including people, infrastructure and funding. One participant shared that their community had "built on what was already so great about [our town] and made it even better," [CM6, Millet] while another explained that "there's a lot of people that are willing to share their knowledge and expertise

and talents, which I think really drives a lot of the projects" [CM3, Langdon]. Similarly, a participant described the importance of leveraging resources to increase community capacity:

> At the end of the day nothing beats real live bodies inside a room, with ideas, like building relationships and really like centring those relationships… I think a lot of times we externalize things and we go looking outside for solutions, which is also important. But the wisdom and the talent and the ideas and the people who understand the context … are right here inside of these organizations already. They're right here in the towns that we live in, in the businesses that we run, and we can actually lean on each other, support each other, and be there for one another as a community [CM1, Edson].

To support and expand their initiatives, communities leveraged the data and resources generated from the AHCA to secure additional funding and in-kind contributions. When reflecting on the unexpected impacts of the AHCA, one participant said:

> I think organizing ourselves a bit more and, like, selling the benefit of this approach to social change might have elevated the profile of what we're doing with our elected officials and thus created more opportunities for funding and local government buy-in [CM1, Jasper].

Communities also recognized that their increased capacity to leverage resources supported the sustainability of their healthy community initiatives. As one community member said:

> I don't worry [about when] the funding and stuff is done because I feel like there's so much already embedded in the community. That, and I mean it needs to be community led. That's how things work is when the community leads it [CM7, Millet].

Discussion

The aim of this study was to evaluate and describe community-level outcomes and impacts of the AHCA II. The evaluation with the 19 MSTs who implemented the AHCA in rural communities found that the process resulted in changes to the built environment and positive short-term outcomes related to primary cancer and chronic disease prevention.

Most research on the built environment and health outcomes and behaviours in Canada is focused on urban areas, and health-related initiatives often fail to account for the unique demographic characteristics and social, cultural and economic conditions of rural communities.[3,5,12] Recognizing the diversity within and between rural places, the AHCA is a flexible process that can be tailored to the specific needs, strengths and determinants of health in different rural communities. This study provides an example of an approach that resulted in improved built environments and in shifts in cultural values and community capacity to promote and sustain healthy behaviours and community development.

Using the AHCA, MSTs collaborated to create and/or enhance environments that promote and support healthy behaviours in their respective rural communities. The evaluation was based on self-reported data and was not designed to objectively capture changes in individual-level health outcomes (e.g. waist circumference) or behaviours (e.g. fruit and vegetable intake). Nevertheless, community members reported that improvements to the built environment increased healthy behaviours. Programming further supported these changes in behaviours by helping to address barriers to accessing and/or affording health-promoting resources.

Although the connections are complex, researchers have demonstrated the reciprocal links between the built environment and individual health behaviours, which in turn, influence individual and population health outcomes.[4,25,26] Our findings support the evidence that changes to the built environment in rural areas can positively influence health behaviours and outcomes by providing opportunities, resources and supports for community members.[26,27] For instance, a recent study found that bike lanes, pedestrian safety features and community beautification were inversely associated with obesity in a cohort of individuals from urban and rural communities in 21 different countries.[28]

In this study, rural MSTs designed and implemented a number of initiatives related to healthy eating, physical activity and UVR exposure, based on community-identified priorities. A scoping review that did not consider community type found that transportation, housing and spatial accessibility influence key risk factors for cancer such as air quality, diet and physical activity.[29] These factors may disproportionately affect rural areas, which generally have more hazardous environmental conditions, a lack of facilities and infrastructure, and poorer health service availability.[7,30] As such, achieving long-term impacts on cancer and other chronic diseases may require thinking beyond the physical elements of rural communities and assessing and addressing the wider set of resources, conditions and built environment features that impact residents' health behaviours and outcomes. For instance, ensuring that community members can access safe and affordable transportation, housing and health services through community design and land use planning may serve to improve the built environment in ways that optimize health outcomes.[31]

The findings of this evaluation also indicate that the AHCA implementation resulted in outcomes and impacts that indirectly relate to the built environment. The MSTs observed important cultural changes in their communities, including those related to perceptions of health, willingness to support community activities and events, and family traditions that incorporate health-promoting behaviours. The combined effects of tangible enhancements to the built environment, supportive programming and shifting attitudes on health and well-being enabled community members to engage more frequently in physical activity, adopt healthier eating habits and prioritize overall wellness. This suggests that the participating communities embraced the value system associated with the AHCA, which is critical for implementing specific health-promoting initiatives and reducing health inequity.[32,33] Given that cultural elements—including values, beliefs, norms and practices concerning health and well-being—are core to rural ways of life, changes to the sociocultural environment within rural communities can promote or inhibit health equity at a local level.[5,34,35] When reinforced by the built environment, cultural changes in communities thus have the potential to further influence actual health behaviours and reduce risk of cancer and other chronic diseases in the longer term.

Although these findings are encouraging, making widespread changes to the built environment is difficult and observing the related health outcomes takes considerable time and effort. Given the complexity of social and physical environments, it is also challenging to link cancer and chronic disease prevalence to specific aspects of the built environment. Nevertheless, there is a need for rigorous evaluations of community initiatives that modify the built environment, in different contexts, to determine whether and to what extent they result in health outcomes as well as to determine why and for whom they are effective (or ineffective). While longitudinal study designs are ideal, they are not always possible in community settings because of time, capacity and resource constraints. However, natural or quasi-experiments like the one in this study are appropriate for evaluating the efficacy of built environment changes on health outcomes.[36] To support the design of strong studies, conceptual frameworks that consider the built environment and its impact on health[37-39] may help identify features of the built environment that mediate modifiable health behaviours for cancer and chronic disease, guide the evaluation of health outcomes based on comprehensive indicators and determine the mechanisms behind any effects.

Finally, this evaluation demonstrated that the AHCA improved community capacity to achieve supportive environments for health through multisectoral collaborations, community participation and leveraging resources. Rural communities generally have poorer access to funding, infrastructure and human capital, which can influence their capacity to initiate and sustain health-promoting initiatives.[5,12,40,41] Previous research and strategic recommendations for rural health equity focused on leveraging formal and informal skills of community members, using local resources and existing infrastructure and building multidisciplinary and multisectoral collaborations to make environmental changes and create opportunities for rural residents to engage in healthy behaviours.[5,12,41,42] Indeed, our study found that the AHCA helped bring community members, organizations and other partners together to enhance the built environment through creative solutions that leveraged collective strengths and resources.

Innovative and creative ways of working that actively engage and connect diverse community members and other partners (e.g. mayors and municipal leaders, community support services staff, health care personnel, youth leaders, school officials, librarians, business owners, religious leaders) are required in order to foster long-term changes to the built environments that shape rural areas and influence residents' health behaviours. Although one of the MSTs that participated in AHCA II had dissolved by project end, the remaining 18 had sustained their collaboration and their healthy community initiatives. This suggests that the AHCA is a sustainable platform for engaging and enabling individuals from different sectors, groups and organizations to facilitate action at the local level and promote health and ultimately improve cancer and chronic disease outcomes. Nevertheless, it is crucial for all MSTs to consider how to sustain collaborations and partnerships from the earliest stages and throughout the AHCA process. The availability of funding, staff and volunteers must also be considered and accounted for to support maintenance of healthy community initiatives aimed at improving the built environment.

Strengths and limitations

This project was conducted in collaboration with communities to build capacity to develop, implement and evaluate health promotion initiatives. We utilized a rigorous evaluation design as well as multiple measures and data sources to determine effectiveness. However, it is important to consider the impact of the COVID-19 pandemic on the AHCA II evaluation given that a state of public health emergency was declared in Alberta about a year into the project. Communities exhibited considerable resilience in navigating pandemic-related challenges to participate in evaluations,[43] but were dealing with many social and economic issues when completing the HPAT and CCAT assessments. These circumstances resulted in significant MST turnover, and in one case, forced them to withdraw from the AHCA II. Communities also had to transition to online collaboration in the middle of completing assessments. As a result, not all communities completed pre- and post-HPAT and CCAT assessments in full (or at all). Overall, these unique circumstances may have inadvertently skewed findings so that they did not reflect all community experiences or were not representative of the contextual conditions influencing AHCA outcomes.

Despite these potential limitations, the evaluation reflects the strengths, priorities and characteristics of diverse rural communities in Alberta. The transferability of the findings to other communities will depend on whether other communities (and researchers) determine if and how they apply to the new settings. However, the observational study design we used limits the potential to detect causal influences and mechanisms as well as health outcomes. Additional longitudinal studies are necessary to determine which features of the built environment cause changes in health, the mechanisms and mediators of change, and whether there are differential effects on diverse populations over time. As others have suggested, future studies could use causal inference methods to allow for associations between community environments and cancer and chronic disease outcomes.[44]

It is also important to note that an equity lens was not included in the evaluation design, and we do not know whether and to what extent the changes to the built environment were acceptable to, equally available to and utilized by all the individuals within the participating communities. It is therefore possible that there were negative consequences of the built environment changes but that these were not reported. Our team is currently adapting the AHCA to include a stronger focus on promoting and improving equity in urban contexts, and this adaptation will also be evaluating equity outcomes.

Conclusion

This evaluation has demonstrated that the AHCA results in positive short-term outcomes within and across rural communities in Alberta. In addition to improving supportive environments for health, the AHCA has facilitated cultural changes and improved community capacity. Each of these components is required to support long-term behaviour change to promote health and prevent and reduce incidence of cancer and chronic disease. While the positive changes reported in rural communities are encouraging, it takes time to determine whether changes to the built environment and individual health behaviours are maintained. Seeing the individual, community and population-level health effects of these changes also requires considerable capacity to systematically collect and share evidence over time. Long-term follow-up is required to determine whether

changes initiated by healthy community approaches like the AHCA are sustained within rural communities and result in positive behaviour changes that shape healthy futures characterized by lower incidence of cancer and chronic disease.

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Conflicts of interest

None.

Authors' contributions and statement

CG: Conceptualization, formal analysis, methodology, project administration, supervision, writing—original draft, writing—review and editing.

LKAS: Conceptualization, project administration, writing—review and editing.

CB: Formal analysis, writing—review and editing.

NF: Data collection, writing—review and editing.

JKKL: Data collection, formal analysis, writing—review and editing.

SP: Conceptualization, project administration, writing—review and editing.

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Original quantitative research

The impact of revitalized urban and rural recreation infrastructure on usage levels: evidence from a longitudinal quasi-experimental study in Alberta, Canada

Ana Paula Belon, PhD; Laura Nieuwendyk, MSc; Vijaya Krishnan, PhD; Candace I.J. Nykiforuk, PhD, CE

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Abstract

Introduction: Few studies have analyzed the impact of public investments in indoor and outdoor recreational spaces, and even fewer have assessed this impact longitudinally. This hinders informed decision-making about returns on investments made with limited public budgets. We assessed the impact of a 2008 municipal plan to revitalize existing urban and rural public indoor facilities and outdoor spaces by evaluating changes in usage levels before and after implementation of Phase 1 (2009–2013) of the revitalization plan.

Methods: A quasi-experimental study involving a telephone survey of 750 participants was conducted before and after Phase 1. A region with similar demographics and public recreational indoor and outdoor infrastructure was used for comparison.

Results: Our analysis found no changes in usage of recreational venues over time whether indoor (e.g. multipurpose recreational facilities, community halls) or outdoor (e.g. golf courses, off-leash dog parks, multiuse trails), in either the intervention or comparison region. Only one rural multipurpose indoor recreational facility showed a statistically significant increase in usage during Phase 1.

Conclusion: Strategies targeting only physical infrastructure may not result in increased usage across a municipal population. To address existing inequities in access to publicly funded community resources that support health, both the built and social environments must be considered.

Keywords: *natural experiment, surveys and questionnaires, physical activity, sports and recreational facilities, parks*

Highlights

- Using longitudinal data in a quasi-experimental study, we found that despite investment in revitalizing existing public urban and rural indoor recreational facilities and outdoor spaces, usage increased in only one rural indoor multipurpose facility.
- Upgrades to physical infrastructure may not have addressed barriers to usage, for example, a lack of diverse programming or high fees.
- Addressing residents' perceptions and experiences may be critical to ensuring that they increase their use upgraded public recreational facilities more.

Introduction

Access to public indoor recreational facilities and outdoor spaces can increase population levels of physical activity (PA), promoting mental and social health[1-5] and preventing chronic diseases.[2,6] There is also strong evidence for the cost-effectiveness of environmental interventions in increasing facility usage and PA levels.[7-9]

Given its critical role in health and well-being promotion, public PA infrastructure should be primed to meet the evolving community needs that come with population growth and aging, changes in ethnic composition, and so on. However, construction of new recreational spaces may be unfeasible environmentally or financially, including in municipalities operating with smaller budgets. Revitalizing existing infrastructure may be a more viable way to invest in the longer-term health of the community. Municipal revitalization projects can attract new users while helping current users maintain or increase their facility usage.[10,11] An indirect, expected outcome of such revitalization is the creation of more vibrant communities with increased everyday social interactions.[11,12] Public infrastructure also offers recreation opportunities at lower or no cost to the entire socioeconomic spectrum.[1,11]

Author reference:

School of Public Health, University of Alberta, Edmonton, Alberta, Canada

Correspondence: Candace I.J. Nykiforuk, School of Public Health, University of Alberta, 3-300 Dianne and Irving Kipnes Health Research Academy, 11405 87 Avenue NW, Edmonton, AB T6G 1C9; Tel: 780-492-4109; Fax: 780-492-0364; Email: candace.nykiforuk@ualberta.ca

There are few studies on the impact of environmental interventions that promote the usage of public recreational venues and even fewer that assess such impact longitudinally.[1] Most natural or quasi-experimental assessments of recreational venues are conducted within one year of their revitalization[13] and use direct observation or user surveys.[1] Studies with short follow-ups and smaller sample sizes are more likely to report null or mixed results.[1,13] Evidence for effective environmental interventions is clearly needed[7] to better support government strategic planning and resource allocation. Further, there is a need for research that focuses on rural settings;[14] these settings often lack PA infrastructure (or have to deal with the maintenance of aging facilities), leading to widening rural–urban inequities in leisure-time PA engagement.[14,15]

The implementation of a municipal plan for the revitalization of existing urban and rural recreational venues in a mid-sized Canadian municipality served as an opportunity for a quasi-experimental study to assess impact on usage levels and, ultimately, identify the value of such investment. We evaluated the difference in usage of this infrastructure from before the implementation of the revitalization plan to after its implementation (2009–2013) in that region, compared to a proximal region of similar size and profile.

The municipal revitalization plan

In response to demographic changes and community demands for more recreation infrastructure, the intervention region (in Alberta, Canada) launched a strategy to revitalize public recreational spaces in 2008. As a result of extensive public engagement and consultation, the 15-year strategic plan (2009–2023) was divided into three 5-year phases. After conducting needs and impact assessments (including cost–benefit and environmental impact analyses), the region opted to expand and improve three indoor venues at a lower cost instead of constructing a new multipurpose indoor recreational facility.[16] Investment in 13 outdoor spaces included improvement of the trail network, landscaping, baseball diamond revitalization or improvement, new outdoor skating surfaces, a new bike skills park, new playgrounds and acquisition of park furniture and signage in the urban and rural areas within this region.[16] The aim was to create an array of interconnected recreation opportunities across major and specialized indoor and outdoor spaces in order to promote use and improve residents' physical health and well-being. The variety of revitalized recreational venues across the region would suit residents' preferences and meet their needs for diverse activities and sports.

This study evaluated the impact of Phase 1 of the 15-year strategic plan to revitalize public recreational spaces.

Settings

The intervention region is a "specialized municipality,"[17-19] a municipal structure that is made up of small settlements (in this case, nine hamlets) with a total area of 1170.65 km^2. One of these hamlets is urban (the largest in Alberta) and eight are rural. To assess the trends in the intervention region, we used a comparison region comprising three municipalities (totalling 2448.64 km^2)[18]: a city (City of Spruce Grove), a town (Town of Stony Plain) and a municipal district (Parkland County) that includes rural areas such as hamlets, unincorporated communities and summer villages. These three municipalities are referred to as the "tri-municipal region" as they are near to each other and work closely together.

We chose this tri-municipal region as the comparison region because of the numerous similarities with the intervention region in terms of demographics, PA infrastructure, geographic location and climate. More specifically, in 2011 the intervention and comparison regions had populations of 92 403[20] and 71 790,[21] respectively, and population growth rates higher than the national average of 5.9%,[20] at 12.1%[20] and 17.4%.[21] Each region had one multipurpose indoor recreational facility, a small number of specialized indoor facilities and a variety of outdoor recreational spaces in urban or rural areas; these facilities were owned and operated by the municipalities.[22] Another deciding factor was that both the intervention and comparison regions are within 30 km of Alberta's capital, Edmonton, but sufficiently far apart from each other to limit study contamination, for example, by residents' using the other region's facilities.

Despite their similarities, the regions were at different stages of their recreational facility policies and funding opportunities at the time of the study. After public consultation in 2009, the comparison region developed a business plan that guided investment in existing recreation infrastructure with a shared budget of CAD 105 000, which was approved in 2015. The intervention region's budget was CAD 41 million for Phase 1. None of the venues were closed during their upgrading. Table 1 shows an overview of the indoor recreation facilities and outdoor spaces in the intervention region that underwent upgrading.

The intervention region's department of recreation, parks and culture and the three municipalities comprising the comparison region partnered with our research team for this quasi-experimental study. Partners informed the study design, contributed to the development of data collection tools and helped to interpret data using their in-depth knowledge of community-specific information.

The study received ethical clearance from the University of Alberta Health Research Ethics Board (Pro00022189).

Methods

This mixed-methods quasi-experimental project involved telephone surveys and focus groups before and after Phase 1, and the revitalization of public recreational spaces to increase usage, in both regions. The telephone survey includes longitudinal and repeated cross-sectional designs. In this article, we analyze longitudinal data obtained through the telephone surveys. Data obtained from the focus groups are published elsewhere.[24]

Data collection

Two digital dial telephone surveys were conducted before (August to October 2011, i.e. end of summer to mid-fall) and after (August to October 2013, i.e. end of summer to mid-fall) the Phase 1 implementation.

For the 2011 survey, participants were recruited by a contracted survey firm that randomly selected residents' telephone numbers. Potential participants were asked if they were 13 years or older and resided in one of the municipalities in each region; they were also asked the first three digits of their postal code. Awareness or previous use of either the indoor or outdoor recreational facilities and spaces were not eligibility criteria.

TABLE 1
Revitalization of each indoor facility and outdoor space owned and operated by the municipal government in the intervention region, Alberta, Canada

Recreational space / location[a] / access	Description	Revitalization activities (completed between 2011 and 2013)
Indoor		
Multipurpose recreational facility Rural Fee-based	Includes a fitness centre, 2 ice-skating areas, an indoor track, a curling rink, a play-based room for preschool-aged children, an indoor playground, a team-training room, a fitness studio and a youth lounge	Renovated 1 full-size arena, built 1 new full-size indoor arena with an ice sheet and added a 557 m^2 fitness centre, a new indoor track, community spaces, an indoor playground and multipurpose rooms
Arena (ice and dry surface) Urban Cost-free and fee-based	An ice arena (two-thirds of a regular size) with dry surfaces in the spring and summer	Renovated and retrofitted the ice arena
Multipurpose recreational facility Urban Fee-based	The largest multipurpose recreation centre in the region includes a wellness centre, an aquatics centre, 2 ice arenas, a leisure ice surface, a gymnasium, 2 indoor soccer fields and an indoor playground	Doubled the size of the indoor leisure ice surface, added to the wellness centre and increased track accessibility; built a new group fitness space and a new youth lounge; expanded the gymnasium and the indoor playground; and added multipurpose community activity rooms
Outdoor		
Golf course Urban Fee-based (in the summer)	An 18-hole golf course	Renovated the indoor community clubhouse
Off-leash dog parks Urban and rural Cost-free	Large off-leash dog parks with fenced areas, enclosed spaces for smaller dogs and boarded rinks	Improved trails and open areas inside the dog parks and added new park furniture and signage
Parks, playgrounds and green spaces Urban and rural Cost-free	The many different parks and playgrounds include amenities such as basketball hoops, firepits and a trail system connecting ponds. Most parks are wheelchair accessible and include specialized equipment	Upgrades at various locations included the addition of a community garden space, a spray deck, playgrounds, seating, gazebos, tree plantings, a viewing deck, interpretive signage, trails around the wetlands and, whenever possible, trail access points Within the BMX/bike skills park, a children's pump track was added alongside dirt ramps, rock boulders and logs, which together make ladder bridges, a wall ride and different-sized dirt jumps for all ages and skill sets
Community ball diamonds Urban and rural Cost-free	More than 40 community baseball diamonds, of which 9 are Class A premier, i.e. high-quality amenities requiring more frequent maintenance	Four baseball diamonds with expanded infields and outfields, new sod and foul-line fencing, backstops, dugouts and granular trails
Outdoor skating surfaces Urban and rural Cost-free	More than 20 outdoor skating surfaces that are open between December and March (weather dependent). Most have lights, boards and skating pathways	A new outdoor ice rink with boards, lights, newly planted trees and park furniture. A relocated leisure ice-skating area
Multiuse trails Urban and rural Cost-free	More than 200 km of trail (asphalt, gravel, shale or limestone)	New and upgraded trails with 3 m wide asphalt paving and connections with other trail systems

[a] Any areas outside of population centres, which have populations of at least 1000 people and population densities of at least 400 people per km^2, are considered rural areas in Canada.[23] In the intervention region, rural areas include hamlet communities, residential acreages and large and small lots for agricultural operations.

The survey firm called residents up to five times over a 2-week period and requested the participation of the household member with the birthday coming next to facilitate stratification of respondents by age category and sex. Targeted recruitment of youth aged 13 to 17 years and adults aged 18 to 29 years was undertaken to reach these population segments. On calling a household, the survey firm asked if there were any people in those two age groups living in the household; if yes, the interviewer asked if they could talk to them and invited them to participate in the telephone survey.

After completing the survey, participants had the option to provide their contact information if they wished to participate in a follow-up survey. They were subsequently contacted to confirm their interest in continuing to participate. New participants were also randomly selected in 2013 to mitigate attrition since 2011 and to increase the sample size to permit a more robust analysis (reported elsewhere[25,26]).

The pre-intervention survey had 1045 and 1047 participants in the intervention and comparison regions, respectively, and the post-intervention survey 1057 and 1045 participants. Of these, 64 participants from the intervention region and 69 from the comparison region were removed because of self-reported inconsistencies in age and sex. We analyzed the participant populations in both surveys—406 in the intervention region and 344 in the comparison region, to a total of 750, or 38.2% of all 2011 participants who responded to the 2013 questionnaire.

The questionnaires collected data on demographics, self-reported health, self-reported weekly PA engagement and attitude toward and use of recreation infrastructure. Using a validated questionnaire,[27,28] we asked participants about their levels of leisure-time PA in the past week. Attitudinal variables were based on agreement (on a scale from 1, for "strongly disagree," to 10, for "strongly agree") with the following four statements: "I would use indoor public recreational facilities more often if it weren't for personal reasons"; "I would use indoor public recreational facilities more often if the facilities better met my needs"; "I would use outdoor public recreational facilities more often if it weren't for personal reasons"; and "I would use outdoor public recreational facilities more often if the facilities better met my needs." The expressions "personal reasons" and "met my needs" were left undefined and the respondents were free to interpret these as they wished.

We also asked participants about their use of each venue in the last year. The response options were 0 for "never," 1 for "less than monthly," 2 for "monthly," 3 for "weekly" and 4 for "daily."

The list of the facilities and outdoor spaces revitalized in Phase 1 was provided by the intervention region prior to the survey. Only those facilities and spaces where revitalization had been completed by 2013 were included in the 2013 survey questionnaire. Given that the revitalized spaces were in both urban and rural areas across the region, most of residents could have benefitted from the upgrades.

Data analysis

Baseline characteristics of both regions were compared through chi-square tests and *t* tests. Item nonresponse was the main source of missing survey data. Approximately 30% of responses for annual household income were missing in each region; to address this, we imputed a median income of CAD 70 000, the median household income in Canada at the time of the study.[29] Tests were performed to ensure data were not skewed with the imputation but remained representative of the populations in each region. That classification was used to distinguish households with an annual income of CAD 70 000 or less versus more than CAD 70 000.

Following the guidelines suggested by Godin,[28] participants' answers to mild, moderate and strenuous PA weekly engagement were multiplied by 3, 5 and 9, respectively. A total score was calculated based on the sum of the products, which was classified into physically active (scores ≥ 24 units) or moderately/insufficiently active.

We analyzed the trends in public PA infrastructure usage using paired *t* tests. For comparative analyses, we selected indoor and outdoor spaces in the comparison region to match revitalized ones in the intervention region. Four summary indexes compiling usage data were created based on frequency of use for the indoor facilities (three in the intervention region and five in the comparison region) and outdoor spaces (six in both regions).

Given the study's time span, a two-way analysis of covariance (ANCOVA) was conducted on all indoor and outdoor spaces with statistically significant changes in usage over time. We analyzed whether variables showing significant differences between the two regions in 2011 influenced the change over time (main and interaction effects). A number of assumptions associated with ANCOVA were tested before applying the technique to ensure no violation of normality, reliability of measurement of the covariate, linearity, homogeneity of variances or homogeneity of regression slopes.[30] We calculated eta-squared values for all indoor and outdoor spaces with significant changes over time to assess the magnitude of the revitalization effect.

Of note, a sensitivity analysis comparing the characteristics of the sample of participants who responded to both surveys (n = 750) and the sample of participants who only completed the 2011 survey (n = 1209, after removal of the 133 cases with inconsistent data on age and sex) detected statistically significant differences. The sample of participants who completed both surveys was more educated (p = 0.001), included fewer full-time workers (p = 0.004), reported better self-rated health (p = 0.013) and were more likely to agree that indoor facilities met their needs (p = 0.034).

Results

Relative to the comparison region, the intervention region had a higher proportion of urban residents, higher usage of indoor facilities, better self-rated health, lower usage of outdoor spaces and less agreement that the indoor and outdoor spaces met residents' needs (Table 2).

In the intervention region, usage of the rural indoor multipurpose recreational facility increased (Table 3), but the golf course recorded a decrease in usage. In the comparison region, the usage of the golf course and off-leash dog parks decreased over time. The eta-squared values (0.40 for rural indoor multipurpose recreational facility and 0.30 for golf course in the intervention region; 0.49 for golf course and 0.29 for off-leash dogs park in the comparison region; data not

TABLE 2
Baseline characteristics of study populations in the intervention and comparison regions, Alberta, Canada, 2011 and 2013

Variables	Total (n = 750)	Intervention region (n = 406)	Comparison region (n = 344)	*p* value[a]
Mean age, years	48.9	48.4	49.6	0.347
Sex, %				0.726
Male	41.5	40.9	42.2	
Female	58.5	59.1	57.9	
Area of residence, %				0.000
Rural	34.5	27.6	42.7	
Urban	65.5	72.4	57.3	
Education level, %				0.058
Postsecondary graduate	76.2	79.0	73.0	
Less than postsecondary	23.8	21.0	27.0	
Employment, %				0.765
Part-time/retired/other	60.2	60.7	59.6	
Full-time	39.8	39.3	40.4	
Annual household income, %				0.177
< $70 000	52.3	50.0	54.9	
≥ $70 000	47.7	50.0	45.1	
Household size and composition				0.797
0 children in the household, %	58.8	58.4	59.3	
≥ 1 children in the household, %	41.2	41.6	40.7	
Mean household size, n	3.0	3.1	2.9	0.319
Leisure-time physical activity				
Mean total weekly score[b]	48.3	51.0	45.6	0.405
Weekly score, %				0.076
Moderately or insufficiently active participants (< 24)	23.9	22.7	28.3	
Physically active participants (≥ 24)	76.1	77.3	71.7	
Self-rated health, %				0.000
Low (poor/fair/good)	39.2	31.6	48.3	
High (very good/excellent)	60.8	68.4	51.8	
Mean frequency of use and meeting usage needs				
Frequency of use of indoor facilities[b]	2.1	2.2	1.9	0.002
Frequency of use of outdoor spaces[b]	2.8	2.6	2.8	0.050
Meeting indoor usage needs	5.5	5.0	6.0	0.000
Meeting outdoor usage needs	4.4	4.2	4.7	0.009

[a] *p* values are based on the chi-square test of statistical independence for categorical data and the Student *t* test for parametric data.

[b] Weighted mean.

shown) indicate large effect sizes[31] for the significant differences in the usage.

Residents in both regions reported monthly usage of the indoor facilities (mean = 1.98–2.04) and weekly usage (mean = 2.57–2.71) of the outdoor spaces in 2011 and 2013 (Table 4). The results indicated no significant change in any of the summary indexes for indoor and outdoor venues in both regions between 2011 and 2013.

For the two-way ANCOVA, we included those variables with significant differences in 2011 (Table 2). Agreement with meeting indoor and outdoor needs, despite differences, was not included because of violation of the assumption on homogeneity of slopes (Table 5).

Overall, all four models were significant, with large effect sizes. For the rural indoor multipurpose recreational facility, effects of area of residence and self-rated health on the increased usage over time were statistically significant with moderate effect sizes. The results suggested no interaction effect from the two independent variables. The 2011 usage had a statistically significant and large effect in the model of the intervention region's golf course. Neither of the main nor the interaction effects of residence and self-rated health were significant.

TABLE 3
Usage of each indoor and outdoor facility in the intervention and comparison regions, Alberta, Canada, 2011 and 2013 (n = 750 participants)

Recreational spaces	n[a]	Usage mean[b]				*p* value	95% CL
		2011	2013	Change	SD		
Indoor							
Intervention region							
Rural indoor multipurpose recreational facility	52	0.88	1.42	0.54	1.26	0.003	0.19, 0.99
Urban indoor arena (ice and dry surface)	41	0.98	1.17	0.20	1.10	0.253	−0.15, 0.54
Urban indoor multipurpose recreational facility	264	1.98	1.89	−0.09	1.18	0.231	−0.23, 0.06
Comparison region							
Urban indoor multipurpose recreational facility	221	1.95	1.83	−0.11	1.04	0.107	−0.25, 0.02
Urban indoor arena (ice and dry surface)	32	1.31	1.13	−0.19	1.15	0.363	−0.60, 0.23
Urban indoor arena (ice and dry surface)	78	1.35	1.17	−0.18	1.04	0.132	−0.41, 0.06
Rural indoor community halls	36	1.31	1.36	0.06	1.31	0.800	−0.39, 0.50
Urban indoor community halls	48	1.27	1.63	0.35	1.42	0.091	−0.06, 0.77
Outdoor							
Intervention region							
Golf courses	59	1.58	1.32	−0.25	0.82	0.021	−0.47, −0.04
Off-leash dog parks	36	2.47	2.28	−0.19	0.86	0.182	−0.48, 0.10
Parks, playgrounds and green spaces	242	2.68	2.53	−0.15	1.28	0.073	−0.31, −0.04
Community ball diamonds	47	1.79	1.74	−0.04	1.27	0.819	−0.41, 0.33
Outdoor skating surfaces	81	1.93	1.98	0.05	1.13	0.695	−0.20, 0.30
Multiuse trails	61	2.38	2.54	0.16	1.13	0.261	−0.12, 0.45
Comparison region							
Golf course	34	1.85	1.53	−0.32	0.59	0.003	−0.53, −0.12
Off-leash dog parks	47	2.40	2.11	−0.30	0.10	0.047	−0.59, −0.01
Parks, playgrounds and green spaces[c]	214	2.33	2.18	−0.15	1.39	0.116	−0.15, −0.34
Community ball diamonds	34	1.65	1.44	−0.21	1.16	0.314	−0.62, 0.20
Outdoor skating surfaces	82	1.66	1.76	0.01	0.83	0.288	−0.08, 0.28
Multiuse trails	245	2.00	1.98	−0.03	1.16	0.741	−0.17, 0.12

Abbreviations: CL, confidence limit; SD, standard deviation.

Note: Paired *t* tests were performed for within-group comparisons.

[a] Number of people who reported using the facility.

[b] Based on responses on a 5-point scale where 0 stands for "never," 1 for "less than monthly," 2 for "monthly," 3 for "weekly" and 4 for "daily."

[c] Refers to a composite variable.

TABLE 4
Usage of all indoor and outdoor facilities in the intervention and comparison regions, Alberta, Canada, 2011 and 2013

Recreational spaces	n[a]	Usage mean[b]				*p* value	95% CL
		2011	2013	Change	SD		
Intervention region							
Overall indoor usage[c]	276	1.98	1.98	0.00	1.23	1.000	−0.15, 0.15
Overall outdoor usage[d]	282	2.71	2.62	−0.09	1.19	0.232	−0.22, 0.05
Comparison region							
Overall indoor usage[c]	230	2.04	2.00	−0.04	1.14	0.564	−0.19, 0.10
Overall outdoor usage[d]	246	2.69	2.57	−0.12	1.15	0.099	−0.27, 0.02

Abbreviations: CL, confidence limit; SD, standard deviation.

[a] Number of people who reported using the facility.

[b] Based on responses on a 5-point scale where 0 stands for "never," 1 for "less than monthly," 2 for "monthly," 3 for "weekly" and 4 for "daily."

[c] Monthly usage.

[d] Weekly usage.

TABLE 5
Results of two-way ANCOVA: tests of between-subject effects

Recreational spaces	Type III sum of squares	*F* statistic	*p* value	Partial eta-squared	Adjusted R^2
Intervention region					
Major rural indoor multipurpose recreational facility					
Adjusted model	16.152	3.755	0.010	0.242	0.178
Area of residence in 2011	5.045	4.691	0.035	0.091	
Self-rated health in 2011	5.116	4.758	0.034	0.092	
Frequency of use in 2011	2.295	2.135	0.151	0.043	
Area of residence in 2011 × self-rated health in 2011	0.049	0.460	0.831	0.001	
Golf course					
Adjusted model	13.128	6.696	0.000	0.336	0.286
Frequency of use in 2011	12.488	25.480	0.000	0.325	
Area of residence in 2011	0.000	0.000	0.985	0.000	
Self-rated health in 2011	0.435	0.888	0.350	0.160	
Area of residence in 2011 × self-rated health in 2011	0.534	1.089	0.301	0.200	
Comparison region					
Golf course					
Adjusted model	15.419	15.852	0.000	0.686	0.643
Frequency of use in 2011	14.025	57.676	0.000	0.665	
Area of residence in 2011	0.163	0.669	0.420	0.023	
Self-rated health in 2011	0.068	0.278	0.602	0.010	
Area of residence in 2011 × self-rated health in 2011	0.068	0.278	0.602	0.010	
Off-leash dog parks					
Adjusted model	17.377	5.514	0.001	0.344	0.282
Frequency of use in 2011	11.974	15.197	0.000	0.266	
Area of residence in 2011	3.418	4.338	0.043	0.094	
Self-rated health in 2011	0.503	0.638	0.43	0.015	
Area of residence in 2011 × self-rated health in 2011	1.326	1.683	0.20	0.039	

Abbreviations: ANCOVA, analysis of covariance; R^2, multivariate coefficient of determination.

For the comparison region's golf course model, significant and large effects were found in the 2011 usage. For the off-leash dog parks in the comparison region, the 2011 usage of these outdoor spaces and area of residence had statistically significant effects. The effect sizes were large for frequency of use in 2011 and moderate for area of residence.

Discussion

This quasi-experimental study showed that Phase 1 of a 15-year municipal plan to revitalize urban and rural recreational indoor and outdoor spaces did not increase usage levels in most of the renovated venues over a 2-year period. After a new arena for recreational skating, a wellness centre, a fitness track and an indoor playground were built, usage of the rural multipurpose indoor recreational facility increased.

While the lack of indoor recreational facilities in rural areas in North America is an issue,[14,15] the existing infrastructure in the intervention region may have been obsolete, not meeting people's evolving needs and even creating barriers to usage. However, changes to programming following the renovations may have contributed to the increased usage.

The major urban multipurpose indoor recreational facility was the most used in the intervention region in both years. However, its revitalization did not increase usage (usage demand was over capacity prior to revitalization). Revitalization doubled the size of indoor leisure ice arenas, improved track accessibility, expanded the gymnasium, multipurpose community activity rooms and the indoor playground area and added a wellness centre, fitness spaces and youth lounge. These upgrades may not have addressed some barriers to using this facility, as has occurred elsewhere.[32] Focus group participants described non-physical environmental factors such as crowdedness and cleanliness as barriers, for instance.[24]

The lack of change in usage in the revitalized urban indoor ice and dry arena may have been because the revitalization plan did not address some barriers. For example, focus group participants were concerned that the facility prioritized hockey-related activities over recreational ice skating.[24] Demand for ice surfaces that exceeds facility availability is typical for municipalities across Alberta and is further complicated by demand from competing activities.

In both regions, usage of the golf courses decreased over time, possibly due to the high costs of playing golf across North America and the sport's decreased popularity among younger generations.[33] We also found decreased usage of off-leash dog parks in the comparison region and no change in usage in the upgraded equivalent spaces in the intervention region.

Outdoor space usage levels in the intervention region did not increase after revitalization. Outdoor spaces (except for golf courses) offer opportunities for recreation at no cost to communities regardless of their socioeconomic status. Parks, multiuse trails and other types of outdoor spaces can be an alternative to indoor recreational facilities, especially for people living at low income who cannot afford membership fees, drop-in rates and sport equipment. The populations of both regions used indoor and outdoor spaces, on average, on a monthly and weekly basis, respectively, at both baseline and follow-up periods. Comparison of the baseline and follow-up usage levels of indoor and outdoor venues revealed no statistical increase. Still, it should not be inferred that the intervention region's revitalization plan did not succeed in increasing usage. First, this study reports on a relatively short-term follow-up assessment of usage after the revitalization, and our follow-up survey coincided with the end of Phase 1 of the revitalization plan due to construction delays. Second, the 15-year intervention plan and upgrading of the other recreation infrastructure was still underway at the time of our analysis. Assessment of usage after completion of all phases of the plan may describe another scenario.

Of note, at the time of writing, the intervention region had completed Phase 2 (2014–2018) and Phase 3 (2019–2023) of the revitalization plan, which involved improvements to other existing recreation infrastructure.[34] Analysis of the impacts of these phases at the population level were not performed due to funding constraints and the nature of the available local data.

However, our findings suggest that strategies targeting only physical infrastructures may not result in increased usage across a municipal population. While the recreational venues are geographically dispersed across the region, which would ostensibly facilitate access, local sociocultural needs and leisure-time PA-associated costs may have precluded more frequent use. As discussed elsewhere,[10,11] a key component in revitalizing physical environments is the creation of new PA programs and activities that attract new users and increase the usage levels of current users.

Our null results may be further explained by population preference. Municipal recreation infrastructure may not appeal to everyone, despite the intention that these resources be inclusive, accessible and community-wide. After Phase 1, our focus groups participants described barriers at the intrapersonal level (e.g. family dynamics); facility features unrelated to the PA infrastructure (e.g. unhealthy food options offered by food vendors); facility programming (e.g. no programs for youth and older adults); economic aspects (e.g. high membership fees); social environment (e.g. safety concerns); and policy environment (e.g. inadequate public transportation to get to recreational spaces).[24] These factors determined participants' usage of the facilities, but from a policy perspective, went beyond the scope of the intervention region's revitalization plan. Therefore, initiatives with the aim of addressing inequities in access to publicly funded, health-promoting community resources should consider both the built and social environments when designing and evaluating interventions.[1,35,36] Considering people's experiences when using or trying to use these venues is key to tailoring the intervention to local needs.[10,37] That is particularly relevant for longer-term interventions conducted in multiple phases because the reassessment of residents' needs allows for adjusting the ongoing and future revitalization activities vis-à-vis demographic and social changes.

Recreation literature[6,37] and socioecological frameworks[35,36] call for coordinated, multifaceted population-level interventions that target people's diverse physical and social needs. A recent meta-narrative evidence synthesis on urban green spaces identified stronger evidence for interventions combining built environment changes and PA programming compared to only built environment–oriented interventions.[1]

Our findings reinforce the need for collaborative multisectoral work around a common, shared agenda for a more effective population health intervention and healthier and more active people. Strengthening existing partnerships between municipal departments (e.g. recreation and leisure service delivery, education) may increase the usage of public recreational venues. For instance, improving travel connections in urban settings may enhance usage of venues[1] and offering organized activities will likely increase the usage of outdoor spaces.[22] In rural settings, promoting community trails as social gathering places (e.g. sporting events and charity walks and races) may increase the usage of public outdoor spaces.[38] A multilevel approach informed by the socioecological framework may more effectively improve usage of public recreational venues.[35]

These findings remain relevant and may be even more critical to the current Canadian context of austerity measures and increased costs of living.[39,40] Engagement of residents to assess community needs and of intersectoral partnerships to address barriers to get to and use the recreational venues for different activities are key to guiding community investments in public recreation infrastructure, especially when public resources are scarce. As more people are struggling financially, providing opportunities to use and enjoy the newly renovated, cost-free outdoor spaces can support PA engagement, socialization and well-being.

Strengths and limitations

Limitations of this study include the potential coverage bias that occurs with conducting landline telephone interviews and the relatively low response rate (19% to 33%). Loss to follow-up was also a limitation as only 38.2% of the participants in 2011 completed the questionnaire in 2013. In our sensitivity analysis, we found statistically significant differences between the sample who completed the 2011 survey alone and the sample who completed both surveys, which means that our findings may not be generalizable to the full pre-survey population. The missingness in our dataset was related to item nonresponse (shown in the high percentage of missing income data).

This study did not capture PA engagement; we measured the impact on indoor and outdoor space usage for PA purposes. Because of the construction delays, the follow-up survey was conducted near the end of the Phase 1 of the revitalization plan; study funding constraints precluded conducting the survey later, although the

results would probably have been different had the survey been administered when residents had had longer to become aware of the upgrades. The results might also have been different if the data had been collected in winter or spring, but to ensure comparability, both surveys were administered at between the end of summer and the middle of fall. The timing of the revitalization may have played a role in participants' responses as some spaces were revitalized in 2011 and others in 2013, when only a few months had elapsed between completion of the upgrades and administration of the follow-up survey.

A full analysis of representativeness for each region was not performed; however, because municipal recreational venues are not uniformly used in the regions, those who participated in the survey either had a positive or negative motivation for self-reporting on this topic.

Another limitation was the impossibility of being able to control multiple external factors affecting our outcome—an inherent disadvantage of quasi-experimental studies. However, the quasi-experimental design provides stronger evidence regarding the degree and the direction of temporal changes,[41] to better support decision-making and resource allocation.

To date few longitudinal quasi-experimental studies have examined environmental interventions for PA promotion, and most of the existing ones have focused on outdoor spaces.[13,42] Our study adds to the literature by including both indoor and outdoor spaces and different types of recreation infrastructure; and by analyzing the usage of recreational venues located in both urban and rural settings.

Considering the time delay between the environmental intervention and subsequent impacts on population-level health outcomes,[13,41] an advantage of our study is the use of a 2-year follow-up period instead of the more typical follow-up of less than 1 year.[13,42] Another advantage is the provision of real-time information on the impact of Phase 1. Assessing the Phase 1 of an ongoing strategic plan helped the region evaluate current revitalization activities to better tailor future efforts to meet the goal of increasing usage among residents. The other strengths are the inclusion of both youth and adult populations and collection of pre–post data at the same time of year to control for seasonal variation, which is important for outdoor spaces.[1]

Conclusion

Our longitudinal analysis with a comparison group found that the Phase 1 goals of a three-phase municipal revitalization plan to increase usage levels of the interconnected major and specialized public indoor and outdoor recreational venues had not been fully realized at the time of the study. Upgrading the physical infrastructure of public recreational venues is fundamental for increasing usage levels; however, revitalization followed by the implementation of strategies to address perceived barriers to accessing venues are more likely to increase usage. We recommend that environmental interventions seek to promote equitable inclusivity, livability and well-being, taking into account residents' perceptions and experiences of municipal venues. Public recreational venues offer much more than PA opportunities. These community-wide resources act as places of connection, well-being and health promotion. Thus, municipal efforts to create a welcoming environment in public recreational facilities and outdoor spaces may help attract diverse users, from professional and amateur athletes to spontaneous users seeking to get out in their community.

Working with smaller budgets, decision-makers and managers of public recreational venues are seeking alternatives to maximize cost-savings while improving residents' usage levels. This might require investing in programming and marketing and promotion activities for outreach to ensure residents are aware of and motivated to use the upgraded recreational venues, thus increasing usage among current users and attracting new ones.

Environmental audit tools may provide some context of the physical and working conditions of equipment and amenities and other social aspects of facilities (e.g. trained staff and changes in demand for access to indoor public spaces during extreme weather emergencies). Defining a benchmark of usage for each venue may support the revitalization plans and program development. Finally, collaborative work from multiple departments (e.g. urban design, public health) can offer a systems or wrap-around approach for mitigating barriers faced by residents. Exploring the impacts of the revitalized recreational venues located in urban and rural settings on urban or rural residents, respectively, can support further analysis on the successes of local community investments in meeting the diverse needs of the local population group.

Little is known about the impact of public investments in existing indoor and outdoor recreational spaces,[1,7,10] which compromises evidence-informed decision-making by municipal, provincial and federal governments regarding returns on investments with smaller public budgets. Identifying effective population-level environmental strategies to increase usage of these spaces is needed to help guide investments and to serve as a cornerstone for multifaceted, comprehensive population health initiatives.

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Conflicts of interest

CIJN is a member of the *HPCDP Journal* Editorial Board, but had no role in the

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The authors declare no conflicts of interest.

Authors' contributions and statement

APB: Investigation, methodology, visualization, writing—original draft, writing—review and editing.

LN: Data curation, investigation, project administration, writing—review and editing.

VK: Formal analysis, methodology, visualization, writing—review and editing.

CIJN: Conceptualization, data curation, funding acquisition, investigation, methodology, supervision, writing—original draft, writing—review and editing.

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Evidence synthesis

Impacts of built environment changes on physical activity in Canada: a systematic review of natural experiments

Stephanie A. Prince, PhD (1,2); Justin J. Lang, PhD (1,2,3); Sarah Lawrason, PhD (4); Eric Vallières, PhD (5); Gregory P. Butler, MSc (1); Alison Lake, MLS (6); Gavin R. McCormack, PhD (7)

This article has been peer reviewed.

Abstract

Introduction: The built environment supports physical activity (PA) by providing opportunities to be active in daily life. Natural experiments are valuable for assessing how real-world changes to the built environment affect PA and are critical for guiding policies to improve population-level PA. The objective of this review was to summarize the evidence from natural experiments that investigated the impacts of built environment changes on PA in Canada.

Methods: Searches were conducted in MEDLINE, Embase, PsycINFO, ProQuest Public Health and SportDISCUS, from inception to 27 November 2024. Natural experiment evaluations that included a comparator or historical control group and assessed changes in PA associated with changes in the built environment were eligible. A narrative synthesis summarizes the evidence and the certainty of the evidence.

Results: Results from the included natural experiments (n = 25) suggest positive effects, with low to moderate certainty, of increased walkability, new cycling and pedestrian infrastructure, bike share (bike rental) programs and new trails. However, there was very low to low certainty of no significant effects for bus rapid transit, school building and yard improvements and school zone improvements. Some evidence suggests negative effects of off-leash dog park areas on children's park-based PA and of daycare yard improvements on moderate-to-vigorous intensity PA.

Conclusion: Few Canadian studies have evaluated the impact of built environment changes on PA, with most emerging in the last decade. Future studies should include larger and more diverse samples and all regions, control for confounders including seasonal variation in outdoor PA, use well-matched control groups and incorporate objective PA measures.

Keywords: *cycle paths, walkability, transit, parks, schools, pedestrian, active transportation, children, adults*

Highlights

- Increased neighbourhood walkability, new cycling and pedestrian paths, and bike share programs are the most studied and promising interventions for promoting physical activity.
- New bus rapid transit routes and improvements to school buildings, yards and zones were less studied, and were not as effective at increasing physical activity.
- Few Canadian studies have evaluated the impact of built environment changes on physical activity, and the certainty of the evidence is largely low to very low.
- Natural experiments provide a valuable way to assess the effectiveness of real-world changes to the built environment and are critical for guiding policies to improve population-level physical activity.

Introduction

Regular physical activity (PA) plays an important role in supporting mental and physical health and well-being.[1-4] The built environment can support PA across the domains of work, school, home, leisure and transportation. The built environment refers to physical environment features that are manufactured or modified by people, including structures and buildings, recreation facilities, green spaces and parks, transportation systems and community design.[5] The World Health Organization's *Global Action Plan on Physical Activity 2018–2030* acknowledges

Author references:

1. Centre for Surveillance and Applied Research, Health Promotion and Chronic Disease Prevention Branch, Public Health Agency of Canada, Ottawa, Ontario, Canada
2. School of Epidemiology and Public Health, Faculty of Medicine, University of Ottawa, Ottawa, Ontario, Canada
3. Alliance for Research in Exercise, Nutrition and Activity (ARENA), University of South Australia, Adelaide, South Australia, Australia
4. Regulatory, Operations and Emergency Management Branch, Ontario Region, Public Health Agency of Canada, Toronto, Ontario, Canada
5. Regulatory, Operations and Emergency Management Branch, Quebec Region, Public Health Agency of Canada, Montréal, Quebec, Canada
6. Health Library, Public Health Agency of Canada, Ottawa, Ontario, Canada
7. Department of Community Health Sciences, Cumming School of Medicine, University of Calgary, Calgary, Alberta, Canada

Correspondence: Stephanie A. Prince, Centre for Surveillance and Applied Research, Health Promotion and Chronic Disease Prevention Branch, Public Health Agency of Canada 785 Carling Avenue, Ottawa, ON K1A 0K9; Tel: 613-324-7860; Email: stephanie.prince.ware@phac-aspc.gc.ca

the importance of safe and enabling built environments for providing people with opportunities to be physically active in their daily lives.[6]

Systematic reviews have shown that built environment features such as walkability and recreation facilities, parks and green spaces are positively associated with PA;[7,8] this has important implications for health.[5] However, much of this evidence is cross-sectional, despite the lack of natural experiments being consistently noted as a limitation.[7-12] A recent Delphi study identified the need for stronger study designs, including natural experiments, to establish causality between changes in the built environment and PA.[13] Natural experiments are interventions that occur in real-world settings where the exposure is not directly manipulated by the researcher.[14,15] Such interventions evaluate the effects of "naturally occurring" changes to the built environment (e.g. bicycle paths, park improvements, light rail transit) on PA. Natural experiments are more practical than traditional experimental studies (such as randomized controlled trials [RCTs]) for investigating the health impacts of environmental interventions where random allocation to exposure is not feasible due to naturally occurring and often large-scale built environment interventions or changes. Natural experiments are critical for advancing the evidence and informing policies to improve population health.[16,17]

Previous reviews that focused on natural experiment evidence, regardless of country, have generally found that creating new pedestrian and/or cycling infrastructure (e.g. walking/cycling paths) and public transit including bus rapid transit and light rail transit routes and stops were associated with increased PA including active transportation and total walking and cycling, though not all associations were positive.[10-12,18-21] Although less studied than pedestrian and cycling path improvements, park and playground improvements (e.g. signage, walking paths, play equipment, seating, waste facilities) have also generally been associated with higher PA or park use.[10,12] Less evidence from natural experiments is available for other built environment changes.

Using these stronger study designs, compared to cross-sectional studies, results in evidence that is more mixed.[12] Still, evidence for positive associations between walkability and transport-related PA has been consistent regardless of study design.[7,8] PA has mostly included self-reported measures of general moderate-to-vigorous intensity physical activity (MVPA) or intervention-specific outcomes such as walking and cycling. Most studies have included smaller samples with limited understanding of the representativeness to the general population.

Most evidence has emerged from the United States,[11,12,18] and associations between built environments and PA may not always be consistent across countries.[22,23] Country- and region-specific factors such as climate, social norms, culture, geography, topography, socioeconomics, funding and policies influence the built environment and how it is used. PA patterns also differ across countries and global regions.[24] Canadian sociocultural, geopolitical and behavioural contexts differ from those of other countries, thus country-specific evidence on built environment effects on PA may be more relevant for informing local urban design decisions and policies. Of note, Canadian and American cities are often combined in studies, and while there are similarities in their built environments, such comparisons require careful examination of seemingly comparable parameters.[25]

Several national initiatives have recognized the importance of creating supportive built environments to promote healthy active living in Canada.[26-30] Yet we are aware of only two reviews that summarized Canadian-specific evidence on the associations between built environments and PA.[31,32] Christie et al. found that street connectivity, greenness, destination density and walkability were positively associated with PA among adults living with low socioeconomic status in Canada.[31] Farkas et al. summarized the literature examining associations between neighbourhood built characteristics and walking among Canadian adults and found that walkability and land use were consistently associated with walking for transportation, while destination proximity was associated with walking for any purpose.[32]

Christie et al. included studies up to 2017[31] and Farkas et al. up to 2016.[32] Of these studies, almost all were cross-sectional, thereby precluding the ability to infer causality. Hence, there remains a need for an update to further understand the scope of natural experiment studies of the built environment and PA in Canada.

Summarizing the effectiveness of built environment changes identifies successful strategies that can improve population PA levels in Canada. In addition, natural experiment evaluations improve our understanding of causality and, accordingly, have gained popularity in the last decade or so.[33] The objective of this review was to summarize evidence on natural experiments that investigated changes to the built environment and their impact on PA patterns in a Canadian context.

Methods

The review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses[34] and was prospectively registered (http://www.crd.york.ac.uk/PROSPERO/view/CRD42024620614).

Inclusion criteria

Population

Studies included measurable Canadian data, in urban or rural settings. No age or health restrictions were applied.

Exposures

Environmental interventions could include the addition, removal or modification of built environment features or components at macro or micro scales, for example, walking and/or cycling infrastructure, recreation facilities, parks, trails, public transit, traffic-calming features, school design and green spaces. Studies that examined changes in PA as a result of residence relocation were also eligible. Studies examining policies or laws related to the built environment (e.g. vehicle speed limits) were eligible provided these were evaluated in the context of changes in PA.

Studies examining built environment changes to clinical settings (e.g. hospitals) were not eligible. Only objective changes to the built environment were eligible; self-reported or perceived changes to the environment were not included.

Controls

Studies must have included a historical or comparator control. A historical control consists of data collected prior to the change in the built environment, either at the individual or the population level. A comparator control consists of individuals or clusters of individuals not exposed to

the same change in the built environment, such as a similar neighbourhood or city without exposure to the intervention.

Outcomes

PA included behaviours with an energy expenditure of more than 1.5 metabolic equivalents of task (METs), including time spent in light, moderate or vigorous intensity PA,[35] as well as step counts. PA could occur across active living domains such as recreation, transportation, occupation or schools and households,[36,37] and could be measured either via self-report (e.g. questionnaire, diary or log, ecological momentary assessment), device (e.g. pedometer, accelerometer, global positioning system [GPS]) or direct observation. PA outcomes could be reported as continuous time (e.g. minutes per day) or counts (e.g. the number of people engaged in PA).

Study designs

All natural experiments assessing changes in the built environment were considered, including quasi-experimental, longitudinal interrupted time series, pre–post longitudinal studies, repeated interrupted time series, repeated cross-sectional studies and both prospective and retrospective residential relocation studies.

Publication status

Eligible studies could be peer-reviewed journal articles or indexed dissertations.

Language

No language restrictions were imposed on the search strategy, but only publications in English or French were included based on authors' language knowledge capacity.

Time frame

All published literature regardless of date of publication was considered.

Exclusion criteria

Studies were ineligible if they were animal studies, focused on a clinical setting (e.g. hospitals), did not report on changes in an environmental feature or an environmental exposure, did not report on changes in a PA outcome (i.e. pre–post or post relative-change measure) or were published in a language other than English or French. Conference abstracts, commentaries, editorials and reviews were also not eligible.

Search strategy

A comprehensive search strategy was developed by all the authors and a research librarian [AL]. The primary search was created in MEDLINE (via Ovid), peer reviewed using the Peer Review of Electronic Search Strategies (PRESS) guideline[38] and translated to Embase (via Ovid), APA PsycINFO and ProQuest Public Health. A second research librarian translated and completed the searches in SPORTDiscus (via EBSCOhost). All searches were run from inception until 27 November 2024. References of topical systematic reviews and included studies were manually searched for additional studies. (See Supplementary Tables 1–5 for the search strategies.)

Article screening

Articles were imported into Covidence (Veritas Health Innovation, Melbourne, AU) for screening and duplicates were removed. Two reviewers [SAP, JJL, SL, GRM or GPB], working independently, screened the titles and abstracts to identify potentially relevant articles. The full texts of the potentially eligible studies were then screened by two reviewers [SAP, JJL, SL, GPB or EV], also working independently. If any disagreements arose, they were resolved through discussion, with a third reviewer if necessary.

Data extraction

Standardized data extraction forms were piloted and completed in Covidence by two reviewers [SAP, JJL, SL, GPB, EV or GRM], working independently. The reviewers were not blinded to the authors or journals when screening or extracting data, but did not extract data from their own work.

Risk of bias appraisal

The risk of bias (RoB) of the individual studies was assessed using the Risk of Bias in Non-randomized Studies of Exposure (ROBINS-E) tool.[39] Studies were assessed for the following potential biases: confounding; participant selection; exposure assessment; postexposure interventions; missing data; outcome measurement; and selective outcome reporting. For each study, the RoB was reported as low, moderate, serious or critical. RoB assessments were carried out by two reviewers [SAP, JJL, SL, GPB, EV or GRM], working independently, and disagreements were resolved through discussion with a third reviewer [SAP].

Data synthesis

A narrative synthesis was used to report findings grouped by built environment change and PA outcome. A meta-analysis was not possible as we did not identify at least two studies reporting on the same built environment change and using the same outcome.

Grading the overall evidence

The certainty and strength of the evidence was rated using a modified Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach.[40] GRADE provides a transparent and structured process for summarizing the quality of evidence as high, moderate, low or very low. Usually RCTs begin as high quality and other study designs as low; given that RCTs are generally not feasible when evaluating changes to the built environment, for the purposes of this review, natural experiments (i.e. nonrandomized studies) began as high quality.[41] Quality was based on confidence in the effect estimate and was reduced due to limitations in study design or execution, inconsistency of results, indirectness of evidence, imprecision and publication bias (see Supplementary Table 6 for a summary of decision rules). One reviewer [SAP] assessed the evidence for each built environment intervention and outcome, and the review team verified the assessment for accuracy.

Results

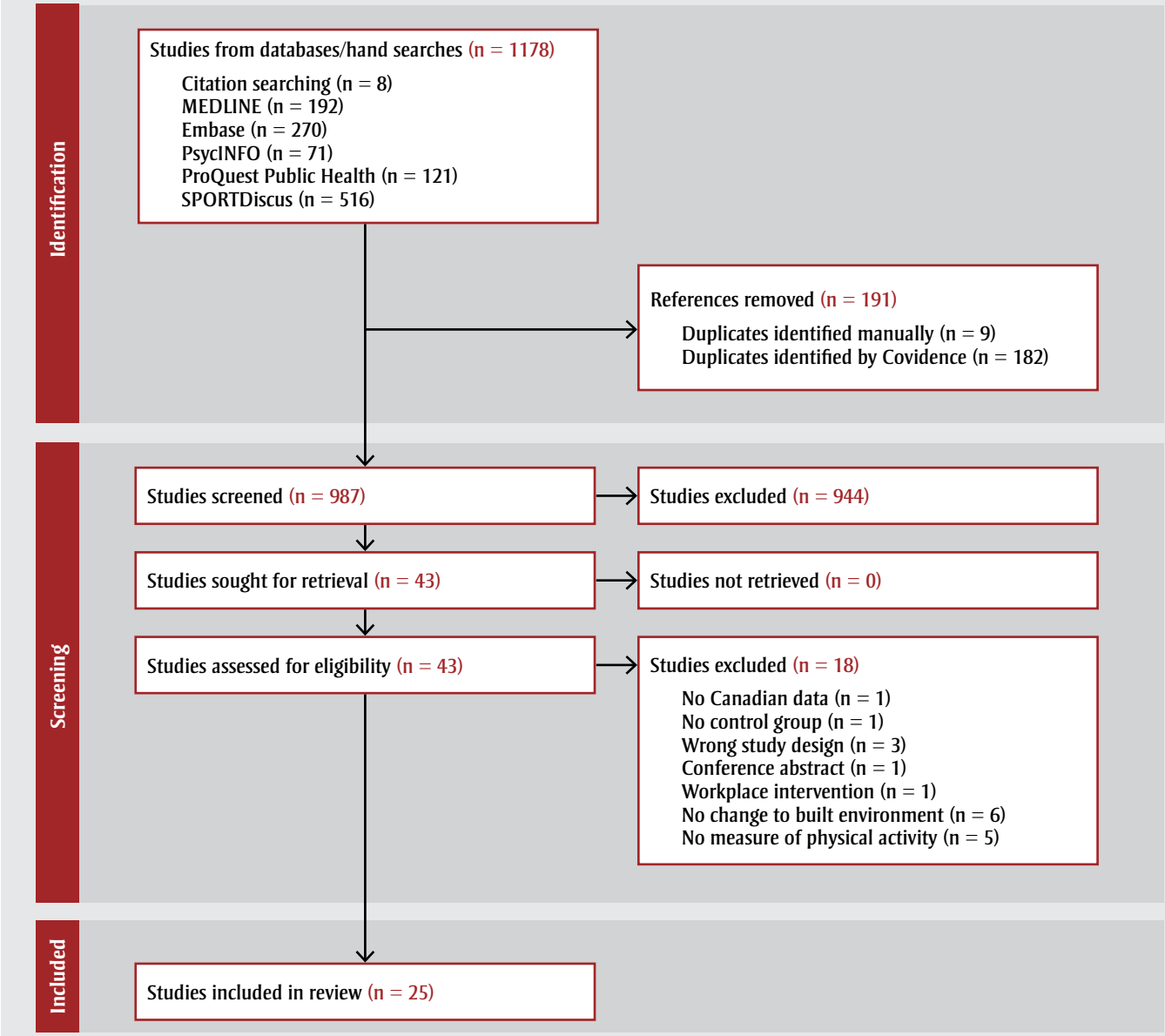
Study characteristics

The search identified 1170 potentially relevant papers—192 were identified in MEDLINE, 270 in Embase, 71 in PsycINFO, 121 in ProQuest Public Health and 516 in SPORTDiscus (in order of merging the databases into Covidence). Eight additional papers were identified by manually searching the reference lists in relevant reviews. After removing duplicates, 987 articles were retained for title and abstract screening. Of these, 43 full texts were screened (see Figure 1).

A total of 25 papers met the inclusion criteria.[42-66] For a list of the 18 excluded full texts and the reasons for their exclusion, see Supplementary Table 7. Characteristics of the included studies are shown in Table 1.

Studies were published between 2013 and 2024 and mainly included middle-aged adults (e.g. 35–57 years) in the general population. A quasi-experimental study design was the most frequently used,

FIGURE 1
PRISMA[34] flow diagram



Abbreviation: PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

followed by residential relocation and pre–post designs. Follow-up times ranged from 3 months to 5 years, with 1 year the most common.

One study was at the national level (except Quebec)[54] and another included all the provinces.[64] Nine studies took place in Alberta,[45,52,55-59,61,66] seven in British Columbia,[42,44,48,49,51,62,65] six in Ontario,[43,46,47,52,53,63] two in Quebec,[43,50] one in Manitoba[60] and one in Nova Scotia.[65] Aside from the national studies,[54,64] no studies were conducted in the territories, Saskatchewan, Prince Edward Island, New Brunswick or Newfoundland and Labrador.

Changes in 10 built environment features were evaluated, with most in the context of residential neighbourhoods. The most studied change was increased walkability as a result of residential relocation (31%). New cycling-specific (15%) and combined multiuse (12%) paths were the next most studied changes. PA outcomes were mainly self-reported (64%), measured using devices (20%) or directly observed (12%).

Risk of bias

Overall, three studies (12%) had very high risk of RoB, 14 (56%) had high risk of RoB and eight (32%) had some concerns of RoB (see Table 2). No studies were deemed to have a low RoB. The areas with the most concern included a lack of adjustment for important confounding factors (56%) and issues with missing data (52%).

Summary of evidence

Table 3 shows the summary of findings across each built environment change and PA outcome.

Change in walkability (via residential relocation)

There is very low certainty of evidence for a positive effect of moving to a

TABLE 1
Characteristics of included studies (n = 25)

First author, year / City or province / Setting	Population description (cohort)	Mean age (SD) or range / Sample size analyzed	Study design / Follow-up time	Built environment change / Comparator	PA outcome (method of assessment measurement)
Change in walkability (via residential relocation)					
Adhikari, 2020[42] Vancouver, BC Urban	General population: 66.7% F, 67.7% college degree, 20.2% household income < $20 000	35.7 (13.8) years N = 223, I: n = 68, C: n = 155	Residential relocation Average 10 months	I: Increased walkability (residential density, commercial floor area, land-use mix, intersection density) as a result of moving C: Decreased walkability or no change	Total walking trips per day (self-report, travel behaviour survey)
Christie, 2022[45] Alberta Urban	General population participating in ATP: 64.3% F, 29.0% with low income, 21.2% with high school or lower education	52.5 (9.1) years I1: n = 235 I2: n = 234 C: n = 234 T: n = 703	Residential relocation Mean 2.94 years	Built environment characteristics (population counts, diversity of destinations and street connectivity) and a composite walkability index estimated for 400 m Euclidean buffers around each residential 6-digit postal code at baseline and follow-up; decreased walkability (I1), increased walkability (I2) No change (C)	Total past-week walking time (self-report, IPAQ)
Collins, 2018[47] Ontario Urban	Imminent movers: 71% F, 80% college diploma or higher	51.2 (15.2) years; High–low: n = 9 Low–high: n = 5 Low–low: n = 19 T: n = 35	Residential relocation Approximately 1 year	Change in neighbourhood walkability measured by Walk Score: low walkability vs. high walkability Pre-move values	Total transportation walking, occupational and recreational PA (self-report, diary)
McCormack, 2017[56] Calgary, AB Urban	General population: 61.3%–74.5% F, 75.0%–89.5% White, 68.1%–72.2% university educated, 10.2%–19.1% household income < $60 000	I1: 41.6 (16.7) years, n = 47 I2: 42.8 (15.6) years, n = 48 C: 54.4 (13.8) years, n = 820	Residential relocation 12 months	Change in neighbourhood walkability measured by Walk Score at the level of the postal code: decline in walkability (I1); improved walkability (I2) Non-movers vs. maintainers (C)	Perceived direction and relative magnitude of change in total transportation walking, transportation cycling and overall PA (self-report)
McCormack, 2021[58] Alberta Urban	General population participating in ATP: 61.7%–66.7% F, 58.2%–58.5% completed postsecondary education, 17.1%–24.2% household income ≤ $49 999	I1: 51.8 (8.7) years, n = 165 I2: 51.8 (8.7) years, n = 130 C: 55.7 (9.1) years, n = 5646	Residential relocation 1.5–1.8 years	Moved to neighbourhood with less street integration (I1), moved to neighbourhood with greater street integration (I2); street integration was street connectivity reflecting changes in direction needed to travel between locations in a 1.6 km radial buffer C: Non-movers	Total daily MVPA, active transportation time, leisure VPA, leisure MPA, LW, leisure MPA including walking (MPA+LW), leisure MVPA including leisure walking (MVPA+LW), transportation walking, leisure and transportation walking (self-report, IPAQ)

Continued on the next page

TABLE 1 (continued)
Characteristics of included studies (n = 25)

First author, year / City or province / Setting	Population description (cohort)	Mean age (SD) or range / Sample size analyzed	Study design / Follow-up time	Built environment change / Comparator	PA outcome (method of assessment measurement)
McCormack, 2023[59] Alberta Urban	General population participating in ATP: 61.6%–67.2% F, 54.5%–61.6% completed postsecondary education, 17.2%–25.6% household income ≤ $49 999	I1: 51.6 (8.2) years, n = 164 I2: 52.2 (9.6) years, n = 134 C: 55.7 (9.1) years, n = 5679	Residential relocation Median 2 years	Change in neighbourhood walkability index (intersections, destinations, population density) ≤ 400 m buffers around homes: moved to neighbourhoods with less walkability (I1), moved to neighbourhoods with more walkability (I2) Non-movers (C)	Total weekly walking time (self-report IPAQ)
Salvo, 2018[61] Calgary, AB Urban	General population (Pathways to Health Project): I1: 73.5% F, 69.4% university educated; I2: 49.3% F, 70.8% university educated	I1: 41.6 (16.7) years, n = 49 I2: 42.8 (15.6) years, n = 48 C: NR	Residential relocation Previous 12 months	Change in neighbourhood walkability measured by Walk Score at the postal code level: less walkable (I1), more walkable (I2) Same walkability (C)	Total perceived change in walking time, cycling time, transportation walking, transportation cycling and overall PA (self-reported change)
Wasfi, 2016[64] All provinces Urban and rural	Urban dwellers (National Population Health Study): 54.4% F, 30.2% completed postsecondary education	38 (9), 18–55 years Movers: n = 1313; non-movers: n = 1663	Residential relocation Every 2 years for 12 years	Cumulative exposure to walkability (Walk Score quartiles) and change in Walk Score quartile between survey cycles (2 years). Dummy variable identified participants who moved 2 or more Walk Score quartiles in either direction (i.e. increase or decrease in walkability) Comparator groups specific to each analysis: low-walkability exposure (quartile 1); movers within same Walk Score quartile	Percent utilitarian walkers (self-report, questionnaire)
New cycling paths and improvements					
Boss, 2018[43] Ottawa–Gatineau, ON and QC Urban	Strava mobile app users	NR N = 52 123	Repeated cross-sectional 1 year	3 new bike and pedestrian bridge installations: Adàwe Crossing, a bike and pedestrian bridge (opened December 2015); Hickory bike and pedestrian bridge (opened August 2015); MacDonald-Cartier pathway (opened December 2015) No comparator or control group. Data collection relied on statistical methods, such as spatial autocorrelation, to distinguish significant changes in ridership patterns from random pattern changes	Cyclist counts on intervention routes (Strava mobile app)

Continued on the next page

TABLE 1 (continued)
Characteristics of included studies (n = 25)

First author, year / City or province / Setting	Population description (cohort)	Mean age (SD) or range / Sample size analyzed	Study design / Follow-up time	Built environment change / Comparator	PA outcome (method of assessment measurement)
Ling, 2020[53] Toronto, ON Urban	General cycling population	NA N = 10 579	Longitudinal pre–post Preimplementation cycling counts were collected on average 14 months (range: 9–29 months) before cycle track implementation; postimplementation cycling counts were collected on average 34 months (range: 9–51 months) after cycle track implementation	6 new cycle tracks spanning a total of 8.81 km: Sherbourne St. (2.54 km); Adelaide St. W (1.61 km); Richmond St. W (1.39 km); Simcoe St. (0.69 km); Wellesley St. E (1.28 km) and Wellesley St. W–Queen's Park (1.30 km) Of these 6 cycle tracks, 3 were upgraded from painted bike lanes: Wellesley St. E, Wellesley St. W–Queen's Park and Sherbourne St. Only 2 of the 6 cycle tracks were one-way: Richmond St. W and Adelaide St. W. The tracks were separated with mixed uses of bollards, planters, raised curbs and raised tracks Preintervention values	Cyclist counts on intervention routes (direct observation)
Slaney, 2021[62] Victoria, BC Urban	Local residents: 51.6% F, 73.5% White, 74.4% household income < $50 000	45.7 (13.7) years Baseline: n = 129 Follow-up: n = 153	Longitudinal pre–post 1.5–2 years	Prior to Wave 1 of the study, only the Pandora Ave. protected cycling path in the AAA cycling network was completed; between Waves 1 and 2, 2 protected bike lanes (Fort St. and Wharf St.) and bridge bike lanes (Johnson St. bridge) were added Preintervention values	Daily MVPA (device, SenseDoc [GPS and accelerometer])
Van Veghel, 2024[63] Hamilton, ON Urban	General population	NR	Longitudinal pre–post 3 years	10 separated cycling infrastructure improvements (painted, plastic and concrete buffers) Preintervention values	Bicycle kilometres travelled on routes (bicycle GPS)
Williams, 2023[65] Victoria, BC, Kelowna, BC, Halifax, NS Urban	General population: 52%–53% F, 82%–92% White, 12%–20% postgraduate degree, 26%–27% household income < $50 000	≥ 18 years Victoria, BC: n = 842 Halifax, NS: n = 764 Kelowna, BC: n = 826	Quasi-experimental nonequivalent group design with repeated cross-sectional surveys 5 years	Change in cycling infrastructure (km) and AAA cycling infrastructure (km) (including protected bike lanes, off-street paths, local street bikeways) City-level control comparison (difference-in-differences analysis): compared changes in cycling activity between Victoria (intervention city) and Kelowna and Halifax (control cities) over time Proximity-based control comparison (triple-difference analysis): "Exposed" (≤ 500 m of AAA infrastructure) or "unexposed" (> 500 m) to assess differences in cycling activity between the cities over time Control cities selected based on similarities in size; urban layout and climate; recommendations of local government partners; and no plans to build AAA cycling infrastructure networks	Any cycling activity in previous 12 months (yes/no) (self-reports, survey questions)

Continued on the next page

TABLE 1 (continued)
Characteristics of included studies (n = 25)

First author, year / City or province / Setting	Population description (cohort)	Mean age (SD) or range / Sample size analyzed	Study design / Follow-up time	Built environment change / Comparator	PA outcome (method of assessment measurement)
Multiuse paths					
Frank, 2019[48] Vancouver, BC Urban	Local residents: 55%–59% F, 77%–86% White, 72%–78% postsecondary education	I: 46.2 years; n = 239 C: 44.7 years; n = 285 T: N = 524	Nonrandomized experimental 2 years	Development of the Comox-Helmcken Greenway (a 2-km long active transportation corridor) with improvements to cycling infrastructure, traffic-calming features, streetscapes, network integration Living > 300 m from the Greenway	Daily total MVPA (self-report, IPAQ)
Frank, 2021[49] Vancouver, BC Urban	Local residents: 55%–59% F, 77%–86% White, 72%–78% postsecondary education	Median = 44 years; I: n = 239 C: n = 285 T: N = 524	Nonrandomized experimental 2 years	Development of the Comox-Helmcken Greenway (a 2-km long active transportation corridor) with improvements to cycling infrastructure, traffic-calming features, streetscapes, network integration Living > 300 m from the Greenway	Total bicycle use (at least 1 cycling trip), total number of cycling trips (self-report, 2-day travel diary)
Bike share programs					
Fuller, 2013[50] Montréal, QC Urban	General population: 56.7% F, 60.2% college/university educated or greater	49.4 years N = 1803	Repeated cross-sectional 1–2 years	Exposure to bike-share docking stations associated with a bike share program Preintervention and after the bike-share docking stations were removed for the 2 seasons	Past-week cycling time; total, utilitarian and recreational cycling for at least 10 minutes in the past week (self-report, IPAQ)
Hosford, 2018[51] Vancouver, BC Urban	General population: 51.8% F, 24.4% household income < $50 000	≥ 18 years Weighted preintervention: n = 939 Follow-up 1: n = 841 Follow-up 2: n = 862	Repeated cross-sectional T1: early phase and T2: postimplementation (15 months)	Bike share program (living ≤ 500 m) Preintervention and living > 500 m from bike share program	Any cycling in the past week (self-report, questionnaire)
Bus rapid transit					
Collins, 2015[46] Kingston, ON Urban	University employees: 66% F, 35% household income < $90 000	NR N = 656	Longitudinal pre–post 1 year	3 new express transit routes that traverse the most common commuter routes in the city Preintervention values	Total active transportation (self-report, survey questions)
McCormack, 2021[57] Calgary, AB Urban	Local residents: 70% F, 75%–76% completed university, 39.6%–42.5% household income < $99 999	46.8 (13.3) years I: n = 80 C: n = 116	Nonrandomized experimental 1 year	New bus rapid transit stops added ≤ 800 m of residence Residences > 800 m from the rapid transit stops	Total weekly MVPA, walking time, cycling time (self-report)

Continued on the next page

TABLE 1 (continued)
Characteristics of included studies (n = 25)

First author, year / City or province / Setting	Population description (cohort)	Mean age (SD) or range / Sample size analyzed	Study design / Follow-up time	Built environment change / Comparator	PA outcome (method of assessment measurement)
Off-leash dog park areas					
McCormack, 2016[55] Calgary, AB Urban	Park visitors: 35.3%–45.2% F	NR Martindale (I1): n = 184 Taradale (I2): n = 167 C1: n = 230 C2: n = 205	Nonrandomized experimental 1 year	Addition of off-leash park areas Parks without designated off-leash park areas	Park-based activities: walking, jogging/running, cycling, dog-related play (direct observation)
New trails					
McGavock, 2019[60] Winnipeg, MB Urban	General population: 77% White, 61.6% household income > $50 000	18–65 years N = 218	Longitudinal pre–post About 5 months from pre to post	Grooming of a natural frozen waterway as a trail A control time period of 20–30 days prior to and immediately after the intervention was selected to match, as closely as possible, the weather conditions during the intervention	MVPA and steps during trail visit, users of the trail as counts (direct observation and device [PiezoRD])
School building and yard improvements					
Hunter, 2016[52] Ontario, Alberta 3.4% rural	Secondary school students (COMPASS study): 53.6% F, 73.7% White	15.1 (0.02) years N = 18 777	Nonrandomized experimental 1 year	21 schools made changes to their physical environments. Quantity changes occurred in 5 schools; condition changes occurred in 10 schools; and both quantity and condition changes occurred in 6 schools. 19 schools reported multiple changes that included combinations of changes to recreational programming, use of public health units, the subjective environment/equipment (as reported in the COMPASS School Policies and Practices Questionnaire) and the physical environment (measured using the COMPASS School Environment Application) Preintervention values; 25 schools that made no PA-related changes were collapsed into one control group and served as the reference group	Total weekly MVPA (self-report, questionnaire)
Wong, 2023[66] Calgary, AB Urban	Grade 1–4 students	NR I: n = 32 C: n = 13	Nonrandomized experimental 16 months postimplementation	Painted designs on tarmac surfaces at 3 intervention elementary schools. The designs were meant to facilitate children's PA through playing traditional games/activities as well as unstructured play One control school that did not receive painted designs	Total weekly MVPA and steps, observed frequency and intensity of activity on school playgrounds (device [ActiGraph GT3X], direct observation [SOPLAY])

Continued on the next page

TABLE 1 (continued)
Characteristics of included studies (n = 25)

First author, year / City or province / Setting	Population description (cohort)	Mean age (SD) or range / Sample size analyzed	Study design / Follow-up time	Built environment change / Comparator	PA outcome (method of assessment measurement)
Daycare yard changes to increase nature-based risky outdoor play					
Brussoni, 2017[44] Vancouver, BC Urban	Children in 2 daycares: 47% F, 69% White	4.3 (0.6) years N = 45	Longitudinal pre–post 2 weeks	Built environment changes that promoted nature-based risky play. The environmental changes addressed the Seven Cs: character (vegetative and natural materials); connectivity (pathways throughout play zones); clarity (well-defined play zones); context (shade); chance (alleys to explore and change encounters); challenge (opportunities for challenge and risky play); and change (arrangements of plants that resulted in group spaces changing with the seasons) Preintervention values	MVPA minutes per 20-minute observation period (device [ActiGraph GT3X])
School zone improvements for active transportation					
Mammen, 2014[54] All provinces and territories (except Quebec) 9.4% rural	Public elementary school, 38.8% high socioeconomic status	NR	Repeated cross-sectional 1 year	School Travel Planning strategies: 35% capital improvement plans (signage relating to school zones, cross walks, stop signs; bicycle rack installation; sidewalk implementation/improvements); 33% activities (walk-to-school days; walking school bus schemes; interclass walking competitions); 26% education (parent and child safety education; mapping of best routes to school; School Travel Planning promotional materials); 6% enforce (altered drop-off/pick-up zones; presence of crossing guards; traffic/speed calming) None	Rates of active school transportation (self-report hands-up survey)

Abbreviations: AB, Alberta; ATP, Alberta's Tomorrow Project; BC, British Columbia; C, control group; F, female; GPS, global positioning system; I, intervention group; IPAQ, International Physical Activity Questionnaire; LW, leisure walking; MB, Manitoba; MPA, moderate intensity physical activity; MVPA, moderate-to-vigorous intensity physical activity; NA, not applicable; NR, not reported; NS, Nova Scotia; ON, Ontario; PA, physical activity; QC, Quebec; SOPLAY, System for Observing Play and Leisure Activities; T, total; VPA, vigorous intensity physical activity.

Note: All dollar amounts are in Canadian dollars.

TABLE 2
RoB summary for included studies

First author, year	RoB due to confounding	RoB due to measurement of exposure	RoB due to selection into study	RoB due to postexposure interventions	RoB due to missing data	RoB due to measurement of outcome	RoB due to selection of the reported results	Overall RoB
Change in walkability (via residential relocation)								
Adhikari, 2020[42]	Low	Low	High	Some concerns	High	Some concerns	Some concerns	High
Christie, 2022[45]	Some concerns	Low	High	High	Some concerns	Some concerns	Low	High
Collins, 2018[47]	Very high	Some concerns	High	Some concerns	Very high	Some concerns	High	Very high
McCormack, 2017[56]	Low	High	High	Some concerns	Some concerns	High	High	High
McCormack, 2021[58]	Low	Low	Some concerns	Some concerns	Some concerns	Low	Some concerns	Some concerns
McCormack, 2023[59]	Low	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	Low	Some concerns
Salvo, 2018[61]	High	Some concerns	Low	Some concerns	Low	Very high	Some concerns	High
Wasfi, 2016[64]	High	High	Some concerns	Some concerns	Some concerns	Some concerns	Low	Some concerns
New cycling paths and improvements								
Boss, 2018[43]	High	Low	Low	High	High	Low	Some concerns	High
Ling, 2020[53]	High	Some concerns	Some concerns	Some concerns	High	High	Low	High
Slaney, 2021[62]	High	High	Very high	High	High	Some concerns	Low	High
Van Veghel, 2024[63]	High	Some concerns	Some concerns	Some concerns	Some concerns	Low	Some concerns	High
Williams, 2023[65]	High	Some concerns	Some concerns	High	Low	Low	Some concerns	Some concerns
Multiuse paths								
Frank, 2019[48]	Some concerns	Some concerns	Low	Some concerns	High	Some concerns	Low	Some concerns
Frank, 2021[49]	Some concerns	Some concerns	Low	Some concerns	High	Low	Low	Some concerns
Bike share programs								
Fuller, 2013[50]	Low	Low	Low	Some concerns	Low	Low	Low	Some concerns
Hosford, 2018[51]	Low	Some concerns	Some concerns	Some concerns	Some concerns	Low	Low	Some concerns
Bus rapid transit								
Collins, 2015[46]	High	Very high	Very high	High	Very high	Low	Some concerns	Very high
McCormack, 2021[57]	Low	Some concerns	High	Low	High	High	Low	High
Off-leash dog park areas								
McCormack, 2016[55]	High	Some concerns	High	Some concerns	Low	High	Low	High

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TABLE 2 (continued)
RoB summary for included studies

First author, year	RoB due to confounding	RoB due to measurement of exposure	RoB due to selection into study	RoB due to postexposure interventions	RoB due to missing data	RoB due to measurement of outcome	RoB due to selection of the reported results	Overall RoB
New trails								
McGavock, 2019[60]	Very high	Some concerns	High	Low	High	Low	Some concerns	High
School building and yard improvements								
Hunter, 2016[52]	Low	High	Some concerns	Some concerns	High	High	Some concerns	High
Wong, 2023[66]	Very high	Very high	High	Very high	High	Low	Low	Very high
Daycare yard changes to increase nature-based risky outdoor play								
Brussoni, 2017[44]	High	Low	Some concerns	Some concerns	Low	Some concerns	Low	High
School zone improvements for active transportation								
Mammen, 2014[54]	Very high	Very high	Some concerns	Very high	Very high	Some concerns	Low	High

Abbreviation: RoB, risk of bias.

TABLE 3
Summary of findings

Summary of effect	No. of participants (no. of studies)	Certainty (quality) of evidence	Interpretation of findings
Positive built environment changes			
Increased walkability (via residential location)			
Walking time Three studies reported a significant increase in transportation walking.[56,61,64] McCormack et al. reported a significant increase in leisure walking.[58] Adhikari et al. reported a nonstatistically significant ($p < 0.1$) increase in transportation walking (adjusted for residential self-selection and life events).[42] McCormack et al. reported no statistically significant change in leisure walking or transportation walking.[59] Christie et al. reported no significant change in total walking (adjusted for change in marital status and presence of children in the home).[45] Collins et al. reported a significant decline in transportation walking.[47]	More walkable: n = 667 (+1313 movers unknown) Non-movers: n = 12 719 (8 studies)	 Very low certainty RoB: −1 pt, 1 very high, 5 high and 2 some concerns Inconsistency: −0.5 pt, 5 out of 8 studies reported positive effects Indirectness: −1 pt, general populations, but only 1 study adjusted for residential self-selection Imprecision: −0.5 pt, OIS met, but CIs were wide and overlapped, indicating no effect	There is very low certainty of positive effects of moving to a more walkable neighbourhood on walking, especially transportation-related walking.
Recreational PA McCormack et al. reported an increase in leisure MVPA and MPA, but no change in VPA.[58] Collins et al. reported an increase in recreational PA after moving from a low to a high walkability neighbourhood.[47]	More walkable: n = 135 Non-movers: n = 5646+ (2 studies)	 Low certainty RoB: −1 pt, 1 very high, 1 some concerns Inconsistency: 0 pt, both reported positive effects Indirectness: 0 pt, general populations Imprecision: −1 pt, OIS for movers not met	There is low certainty of positive effects of moving to a more walkable neighbourhood on recreational PA.
Total PA Salvo et al. reported no perceived change in total PA.[61]	More walkable: n = 48 Non-movers: NA (1 study)	 Low certainty RoB: −1 pt, high Inconsistency: 0 pt, single study Indirectness: 0 pt, general population Imprecision: −1 pt, OIS not met	There is low certainty of no effect of moving to a more walkable neighbourhood on total PA.
Transportation cycling Salvo et al. reported no perceived change in transportation cycling.[61]	More walkable: n = 48 Non-movers: NA (1 study)	 Low certainty RoB: −1 pt, high Inconsistency: 0 pt, single study Indirectness: 0 pt, general population Imprecision: −1 pt, OIS not met	There is low certainty of no effect of moving to a more walkable neighbourhood on transportation cycling.

Continued on the next page

TABLE 3 (continued)
Summary of findings

Summary of effect	No. of participants (no. of studies)	Certainty (quality) of evidence	Interpretation of findings
Occupational PA Collins et al. reported no significant change in occupational PA.[47]	More walkable: n = 5 Non-movers: n = 19 (1 study)	⊕⊕◯◯ Low certainty RoB: −1 pt, high Inconsistency: 0 pt, single study Indirectness: 0 pt, general populations Imprecision: −1 pt, OIS not met	There is low certainty of no effect of moving to a more walkable neighbourhood on occupational PA.
New cycling paths and cycling infrastructure improvements			
Cycling Ling et al. found that the addition of cycling tracks in Toronto, ON resulted in an overall crude increase of 257% in cyclist volume on all affected street segments.[53] Van Veghel and Scott reported mixed effects of separated cycling infrastructure improvements on bicycle kilometres travelled, with a significant increase in 5 out of 10 intervention routes, a significant decrease in 1 and no change in 4.[63] Williams et al. examined the impact of an AAA cycling network in Victoria, BC.[65] Relative to 2 comparator cities (which also saw increases in cycling infrastructure), there was no significant effect on cycling activity. No significant difference in those living closer (< 500 m) vs. further (> 500 m) to the AAA cycling infrastructure was observed in any of the cities.[65]	I: n = 842 C: n = 1590 2 studies reported on cycling counts (3 studies)	⊕◯◯◯ Very low certainty RoB: −1 pt, all 3 studies high Inconsistency: −0.5 pt, variation in the direction of effect across studies and sites Indirectness: −1 pt, 2 general populations of local residents and 1 cycling population from a bike share program. Controls were not always free of contamination; the control cities in 1 study increased their cycling infrastructure, and the COVID-19 pandemic likely affected cycling behaviour in all cities Imprecision: 0 pt, OIS met	There is very low certainty of mixed effects of creating new cycling paths and improving existing cycling infrastructure on cycling, with some studies showing increases and others no significant change. Changes may have been affected by location and pre-existing use of infrastructure.
MVPA Slaney found a nonstatistically significant increase in MVPA of 0.93 min/week (95% CI: −5.28 to 7.14) after AAA cycling paths were added.[62]	N = 153 (1 study)	⊕◯◯◯ Very low certainty RoB: −1 pt, high Inconsistency: 0 pt, single study Indirectness: −0.5 pt, local population, study suggests high probability of confounding by weather Imprecision: −1 pt, OIS not met	There is very low certainty of no effect of creating new cycling paths on MVPA.
New cycling and pedestrian infrastructure (multiuse pathways)			
Cycling Boss et al. suggested that cyclists shifted to new pedestrian and cycling infrastructure from unprotected routes.[43] Frank et al. observed a significant greenway–time interaction (IRR = 3.52; 95% CI: 1.54–8.03) and a 252% increase in the rate of cycling trips among residents who resided ≤ 300 m from a new greenway vs. those living > 300 m from the greenway.[49]	Study 1: N = 52 123 users Study 2: N = 524 (I: n = 239) (2 studies)	⊕⊕◯◯ Low certainty RoB: −1 pt, 1 high, 1 some concerns Inconsistency: 0 pt, both studies suggested increases Indirectness: −0.5 pt, 1 study included Strava app users, the other, local residents' self-reports Imprecision: 0 pt, OIS met	There is low certainty of positive effect of creating new pedestrian and cycling infrastructure on cycling activity.

Continued on the next page

TABLE 3 (continued)
Summary of findings

Summary of effect	No. of participants (no. of studies)	Certainty (quality) of evidence	Interpretation of findings
MVPA Frank et al. found that retrofitting an urban greenway in a dense downtown neighbourhood resulted in an increase in MVPA among those living ≤ 300 m from the greenway. Living ≤ 300 m from the greenway doubled the odds of meeting the 20+ min/day MVPA recommendation (OR = 2.00; 95% CI = 1.00–3.98).[48]	I: n = 239 C: n = 285 (1 study)	⨁⨁⨁◯ Moderate certainty RoB: 0 pt, some concerns Inconsistency: 0 pt, single study Indirectness: 0 pt, local residents Imprecision: −1 pt, OIS not met	There is moderate certainty of a positive effect of creating new pedestrian and cycling infrastructure on MVPA.
Bike share programs			
Cycling Fuller et al. found that living ≤ 500 m from bike-share docking stations was significantly associated with an increased likelihood of total and utilitarian cycling (OR = 2.86; 95% CI: 1.85– 4.42).[50] Hosford et al. found that exposure to a bike share program did not result in a change in cycling behaviour among those who only worked or only lived within the service area (≤ 500 m).[51] Both living and working within the service area was associated with greater odds of cycling at T1 (OR = 2.26; 95% CI: 1.07–4.80) and to a lesser extent, at T2 (OR = 1.37; 95% CI: 0.67–2.83).[51]	N = 2665 (final follow-up) (2 studies)	⨁⨁⨁◯ Moderate certainty RoB: 0 pt, both some concerns Inconsistency: −0.5 pt, both studies showed increases, but there did seem to be differing effect with prolonged exposure Indirectness: 0 pt, local residents Imprecision: 0 pt, OIS met	There is moderate certainty of a positive effect of bike share programs on cycling.
New bus rapid transit routes			
Active transportation Collins and Agarwal examined the effect of adding 3 new bus rapid transit routes and found that while transit ridership among university employees increased by 3%, there was a 0.7% decline in active commuters.[46] McCormack et al. examined exposure to living ≤ 800 m from new bus rapid transit stops. They found that exposure (over ≤ 12 months) neither influenced time spent in active transportation (walking or cycling) in the neighbourhood nor time spent in regular MVPA.[57] The authors posit that this may be due to a shift to transit use rather than to active transportation.[57]	Study 1: N = 656 Study 2: I: n = 80, C: n = 116 (2 studies)	⨁◯◯◯ Very low certainty RoB: −2 pt, 1 very high, 1 high Inconsistency: 0 pt, similar findings Indirectness: −1 pt, one study was among university employees Imprecision: 0 pt, OIS met	There is very low certainty of no effect of bus rapid transit routes on active transportation. Note that these studies did not account for the potential for multimodal transportation (bus + active travel).
Off-leash dog park areas			
Park PA McCormack et al. explored the effect on visitor activities of adding off-leash areas in parks compared to parks without designated off-leash areas.[55] They found that addition of off-leash areas potentially lowered the intensity of PA among children, but did not affect adults' activity. Those visiting parks with dogs participated in less vigorous activity than the visitors without dogs.[55]	I1: n = 184, I2: n = 167, C1: n = 230, C2: n = 205 (1 study)	⨁◯◯◯ Very low certainty RoB: −1 pt, high Inconsistency: 0 pt, single study Indirectness: −1 pt, park visitors Imprecision: −1 pt, OIS not met	There is very low certainty of a negative effect of off-leash dog park areas on children's PA in parks, but no effect on adults' PA in parks.
New trails			
Trail use, MVPA and steps McGavock et al. explored the effect of grooming a natural frozen waterway to make a trail. During the groomed period there was a 4-fold increase in the number of trail users, who achieved a median of 3852 steps and 23 min/visit of MVPA.[60]	N = 218 (1 study)	⨁◯◯◯ Very low certainty RoB: −1 pt, high Inconsistency: 0 pt, single study Indirectness: −1 pt, park visitors Imprecision: −1 pt, OIS not met	There is very low certainty of a positive effect of creating a natural frozen waterway trail on trail use with potential implications for increasing PA.

Continued on the next page

TABLE 3 (continued)
Summary of findings

Summary of effect	No. of participants (no. of studies)	Certainty (quality) of evidence	Interpretation of findings
School building and yard improvements			
MVPA, steps, playground PA Hunter et al. reported on changes to the physical environment of 21 schools. Of the 11 schools that only changed a feature in the built environment (e.g. adding a dance studio, bicycle rack, tennis court, basketball court, fitness/weight room or baseball diamond), average daily MVPA only increased significantly in 1, which had added a bicycle rack.[52] Wong et al. examined changes in MVPA, steps, and frequency and intensity of school playground activity after designs were painted on tarmac surfaces in elementary schools. Compared to a control school, the 3 intervention schools had significantly fewer minutes of MPA, VPA and MVPA and fewer steps per day. The lowest engagement in PA was found for the designs vs. the playground structures.[66]	Study 1: N = 18 777 Study 2: I: n = 32; C: n = 13 (2 studies)	 Low certainty RoB: −2 pt, 1 very high, 1 high Inconsistency: 0 pt, both demonstrate minimal effectiveness Indirectness: 0 pt, students Imprecision: 0 pt, OIS met	There is low certainty of no effect of school built-environment changes (e.g. addition of dance studios, tennis courts, basketball courts, baseball diamonds, fitness/weight rooms, bicycle racks or painted designs on playground tarmac) on student PA.
Daycare yard changes to increase nature-based risky outdoor play			
MVPA Brussoni et al. examined changes in device-measured MVPA during a 20-minute observation period following alterations to a daycare yard to promote nature-based risky play. They found a significant decrease in MVPA 2 weeks after the intervention (−1.32 min; $p < 0.001$), possibly due to an increase in play and social behaviours that did not include MVPA.[44]	45 (1 study)	 Very low certainty RoB: −1 pt, high Inconsistency: 0 pt, single study Indirectness: −1 pt, MVPA was determined during one 20-minute observation period Imprecision: −1 pt, OIS not met	There is very low certainty of a negative effect of daycare yard changes to increase risky outdoor play on MVPA.
School zone improvements			
Active transportation to school Mammen et al. reported on School Travel Planning strategies that included improvements to the built environment near and in 35% of 106 schools. No significant change in active school transportation was found at the national level after 1 year, but variation at the school level was considerable. The timing of data collection, i.e. the season, affected rates, which were lower when follow-up occurred during winter.[54]	Sample size not reported (1 study)	 Very low certainty RoB: −1 pt, high Inconsistency: 0 pt, single study Indirectness: −1 pt, active school transportation was determined using a hands-up survey Imprecision: −1 pt, OIS unclear	There is very low certainty of no effect of School Travel Planning policies (which included changes to the built environment) on active school transportation.
Negative built environment changes			
Reduced walkability (residential relocation)			
Walking time Three studies reported a significant decrease in transportation walking.[47,56,59] Two studies reported no significant change in transportation walking.[61,64] Two studies reported no significant change in leisure walking.[58,59] Three studies reported no significant change in total walking.[45,58,59]	Less walkable: 669 (+1313 movers unknown) Non-movers: 12 564 (7 studies)	 Low certainty RoB: −1 pt, 1 very high, 4 studies high and 2 studies had some concerns Inconsistency: −0.5 pt, variation in direction of effect across outcomes Indirectness: 0 pt, general populations Imprecision: 0 pt, OIS met	There is low certainty of no effect of moving to a less walkable neighbourhood on total or leisure walking. There is low certainty of a negative effect of moving to a less walkable neighbourhood on transportation-related walking.

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TABLE 3 (continued)
Summary of findings

Summary of effect	No. of participants (no. of studies)	Certainty (quality) of evidence	Interpretation of findings
Recreational PA McCormack et al. reported no change in leisure MPA, VPA or MVPA.[58] Collins et al. reported no change in recreational PA after moving from a high to a low walkability neighbourhood.[47]	Less walkable: 174 Non-movers: 5646+ (2 studies)	⬤⬤◯◯ Low certainty RoB: −1 pt, 1 very high, 1 some concerns Inconsistency: 0 pt, 2 out of 2 reported no change Indirectness: 0 pt, general populations Imprecision: −1 pt, OIS for movers not met	There is low certainty of no effect of moving to a less walkable neighbourhood on recreational PA.
Total PA Salvo et al. reported no perceived change in total PA.[61]	Less walkable: 49 Non-movers: NA (1 study)	⬤⬤◯◯ Low certainty RoB: −1 pt, high Inconsistency: 0 pt, single study Indirectness: 0 pt, general population Imprecision: −1 pt, OIS not met	There is low certainty of no effect of moving to a less walkable neighbourhood on total PA.
Transportation cycling Salvo et al. reported a significant decrease in transportation cycling.[61]	Less walkable: n = 49 Non-movers: NA (1 study)	⬤⬤◯◯ Low certainty RoB: −1 pt, high Inconsistency: 0 pt, single study Indirectness: 0 pt, general population Imprecision: −1 pt, OIS not met	There is low certainty of negative effect of moving to a less walkable neighbourhood on transportation cycling.
Occupational PA Collins et al. reported no significant change in occupational PA.[47]	Less walkable: n = 9 Non-movers: n = 19 (1 study)	⬤⬤◯◯ Low certainty RoB: −1 pt, high Inconsistency: 0 pt, single study Indirectness: 0 pt, general populations Imprecision: −1 pt, OIS not met	There is low certainty of no effect of moving to a less walkable neighbourhood on occupational PA.

Abbreviations: AAA, All Ages and Abilities; C, control group; CI, confidence interval; I, intervention group; MPA, moderate intensity physical activity; MVPA, moderate-to-vigorous intensity physical activity; NA, not applicable; OIS, optimal information size; OR, odds ratio; PA, physical activity; RoB, risk of bias; VPA, vigorous intensity physical activity.

neighbourhood with higher walkability on walking (especially transportation-related walking) and recreational PA. There is also low certainty of evidence for no effect of relocating to a neighbourhood of higher walkability on total PA, transportation cycling or occupational PA. There is low certainty for no effect of relocating to a neighbourhood of reduced walkability on total or leisure walking, recreational PA, occupational or total PA, but there is a negative effect on transportation-related walking and cycling.

Neighbourhood walkability was operationalized using four different measures across the studies. Almost all evidence was from urban-dwelling adults in the general population, with follow-ups from 10 months to 3 years. Most of the evidence was from Alberta, with three studies assessing different outcomes using data from the Alberta's Tomorrow Project.[45,58,59] Wasfi et al. used a different approach in a repeated-measures national longitudinal study over a 12-year period.[64] Their study was the only one to capture rural respondents, and included more respondents with a less than postsecondary education.

New cycling paths and improvements

There is very low certainty of mixed effects of creating new cycling paths or improvements to cycle paths (e.g. improved

separation from traffic) on cycling and no effect on MVPA. Outcomes differed across all studies making comparison difficult. Ling et al. found that adding cycle tracks resulted in a 257% increase in cycling volume on affected street segments.[53] Van Veghel and Scott reported a significant increase in bicycle kilometres travelled in five of the 10 intervention routes with improved cycling paths, a significant decline in one and no change in four.[63]

Williams et al. found no significant impact of developing an All Ages and Abilities cycling network, a separated cycling infrastructure project designed to improve cycling accessibility and safety by building protected bike lanes, off-street paths and local street bikeways in Victoria, BC compared to two control cities or among those who lived closer (≤ 500 m) rather than further (> 500 m) to the cycling paths.[65] Findings were likely affected by the intervention city completing only about 50% of cycling infrastructure improvements by study's end, while the control cities built more cycling infrastructure than expected; the COVID-19 pandemic also may have affected cycling behaviour.[65] The final study examined the same AAA network and found a nonstatistically significant increase of 0.93 min/week in MVPA after the addition of the cycling paths.[62]

Multiuse paths

There is low certainty of a positive effect of new multiuse paths on cycling activity and moderate certainty of a positive effect on MVPA. Based on input from cyclists' Strava apps, which track and record PA, Boss et al. suggested that cyclists used new, multiuse routes rather than unprotected routes.[43] In two studies, Frank et al. found that the addition of a new greenway resulted in a significant increase in MVPA[48] and cycling,[49] especially among residents who lived 300 m or less from the active transportation corridor compared to those living more than 300 m from the corridor.

Bike share programs

There is moderate certainty of a positive effect of bike share (or rental) programs on cycling behaviour. Fuller et al. found that exposure to public bike-share docking stations (≤ 500 m from home) was significantly associated with an increased likelihood of total and utilitarian cycling (odds ratio [OR] = 2.86; 95% confidence interval [CI]: 1.85–4.42).[50] Hosford et al. found that a bike share program did not change cycling behaviour among those who either worked or lived 500 m or less from the service area; only those who both lived and worked 500 m or less from the service area had a greater odds of cycling (time 1: OR = 2.26, 95% CI: 1.07–4.80; time 2: OR = 1.37, 95% CI: 0.67–2.83).[51]

Bus rapid transit

There is very low certainty of no effect of new bus rapid transit routes on active transportation, suggesting a potential shift to public transit. In a study of university employees, Collins and Agarwal found that the addition of three new bus rapid transit routes resulted in a 3% increase in public transit, but a 0.7% decline in active transportation.[46] McCormack et al. found no change in time spent in active transportation after 12 months of living 800 m or less from a new bus rapid transit stop.[57] However, neither study accounted for multimodal transportation (e.g. combined walking or cycling and public transportation for a single trip) in the assessment of the outcome.

Off-leash dog park areas

There is very low certainty of a negative effect of off-leash dog park areas on children's PA, but no effect on adults' PA. An evaluation found that off-leash dog park areas potentially lowered the intensity of the PA of children visiting the parks, but did not affect adult PA.[55] In addition, those visiting with dogs engaged in less vigorous PA than those without dogs.[55]

New trails

There is very low certainty of a positive effect of new trails on use. One study found that the grooming of a natural frozen waterway trail resulted in a four-fold increase in the number of trail users.[60] McGavock et al. also used accelerometers to quantify steps (3852 steps/visit) and MVPA (23 min/visit) and suggested that the increase in trail use had potential implications for increasing total PA.[60]

School building and yard improvements

There is low certainty of no effect of school-related built environment improvements on student PA. Hunter et al. reported on school changes to the physical environment in 21 schools.[52] Of the 11 schools that only changed features in the built environment (e.g. additions of dance studios, bicycle racks, tennis courts, basketball courts, fitness/weight rooms or baseball diamonds), average daily MVPA only increased significantly in one, which had added a bicycle rack.[52]

Wong et al. examined changes in MVPA, steps, and frequency and intensity of school playground activity after designs were painted on the tarmac surfaces in three elementary schools.[66] The designs were meant to facilitate children's PA by encouraging them to play traditional games and activities (e.g. hopscotch, left-right-out, bulls-eye toss, four square) and unstructured games (e.g. random circles of different colours and sizes). Compared to a single control school, the intervention schools had significantly fewer MVPA minutes and steps per day; the lowest engagement in PA was with the tarmac designs and the highest with the playground structures. The authors cited potential school-level factors that may have influenced their use, and the painted designs probably required use instructions and play materials (e.g. balls).[66]

Daycare yard changes to increase nature-based risky outdoor play

There is very low certainty of a negative effect of daycare yard changes to increase nature-based risky outdoor play on MVPA. A single study found a significant decrease in MVPA during the single 20-minute observation period (−1.32 min; $p < 0.001$) 2 weeks after changes to a daycare yard.[44] Brussoni et al. speculated that this decline was due to an increase in play with natural materials, independent play and prosocial behaviours.[44]

School zone improvements for active transportation

There is very low certainty of no effect of School Travel Planning policies on active school transportation. One study found that School Travel Planning strategies that included improvements to the built environment (e.g. signage related to school zones, crosswalks, stop signs, bicycle racks, sidewalk implementation or improvements) were observed near and in 35% of 106 schools.[54] At the national level, Mammen et al. found no significant change in active school transportation after 1 year, although results varied considerably at the school

level. There was also evidence that timing of data collection affected rates, which were lower when follow-up occurred in winter.[54]

Discussion

In this systematic review we examined evidence on 25 natural experiments designs evaluating built environment changes on PA levels and patterns in Canada. Most of the experiments occurred in Alberta, British Columbia and Ontario, and none focused on rural areas. Most of the studies focused on adults aged approximately 35 to 57 years and had about 1 year of follow-up. Common changes included increased walkability as a result of relocation and the addition of pedestrian or cycling infrastructure. PA outcomes were mostly self-reported and linked to specific interventions such as walkability and walking or cycle paths and cycling.

The results suggest positive effects, with low to moderate certainty, of increased walkability, new cycling and pedestrian infrastructure, bike share programs and trails. However, there was very low to low certainty of no significant effects for bus rapid transit, school building and yard improvements, and school zone improvements. Some evidence also suggests negative effects of off-leash dog park areas on children's park-based PA and of daycare yard improvements on MVPA.

No studies that fitted our inclusion criteria for study designs examined changes to playgrounds, parks or green spaces, new recreation facilities, aesthetics, lighting, rail transit (light rail, Metro or commuter train), other pedestrian and cycling infrastructure (e.g. benches, bicycle parking) or traffic-calming features.

Comparisons with the literature across built environment interventions

Similar to the present findings, non-Canadian studies also show that relocating to a neighbourhood with improved walkability features (e.g. mixed land use, street connectivity) often increases walking.[10,11,67] Walking was the most consistent outcome,[67] though studies are subject to self-selection bias as individuals who are more active may choose to live in walkable areas. In addition, life changes (e.g. childbirth, job changes) may influence PA. Of the eight studies we reviewed, only two[42,45] adjusted for life events and residential self-selection, and only Adhikari et al. found a positive association ($p < 0.1$).[42]

A review by McCormack et al. found that associations between the built environment and PA are likely independent of residential location choices, but findings were often attenuated when cross-sectional studies adjusted for neighbourhood self-selection.[12] Along with our findings, this suggests that life events and self-selection may in part explain changes in walking due to increased walkability. While residential relocation studies provide observational evidence on the potential for changes in walkability and its influence on PA, future studies could benefit from examining effects on PA that might occur with neighbourhood improvements (e.g. gentrification or urban redesign).

Previous systematic reviews that focused on natural experiment studies regardless of country have also generally found that creating new pedestrian and/or cycling infrastructure (e.g. new multiuse paths, cycle paths, bike share programs) increases active transportation and total walking and cycling, though the studies have also shown no significant changes associated with these additions.[10-12,18,19]

A recent systematic review and meta-analysis of primarily multiuse paths in eight countries (1 in Canada) found that PA (almost entirely self-reported) increased by 12% among individuals exposed to new paths (standardized mean difference = 0.12; 95% CI: 0.04–0.20).[19] Another review looked at the effectiveness of changes to the physical environment, including new walking, cycling and multiuse paths, for promoting walking and cycling.[68] Panter et al. found that only 6 of the 30 studies reported significant positive effects.[68] The most effective interventions targeted accessibility (e.g. new paths) and safety (e.g. segregation from motor vehicles) and higher quality interventions were more likely to report positive effects.[68] We also found similar positive effects for multiuse pathways and mixed effects for cycling-specific paths, which all improved accessibility and safety. Some mixed findings can be attributed to pre-existing exposure to infrastructure, location of the infrastructure and a difficulty to account for changes in control cities. Only two Canadian studies evaluated multiuse pathways (the same greenway), and four evaluated cycling-specific infrastructure. Given the recent investments by the Government of Canada to promote active transportation through the National Active Transportation Strategy,[29] we can expect more opportunities to evaluate the effectiveness of infrastructure projects in the future.

Bike share programs have been less evaluated overall.[69] They have shown promise for increasing cycling in Canada, as reported in a North American study of bike share programs[70] that found that living near (< 500 m) newly implemented bike share docking stations resulted in increases in cycling over 2 years of follow-up. However, no differences were observed in cities with existing bike share programs relative to cities without such programs. There is some evidence that bike share trips replace those previously undertaken by public transit or walking.[71] Since cycling is generally higher intensity than walking,[72] bike share programs may contribute to a greater extent to meeting Canadian PA recommendations. Future Canadian studies are warranted given the increased popularity of e-scooters and e-bikes.

Previous reviews found that new bus rapid transit and light rail transit routes/stops increased PA by 1.76 MET hours/week (approximately 30 min/week of walking or light-to-moderate PA).[20] One review found that installing a new light rail transit led to a 7% to 40% increase in walking and positive if inconsistent associations with MVPA and cycling.[21] Our contrasting findings likely reflect a shift to using transit rather than active transportation as the main mode of travel, with bus rapid transit replacing existing public transit options rather than opening new services. Studying measures of multimodal travel, total PA and location-based PA to assess gains in walking and cycling as modes of travel supporting public transit (e.g. walking to and from transit stations) and to discern effectiveness based on pre-existing transit service could be beneficial. The geography of specific stops (population and commercial density) and their amenities (secure bike storage, safe access points) should be taken into account.

In 2024, the Government of Canada launched the Canada Public Transit Fund to increase the use of public transit and active transportation in Canada.[30] This fund will provide opportunities to evaluate their effectiveness at increasing PA.

Only single studies explored the remaining built environment interventions (school zone improvements, off-leash dog parks, daycare yard improvements), and more evidence is needed to ascertain the direction and strength of effect. No studies identified park or playground improvements (e.g. signage, recreational areas, play equipment, seating, walking paths, waste facilities), despite previous reviews suggesting conflicting results for such interventions.[10,11,18] Similarly, while we found no studies evaluating changes to neighbourhood aesthetics or safety including traffic calming, natural experiments in other countries have found limited evidence that these promote PA.[12] However, evidence from cross-sectional and observational studies suggests largely mixed associations with PA.[7,8,73]

Implications for future research

Previous reviews have suggested that built environment changes show more positive effects over longer follow-up times,[18] indicating a need for cumulative exposure and shifts in behavioural norms.[74] However, we did not identify any clear trends based on follow-up duration. Wasfi et al. found that greater cumulative exposure to higher walkability (i.e. more time spent living in a more walkable neighbourhood) was linked to increased utilitarian walking,[64] while Hosford et al. showed that a bike share program had short-term effects but less of a long-term impact.[51] Future evaluations should explore longer-term and cumulative effects of built environment changes.

Certainty in the evidence was mostly very low to low, often because of confounding, postexposure interventions, missing data, exposure assessment, small sample sizes and inconsistency in findings. These limitations, common in natural experiments, highlight the need for additional studies to confirm findings.[10,11,18,75] Because natural experiments are "real-world" experiments that are challenging to design and implement, many variables are out of the control of the researcher. Nonetheless, the reviewed studies highlight the promise of built environment changes.

While most findings appear to align with review evidence informed from mostly high-income countries, more quasi-experimental research is needed in Canadian contexts to further confirm findings and understand any context-specific implications such as climate, culture and geographic differences. Emerging technologies such as smartphone applications, wearable devices, geolocation devices and artificial intelligence for environmental audits and PA observations allow for easier scaling-up to enable larger samples and greater generalizability.[76] Used alone, and in conjunction with surveys and place-based research, these technologies offer new opportunities to overcome the limitations of previous approaches, to build on strengths and to provide the robust evidence needed to inform policy.[76] For example, a recent US study used a large smartphone cohort of more than 2 million and found that increased walkability as a result of relocation was linked to more steps taken and greater MVPA.[77]

The INTerventions, Equity, Research, and Action in Cities Team (INTERACT), a pan-Canadian collaboration, aims to evaluate natural experiments in four Canadian cities, focusing on greenways, cycling paths, bus rapid transit and urban development initiatives.[78] INTERACT plans to address previous methodological limitations using mobile sensing, accelerometers, geographic information systems and other tools that measure PA and mobility patterns more reliably.

Strengths and limitations

This review has several strengths including a preregistered protocol, a comprehensive search strategy created and peer-reviewed by research librarians, RoB assessments to assess study quality and the use of a modified GRADE approach[40] to assess the evidence certainty. Most previous non-Canadian reviews did not assess the potential for bias from studies and none followed GRADE guidelines. These methodologies help to identify methodological concerns in current studies and a need for higher quality evidence for interventions that can be addressed in future research.

The limitations are largely due to limitations in the evidence identified. While most samples were drawn from the general population, most evaluations emerged from Alberta, British Columbia and Ontario, and the territories and some provinces were unrepresented. No studies explored rural regions or focused on effects among those who are socially marginalized or disadvantaged (e.g. Indigenous Peoples, 2SLGBTQIA+ communities, racial groups, immigrants or refugees, people with disabilities, older adults), limiting generalizability of findings.

There are unique challenges to engaging with the built environment in Canada, including extreme temperatures and precipitation. While most studies adjusted for season or temperature[43,44,51,52,56,57,61] or ensured that data collection periods were in the same season,[46-49,53,55,58,60] many did not. In addition, most current built environment audit tools do not account for weather and seasonal factors.[79] While most built environment changes would provide benefit year-round, their use may be challenged by weather conditions (e.g. bicycle paths needing snow removal). Future work should consider this important confounder.

Although prone to recall and social desirability biases, self-reported measures continue to be the most used. Using devices and novel sources of data would increase reach and improve generalizability.

Many of the nonresidential relocation studies employed a longitudinal pre–post design with participants' preimplementation values serving as historical controls. Future work would benefit from including control groups such as comparator sites without the environmental intervention or those living further from the built environment change.

Conclusion

Few Canadian studies have evaluated the impact of built environment changes on PA, with most emerging in the last decade. Lower-certainty evidence suggests that increased walkability (via residential relocation) and new cycling and multiuse paths and trails are linked to higher PA, while moderate certainty evidence shows that bike share programs increase cycling. There is lower certainty regarding no effect from bus rapid transit initiatives, school building and yard improvements and school zone upgrades. Certainty is also lower regarding negative effects of off-leash dog parks and daycare yards that promote risky play. Future studies should include larger and more diverse samples and all regions, control for confounders including season and residential area selection, use well-matched control groups and incorporate objective PA measures.

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Authors' contributions and statement

SAP: Conceptualization, data curation, formal analysis, investigation, methodology, project administration, writing—original draft.

JJL: Data curation, investigation, methodology, writing—review and editing.

SL: Data curation, investigation, methodology, writing—review and editing.

EV: Data curation, investigation, methodology, writing—review and editing.

GPB: Data curation, investigation, methodology, writing—review and editing.

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AL: Data curation, resources, methodology, writing—review and editing.

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Editorial

Natural experiments for healthier communities: evidence to drive Canadian policy and practice

Stephanie A. Prince, PhD (1,2); Gavin R. McCormack, PhD (3)

Built environments shape how we live, work, learn, eat and play

Our surroundings—where we live, work, learn, travel, eat and play—shape our health in powerful ways. The built environment encompasses that part of our physical surroundings that is manufactured or modified by people. It includes our homes and buildings; public utility structures, schools, hospitals and recreation facilities; green spaces; roads, paths, transportation systems and related structures; and community design. The built environment is recognized as a determinant of health;[1] its influence on our health behaviours and environmental exposures has implications for our well-being and the development of chronic diseases.[2,3]

Natural experiments offer an opportunity to study changes to the built environment that a researcher cannot control or manipulate.[4,5] Results of such experiments can provide important information regarding the effectiveness of built environment changes (e.g. cycle paths, rapid transit development, greening of vacant lots, smoke-free public places) on improving or maintaining health behaviours and promoting health. Natural experiments offer practical means for investigating the health impacts of environmental interventions when randomized controlled trials are not feasible, and they provide robust evidence compared to cross-sectional studies, which fail to establish causality. In addition, they provide the means to understand the real-world impacts of environmental changes.

The motive for this special issue came from calls to action by the Chief Public Health Officer, in the 2017 report on designing healthy living, to evaluate the impact on health of community design features, strengthen existing approaches, and share lessons learned and best practices in Canada.[6] It was our hope that this call would increase the visibility of natural experiment evaluations in Canada and provide timely evidence to further promote their utility for advancing evidence for improving population health.[7]

Insights from the papers included in this special issue

This special issue includes two natural experiment evaluations of built environment changes, one systematic review and one invited editorial. Bauman and Crane set the stage in their opening editorial, defining natural experiments, providing Canadian examples and highlighting their utility and importance for public health.[8] Gillies et al. reported on the impacts of multicomponent changes to physical environments and supportive programming in 19 rural communities in the Alberta Healthy Communities Approach Phase II project.[9] Belon and colleagues evaluated the impacts of a municipal plan to revitalize existing urban and rural public indoor facilities and outdoor spaces.[10] Finally, Prince et al. systematically synthesized the literature on natural experiments of the impacts of built environment changes on physical activity in Canada.[11]

Each article offers important lessons on natural experiment design and the effectiveness of built environment interventions. Gillies et al. reported significant improvements in community capacity (i.e. the ability to address collective priorities) and the supportiveness of environments for physical activity, healthy eating and ultraviolet radiation protection (e.g. outdoor recreation areas, cycling infrastructure, shade trees, sun shelters, community gardens).[9] While multicomponent and multilevel interventions may be more effective at eliciting changes in behaviours and health outcomes than single-component physical infrastructure changes[12,13] and they are better at reflecting pragmatic, real-world scenarios,[14] isolating the causal effects attributable to built environment changes can be challenging.

Belon et al. did not observe any significant changes in the usage of indoor or outdoor recreation facilities over a 2-year period following the revitalization.[10] They suggest that this may be because the infrastructure upgrades did not address barriers to using the facility (e.g. crowdedness, insufficient cleanliness, prioritization of activities). Built environment interventions are likely to be more effective when they are responsive to the needs and preferences of the populations they serve and involve their engagement.[15]

Keywords: *built environment, healthy cities, natural experiment, health, chronic conditions, Canada*

Author references:

1. Centre for Surveillance and Applied Research, Public Health Agency of Canada, Ottawa, Ontario, Canada
2. School of Epidemiology and Public Health, Faculty of Medicine, University of Ottawa, Ottawa, Ontario, Canada
3. Department of Community Health Sciences, Cumming School of Medicine, University of Calgary, Calgary, Alberta, Canada

Correspondence: Stephanie A. Prince, Centre for Surveillance and Applied Research, Health Promotion and Chronic Disease Prevention Branch, Public Health Agency of Canada, 785 Carling Ave., Ottawa, ON K1A 0K9; Tel: 613-324-7860; Email: stephanie.prince.ware@phac-aspc.gc.ca

A notable limitation of the natural experiment evaluations is the lack of data capturing changes to individual-health behaviours or outcomes. Process outcomes are an important aspect of understanding the effectiveness and sustainability of interventions, but without assessments of these outcomes it is difficult to quantify their effects on health. It is important to recognize that built environment changes often require prolonged exposure to generate meaningful effects on behaviours, population-level outcomes and shifts in social norms.

Prince et al. observed that few Canadian studies have evaluated the impacts of built environment changes on physical activity and that the certainty of existing evidence is low to very low, often hampered by unaddressed confounding, concurrent postexposure interventions, missing data, small sample sizes and inconsistency in findings across studies.[11] These limitations, which are common in natural experiments, highlight the inherent challenges of studying changes in the "real world," where many variables lie beyond the researcher's control. This underscores the need to demonstrate the robustness of causal effects by systematically evaluating and, where possible, eliminating competing explanations while explicitly contextualizing those that cannot be fully controlled.

Canadian research on built-environment natural experiments

Formal evaluation and publication of natural experiments for built environments and health in Canada has remained limited, despite the growing recognition of their value in assessing real-world interventions.[16] Natural experiments inherently require precise timing for researchers or evaluators to conduct assessments prior to the environmental change as well as substantial time to assess any impacts. While opportunities may exist, they are often time-sensitive and require collaboration between researchers and those planning and implementing the changes (e.g. planners, policy-makers, municipalities). In many cases, these collaborations do not exist or else researchers become aware of the opportunities too late, resulting in missed or delayed evaluations or insufficient time to identify and obtain the required research funding.

At the time of writing this editorial, there were no open-funding calls specific to natural experiments from the Canadian Institutes of Health Research (CIHR), the funding agency for health research in Canada. CIHR's Healthy Cities Research Initiative[17] has supported studies assessing impacts of built environment changes and the Implementing Smart Cities Interventions to Build Healthy Cities (SMART) Training Platform,[18] which is dedicated to training the next generation of researchers in implementation science to support the development of healthy communities. The previous funding opportunity that specifically targeted the evaluation of natural experiments was in fiscal year 2008 to 2009.[19]

While Belon et al. observed no change in outdoor recreation facility usage, the authors mentioned that analysis of the impacts of the completed second and third phases of the revitalization plan was not performed due to funding constraints and the nature of the available local data for use in evaluation.[10] While natural experiments can be funded through other opportunities, the project time for funding is short, suggesting that flexibility in research funding is needed, not least because natural experiments are complex and messy, often requiring researchers to adapt their methodologies to accommodate changing interventions and policy timelines. Further, the effects of built environment changes may not be realized immediately, but rather emerge after cumulative exposure over longer periods of time.[20]

The path forward

To enable flexible support for natural experiments, future funding programs should consider adopting an open and adaptive call structure. Such an approach would allow researchers to respond to emerging opportunities, foster collaboration with planners and policy-makers and facilitate outcome assessments before, during and after interventions. This flexibility is essential given the extended timelines required to observe environmental changes and the complexity of collecting robust data across multiple phases. In addition, those responsible for designing and implementing built environment changes should explicitly consider their effects on health and allocate funding to evaluate the effects and seek out researchers with the expertise in such evaluations.

Natural experiments should continue to be promoted as a critical approach for evaluating the effectiveness of built environment changes aimed at improving health and preventing chronic disease. As natural experiment methods and guidance evolve,[5] researchers must prioritize rigorous study designs, including mixed methods, that enable the disentanglement of built environment effects from other intervention components and competing plausible explanations. This includes incorporating methodological elements such as appropriate controls, adjustment for key confounders and alignment of measures with the targeted behaviours and health outcomes.

Applying a self-critical lens—purposively seeking and evaluating alternative explanations for observed results—can strengthen study validity, generate more robust evidence on the health impacts of built environment modifications and identify confounders to be addressed in future natural experiments. But seeking perfection can be the enemy of progress, and despite their inherent challenges natural experiments remain an essential part of the evidence hierarchy for population health promotion. With ongoing investments in infrastructure, and growing recognition of the value of natural experiments, we anticipate (and deeply hope) that their role in informing policy and practice to create healthier communities in Canada will continue to grow.

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SAP: Conceptualization, writing—original draft, writing—review and editing.

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With thanks to our 2025 peer reviewers

We are grateful to the following individuals for their significant contribution to *Health Promotion and Chronic Disease Prevention in Canada* as peer reviewers in 2025. Their expertise ensures the quality of our journal and promotes the sharing of new knowledge among peers in Canada and internationally.

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Other PHAC publications

Researchers from the Public Health Agency of Canada also contribute to work published in other journals and books. Look for the following articles published in 2024 and 2025:

Afifi TO, Fortier J, Salmon S, Taillieu TL, Osorio A, Roos L, […] **Tonmyr L**, et al. Youth COVID-19 stressors and associations with self-perceived health, depression, anxiety, and at-risk alcohol and cannabis use. Facets. 2024;9(1):1-10. https://doi.org/10.1139/facets-2023-0160

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