National Collaborating Centre for Methods and Tools

Centre de collaboration nationale des méthodes et outils

School of Nursing | McMaster University

Rapid Review: What are effective policy and program initiatives to increase physical activity and/or reduce sedentary time for cancer prevention?

Prepared for: Canadian Partnership Against Cancer

Prepared by: The National Collaborating Centre for Methods and Tools

Date: December 1, 2021

Suggested Citation:

National Collaborating Centre for Methods and Tools. (2021, December 1). *What are effective policy and program initiatives to increase physical activity and/or reduce sedentary time for cancer prevention?* https://www.nccmt.ca/pdfs/res/physical-activity-cancer

Please Note: An update of this review may be available. Access the most current version of this review by visiting the National Collaborating Centre for Methods and Tools COVID-19 Rapid Evidence Service at the above link.

The National Collaborating Centre for Methods and Tools (NCCMT) is hosted by McMaster University and funded by the Public Health Agency of Canada. The views expressed herein do not necessarily represent the views of the Public Health Agency of Canada.

The authors declare they have no conflicts of interest to report.

Executive Summary

Background

As the leading cause of death in Canada, cancer and its treatment-related side effects pose a significant burden at both an individual and health-system level. Continued investment in effective primary prevention initiatives is important to minimize burden. The relationship between physical activity (PA) and cancer risk is well established, so interventions to promote PA are a promising avenue to reduce cancer risk. Policy and program decisions must be informed by interventions that are most effective at increasing PA and/or decreasing sedentary time.

This rapid review includes evidence available up to August 23, 2021, to answer the question: **What are effective policy and program initiatives to increase physical activity and/or reduce sedentary time for cancer prevention?**

Key Points

- Interventions that probably increase PA (moderate-certainty evidence, GRADE):
  - Whole-of-school interventions
  - Road/street environment improvements
  - Access to facilities and amenities for PA
  - Improvements in neighborhood walkability
- Interventions that may increase PA (low-certainty evidence, GRADE)
  - Combined built environment strategies (such as walking/cycling infrastructure, plus street connectivity and design, and mixed land)
  - Investments in public transit
  - School-based active transport interventions
  - Increased population density
  - Built form features
  - Increased land-use mix
  - Access to neighbourhood green and open space
  - Improvements to neighborhood aesthetics
- Interventions that may decrease sedentary time (low-certainty evidence, GRADE)
  - Whole-of-school interventions
- Interventions with limited evidence for increasing PA (very low-certainty evidence, GRADE)
  - Walking and cycling infrastructure as a sole intervention
  - Sport and recreation for all
- Interventions with limited evidence for decreasing sedentary time (very low-certainty evidence, GRADE)
  - Access to in neighbourhood green and open space
- Other promising practices include multi-component workplace wellness interventions, and multi-component community-wide programs focusing on individual, community, and environmental levels. There is limited evidence to support healthcare-provider delivered interventions on their own or public education, including mass media.

Overview of Evidence and Knowledge gaps

- While evidence for whole-of-school interventions is mainly based on randomized and non-randomized intervention studies, evidence on active transport, active urban design, and sport and recreation for all are mainly based on observational or non-randomized natural experiments due to the nature of the interventions. The certainty of the evidence is inherently low. Further well-designed studies with objective measurement of PA or sedentary time, and appropriate control for confounding are needed to be more certain in the effectiveness of these interventions.

- There is very limited evidence on the cost-effectiveness of interventions with only one evidence synthesis identified across all intervention types and contexts. This review included a small number of studies and found that road and street environment interventions, in particular walking paths, were the most cost-effective. Given the limited availability of cost-effectiveness data these results should be interpreted with caution. Significantly more data on the cost-effectiveness of interventions in different populations and contexts are needed to guide policy decisions.

- Very few reviews reported on the difference in effects for diverse populations; while several reported on the differences between males and females or by age group. More information is needed to address priority populations and ensure population-level interventions are chosen and implemented with a health equity lens in order to not further exacerbate health disparities.

Background

Cancer is the leading cause of death in Canada, responsible for 28.2% of deaths in the most recently available data from 2019 (Statistics Canada, 2019). An estimated 225 800 new cancer diagnoses were projected for 2020 (Brenner et al., 2020). A diagnosis of cancer is accompanied by several adverse physical and mental health consequences for individuals undergoing treatment and is costly to the healthcare system. Thus, ongoing investments in cancer prevention initiatives remain of great importance.

The relationship between PA and cancer risk is well documented. PA is defined as "any bodily movement produced by skeletal muscles that results in energy expenditure and increases heart rate and breathing" (ParticipACTION, 2021). Moderate and vigorous intensity PA is of higher intensity and is generally rated as a 5 to 6 (moderate) or 7 to 9 (vigorous) on a scale of 1 to 10. Sedentary behaviour is defined as "any waking behaviour characterized by an energy expenditure of less than or equal to 1.5 metabolic equivalents (METs) while in a sitting or reclining posture" (ParticipACTION, 2021). Sedentary time is the duration of time (e.g., in minutes per day) in any context (e.g., at school or work, in transit, during meals) spent in sedentary behaviours (ParticipACTION, 2021).

The most recent report from the World Cancer Research Fund/American Institute for Cancer Research found strong convincing evidence for the role of PA in decreasing risk of colorectal cancer, strong probable evidence for the role of overall PA in decreasing postmenopausal breast and endometrial cancer, and strong probable evidence for the role of vigorous intensity PA in decreasing risk of pre- and post-menopausal breast cancer risk (World Cancer Research Fund, 2018). Limited suggestive evidence was also found for the role of PA in reducing esophageal, lung, liver, and premenopausal breast cancer, and for the role of sedentary time in increasing risk of endometrial cancer. These findings were echoed by the International Agency for Research on Cancer's 2020 World Cancer Report, which found strong epidemiological evidence for the role of PA in reducing the risk of bladder, pre- and post-menopausal breast, colon, endometrial, kidney, esophageal and stomach cancer; emerging evidence for the role of PA in reducing risk of lung, prostate, ovarian and pancreatic cancer; and emerging evidence for the role of sedentary time in increasing the risk of pre- and post-menopausal breast, colon, endometrium, and lung cancer (Wild et al., 2020). These assessments are based largely on observational data; given the long latent period between PA exposure and cancer diagnosis and low absolute incidence of cancer, adequately powered randomized controlled trials with cancer diagnosis as an endpoint are not feasible. However, several randomized controlled trials which measure biomarkers of breast cancer risk are consistent with the available observational literature (Kruk, 2013).

Current guidelines from organizations such as the World Health Organization (2021), Canadian Society for Exercise Physiology (2021), and American Cancer Society (Rock, 2020), recommend that children and adolescents complete at least 60 minutes per day of moderate-vigorous PA, as well as vigorous intensity and muscle and bone strengthening activity at least three days per week and that adults should aim for at least 150 minutes of moderate intensity or at least 75 minutes of vigorous intensity PA throughout the week, along with exercise that strengthens

muscles at least two days per week. Limiting sedentary time as much as possible is also recommended.

Despite this evidence, a large proportion of Canadians fail to meet PA guidelines for cancer prevention. Data collected via accelerometers as part of the Canadian Health Measures Survey 2016/20-17 show that only 39.2% of children and youth (ages 5-17) meet Canadian Physical Activity Guidelines (Statistics Canada, 2019). Within this age group, girls were half as likely as boys to meet this target (26% vs. 52%), and youth (ages 12-17) were less likely than younger children (ages 5-11) to achieve the recommended amount of PA (31 vs. 47%). Strikingly, only 16% of adults (ages 18-79) currently report meeting Canadian Physical Activity guidelines. No differences were found between men and women, or by age group. These findings are consistent with results from previous iterations of the Canadian Health Measures survey from 2007 to 2015. More recently collected data during the COVID-19 pandemic has found that while adults aged 18-64 reported stable levels of PA compared to the pre-pandemic period, youth aged 12-17 and older adults age 65+ were less likely to meet PA guidelines (Watt & Colley, 2021). It is hypothesized that school and fitness centre closures and cessation of organized sports contributed to these differences. Thus, these populations represent particularly important targets for population-level interventions to increase PA and/or decrease sedentary time in the coming years.

Little population-level data exists on the likelihood of meeting PA guidelines according to populations identified using the PROGRESS-Plus framework (place of residence, race/ethnicity/culture/language, occupation, gender/sex, religion, education, socioeconomic status, social capital) (Cochrane Methods Equity, 2021). Surveillance data from the Canadian Health Measures Survey 2014-17 indicates that men, and those with lower levels of education were more likely to be employed in jobs with high occupational PA. Conversely, those in high-activity occupational groups self-reported less time in active transport and recreational PA, and more sedentary time (specifically video games, television, and screen time); however total daily minutes per day of self-reported PA were higher (Prince et al, 2020). Data from the 2011-12 Canadian Community Health Survey found that recent new Canadians were more likely to be inactive than established immigrants, and that inactivity was highest amongst new Canadians who were also visible minorities (Mahmood, 2019).

Estimates suggest that adherence to PA guidelines could result in reduction in risk of cancer at the individual level by 10-25% (Wild, 2020). At a population level, this can result in a large reduction in the burden of cancer. Recent estimates suggest that insufficient PA is directly attributable to 10.6% of associated cancers, or 4.9% of total cancer cases in Canada; this translates to over 9000 cases in 2015 (Friedenreich et al., 2019). A 50% reduction in insufficient PA could prevent 39,877 cases of cancer by 2042 (Friedenreich et al., 2019). While the evidence on sedentary time is still emerging, an estimated 1.7% of incidence cancers in 2015 could be attributed to spending at least three hours per day sedentary (Friedenreich et al., 2019). If sedentary time was cut in half, up to 4000 cases of cancer could be prevented by 2042.

Given the substantial evidence that exists for the benefits of PA and reduction in sedentary time to reduce cancer burden, there is a need to understand what types of interventions, particularly those that can be applied at a population level through local, provincial/territorial,

or federal policies are most effective at increasing levels of PA and reducing sedentary time. In 2020, the International Society for Physical Activity and Health (ISPAH) released "Eight Investments that work for Physical Activity", a call to action for system-based approaches to increase PA levels at a population level. This document presents the evidence on interventions related to these eight domains that have been prioritized for investment to increase global levels of PA and improve population level health. Building upon this expert statement, through this rapid review we sought to quantify the effectiveness of policy and program initiatives to increase PA and/or decrease sedentary time that are relevant to the Canadian context.

Methods

Research Questions

Primary Question:

- What are effective policy and program initiatives to increase physical activity and/or reduce sedentary time for cancer prevention?

Secondary Questions:

- What evidence exists for cost-effectiveness or cost-savings associated with successful implementation of effective interventions?
- Are their differential impacts of interventions among diverse populations including but not limited to First Nations, Inuit, and Métis; LGBTQ2S+; youth vs. adult; sex or gender; rural vs. urban; socioeconomic stats; new Canadians; and other important populations?

Search

The following databases were searched for evidence pertaining to the effectiveness of interventions aiming to increase PA and/or reduce sedentary time in line with the ISPAH's Eight Investments that work for Physical Activity using key terms related to PA, physical inactivity and/or sedentary time and systematic review and/or meta-analysis (International Society for Physical Activity and Health, 2021). Searches were limited to English-language records published after January 1st, 2011.

- Health Evidence
- Medline
- PsychInfo
- CINAHL
- Sociological Abstracts
- ERIC
- Applied Social Sciences Index and Abstracts
- Worldwide Political Science Abstracts

A copy of the full search strategy is available in Appendix 1.

Search results were uploaded into Endnote and duplicates were removed. Titles and abstracts were screened in duplicate using DistillerSR software with the DistillerSR Artificial Intelligence System (DAISY). Once the DAISY system determined the likelihood of remaining records to be eligible for inclusion <25%, the remaining records were screened by a single reviewer.

Full texts of potentially relevant records were screened by a single reviewer, and double checked by a second during data extraction.

Study Selection Criteria

English-language guidelines, umbrella reviews and/or systematic reviews with or without meta-analyses that reported on the effectiveness or cost-effectiveness of interventions that fall

within the eight ISPAH domains to increase PA and/or decrease physical inactivity were eligible for inclusion. Given the nature of the interventions not being amenable to experimental research designs, reviews conducted in the areas of active transport or active urban design could also include observational studies.

Reviews that focused on disease or condition-specific populations were excluded, as were reviews that focused exclusively on studies conducted in low to middle income countries. All included studies must have reported effectiveness in terms of PA (proportion meeting PA guidelines and/or duration of PA) or sedentary time (minutes or hours per day or week).

A summary of eligibility criteria is available in Table 1.

Table 1: Eligibility Criteria:

	Include	**Exclude**
Population	General; all ages	Disease-specific populations, including obese, overweight, frailty, inpatients
Intervention/Exposure	Interventions that follow the eight ISPAH domains • Whole-of-school programs • Active transport • Active urban design • Healthcare • Public education, including mass media • Sport and recreation for all • Workplaces • Community-wide programs	Individual-level interventions
Comparator	-	-
Outcome	Physical activity (% physically active, duration of physical activity) or sedentary time (duration or % time spent sedentary)	Obesity, overweight
Setting	All, incl. schools, workplaces, home, community, hospitals	Low-middle income countries
Study design	Guidelines Umbrella reviews of interventions Systematic Reviews with/without meta-analyses of experimental interventions *Note: for urban design and active transport domains, both experimental and observational evidence was eligible*	Single studies Reviews focusing on association or prevalence

Data Extraction and Synthesis

Data were extracted by a single reviewer, and double checked by a second with disagreements resolved through discussion. Data were extracted related to review methodology (primary objective, search date, and inclusion and exclusion criteria), and details of included studies (number of studies and study designs, number of included participants, populations included according to the PROGRESS-Plus tool, quality of included studies where reported). Results

from narrative syntheses and meta-analyses were extracted related to PA and/or sedentary time. Only whole-day or whole-week measures were extracted as they represent an individual's total PA (vs. time active in a specific setting such during school hours). Total PA, moderate-vigorous PA, and domain-specific PA (transportation, occupational, recreational/leisure and household) were extracted; specific types of activity (e.g., walking, cycling, use of a specific facility) were not extracted as they do not represent individuals' total PA and could be offset by decreased activity during other periods throughout the day.

Given the rapid nature of this review, complete data extraction and synthesis was prioritized for ISPAH domains that were most amenable to action at a regional or national policy-level, namely whole-of-school, active transport, active urban design, and sport and recreation for all. Where scientific statements and/or umbrella reviews were identified that reported on multiple domains, outcomes for the remaining domains (healthcare, public education, workplaces, and community-wide programs) were extracted and synthesized. A full list of identified reviews that met inclusion criteria but were not critically appraised or extracted can be requested from the authors.

Appraisal of Evidence Quality

We evaluated the quality of included evidence using the Health Evidence Quality Assessment Tool – Review Articles (Health Evidence™, 2005). Quality assessment was completed by one reviewer and verified by a second reviewer. Conflicts were resolved through discussion. Completed quality assessments for each included study are available on request.

A modified version of the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) approach was used to assess the certainty in the findings based on eight key domains. In the GRADE approach to quality of evidence, **observational studies,** provide **low certainty** evidence, while randomized controlled trials provide **high certainty** evidence. This assessment can be further reduced based on other domains:

- High risk of bias
- Inconsistency in effects
- Indirectness of interventions/outcomes
- Imprecision in effect estimate
- Publication bias

and can be upgraded based on:

- Large effect
- Dose-response relationship
- Accounting for confounding.

The overall certainty of the evidence for each outcome was determined taking in to account the characteristics of the available evidence, and a judgement of overall certainty is provided.

Methodological Limitations

While we followed a rigorous process as outlined in our published rapid review methodology, there are limitations in the rapid review process as compared to systematic review methodology (Neil-Sztramko et al., 2021). For example, the evidence included in this review is limited to English language papers. The exclusion of non-English papers may bias the results in favor of demonstrating intervention effectiveness. Furthermore, the review is limited to syntheses given the large number of reviews available related to the research question. The review does not include single studies published since the syntheses included in this review were published. It is possible that more recently published single studies could change the results of included reviews. To be included in the review syntheses had to be relevant to the Canadian context which resulted in reviews of studies conducted in low and middle income countries being excluded. This may reduce the generalizability of the results to certain populations and contexts in Canada and may exclude interventions shown to be effective in other contexts.

HealthEvidence.org was a key source used for identifying syntheses evaluating intervention effectiveness. While additional sources were searched, the search strategy was not exhaustive. This could have resulted in some syntheses not being captured in our search. Screening of search results was conducted by one screener, as opposed to two independent raters as suggested by Cochrane.org (Cochrane Training, 2021). Syntheses identified in sources other than HealthEvidence.org were appraised by one reviewer and checked by a second reviewer, as opposed to two independent raters. Similarly, data extraction was conducted by one reviewer and verified by a second reviewer, as opposed to two independent raters. It is not possible to quantify the impact of these limitations on the findings of this review, although it is possible that we have overestimated intervention effectiveness.

Findings

The findings of this review focus on the ISPAH domains most amenable to action at a regional or national policy-level, namely whole-of-school, active transport, active urban design, and sport and recreation for all. Reviews relevant to programmatic interventions for the remaining four ISPAH domains of healthcare, public education, workplaces, and community-wide programs, were identified but not synthesized in this review.

Summary of the Certainty of Evidence

A PRISMA diagram outlining the flow of studies through screening is available in Figure 1. Overall, 33 syntheses were included. A breakdown of number of syntheses by intervention domain is listed in Table 2.

Table 2: Intervention domains and definitions, per the ISPAH Framework

Intervention type (per ISPAH framework)	**Reviews of reviews (Date most recently published)**	**Systematic reviews/Meta-analyses (Date most recently published)**
Whole-of-school programs: multi-component interventions applied at the school level, including a combination of regular, high-quality physical education, opportunities for PA throughout the day (before and after school, recess, and/or during class time), promoting active travel to school and engaging staff, families, and communities to increase PA participation	4 (2020)	6/3 (2021)
Active transport: Built environment strategies to increase active transport, active transport policies, public transit, walking and cycling infrastructure, school active transport interventions	2 (2020)	7/3 (2019)
Active urban design: Built environment strategies to increase overall and leisure-time physical activity; may also include strategies to increase active transport	6 (2020)	13/None (2020)
Sport and recreation for all: interventions or infrastructure that provide freely accessible opportunities for individuals to participate in sport and recreation activities	3 (2019)	1/None (2019)
Healthcare-provider delivered interventions	1 (2012)	20 (2021)
Public education, including mass media	3 (2018)	12 (2020)
Workplace-based interventions	3 (2019)	23 (2021)
Community-wide programs	2 (2019)	7 (2020)

Whole-of-School Interventions

Key Findings

- There is moderate certainty evidence that whole-of-school interventions probably increase PA in children and adolescents slightly, with multi-component interventions associated with larger increases.
- There is low certainty evidence that whole-of-school interventions may decrease slightly sedentary behaviour in children and adolescents.
- Syntheses evaluating the cost-effectiveness of whole-of-school interventions for both PA and sedentary behaviour in children and adolescents are needed.
- More primary studies and syntheses are needed exploring the impact of whole-of-school interventions on PA and sedentary behaviour among diverse populations in differing contexts.

A total of 10 syntheses that reported on the effectiveness of whole-of-school interventions to increase total PA and/or reduce sedentary time in children were identified. Whole-of-school interventions were defined broadly and highly heterogeneous, including a combination of regular, high-quality physical education, opportunities to incorporate PA throughout the school day (e.g., before and after school, during recess, and/or during class time), promoting active transport to and from school, and engaging staff, families and communities to increase PA and/or decrease sedentary time.

Table 3: GRADE Summary of Findings for Whole-of-School interventions

Intervention	Outcome	Studies included		Overall certainty in evidence (GRADE)	Key findings
		Study design	n		
Whole-of-school	Physical activity	Syntheses	10	⊕⊕⊕◯ Moderate[1]	Whole-of-school interventions **probably result in small increases in total PA** in children and adolescents
Whole-of-school	Sedentary time	Syntheses	2	⊕⊕◯◯ Low[2]	Whole-of-school interventions **may result in small decreases in sedentary time** in children and adolescents

[1]In the GRADE approach to quality of evidence, **randomized controlled trials,** as included in most syntheses, provide **high quality** evidence, and this assessment was downgraded to **moderate** based inconsistency of effects observed.
[2]In the GRADE approach to quality of evidence, **randomized controlled trials,** as included in most syntheses, provide **high quality** evidence, and this assessment was downgraded to low based on the inconsistency of effects and high risk of bias in included studies.

One umbrella review (Puggina et al., 2018) and three scientific statements (Heath et al., 2012, King et al., 2019, Mozaffarian et al., 2012) concluded there was probable (Puggina et al., 2018, Mozaffarian et al., 2012) and sufficient evidence of effectiveness (Heath et al., 2012, King et al.,

2019) of whole-of-school approaches to increase PA in children and adolescents, recommending implementation of these interventions.

One recent Cochrane systematic review conducted a meta-analysis of RCTs that reported objectively measured PA and sedentary time in students taking part in multi-component interventions; using GRADE, authors concluded that multi-component interventions probably result in small increases in MVPA among children and adolescents (MD 2.42 minutes/d, 95% CI=0.62, 4.22; 16 studies), and may result in small decreases in sedentary time (MD -4.60 minutes/d, 95% CI=-9.08, -0.12; 11 studies) (Neil-Sztramko et al., 2021). A 2019 meta-analysis reported similar findings focused exclusively on adolescent PA, with small effect size (pooled SMD = 0.12, 95% CI= 0.12, 0.27) (van de Kop et al., 2019). A 2015 meta-analysis which included both randomized and non-randomized studies reported a pooled effect size of g = 0.11 (95% CI: 0.03, 0.19) for school-based interventions incorporating at least two independent components to increase student PA (Russ et al., 2015). In sensitivity analyses, the greater the number of components incorporated into the intervention, the stronger the effect of the intervention.

Results were generally consistent in the remaining three syntheses (Jones et al., 2020, McHugh et al., 2020, Woods et al., 2021). While mixed findings were reported across single studies, the general conclusion was that multi-component interventions can increase total PA. Sedentary time was less commonly reported, thus the certainty of the evidence for this outcome is less conclusive.

None of the included reviews reported on cost or cost-effectiveness of whole-of-school interventions. Across reviews, very few studies reported on differential effects among diverse populations. While several reviews compared the findings between boys and girls, results were mixed.

Active Transport

Key Findings

- Combinations of built environment strategies are recommended for increasing PA levels among all age groups; the optimal combination of strategies is unclear.
- School-based active transport may increase PA particularly among primary school children.
- Walking/cycling infrastructure interventions implemented without concurrent built environment strategies may have little to no impact on PA
- Enhanced public transit infrastructure may increase PA.
- The impact of active transport on sedentary behaviour is unknown.
- Syntheses on the cost-effectiveness of active transport interventions are needed.
- More primary studies and syntheses exploring the impact of active transport among diverse populations in differing contexts are needed.

A total of 9 syntheses were identified that reported on the effectiveness of policies or interventions to increase PA through active transportation. None of the included syntheses reported on the impacts on sedentary time. Active transport interventions can be broadly defined. For the purposes of this review, interventions were categorized into overall built environment strategies, active transport policies, public transit, walking and/or cycling infrastructure, and school-based active transport interventions.

Table 4: GRADE Summary of Findings for Active Transport interventions

Intervention	Outcome	Studies included		Overall certainty in evidence (GRADE)	Key findings
		Study design	n		
Active transport: built environment strategies	Physical activity	Syntheses	2	⊕⊕◯◯ Low[1]	A combination of built environment strategies (e.g., walking/cycling infrastructure, street connectivity and design, and mixed land) use **probably increase PA levels in children, adults, and older adults**
Active transport: public transit	Physical activity	Syntheses	5	⊕⊕◯◯ Low[1]	Investments in public transit **may increase total PA levels**; the effect **may be stronger for femal**es and those who **live in closest proximity to transit** locations.
Active transport: walking and cycling infrastructure	Physical activity	Syntheses	3	⊕◯◯◯ Very Low[2]	Walking and cycling infrastructure on their own **may have little to no effect on total PA**, but the evidence is very uncertain
Active transport: school	Physical activity	Syntheses	2	⊕⊕◯◯ Low[1]	School-based active transport **may result in small increases in overall PA**, particularly in primary school children

[1]In the GRADE approach to quality of evidence, **observational studies,** as included in most syntheses, provide l**ow quality** evidence. No additional up or downgrades were made.
[2]In the GRADE approach to quality of evidence, **observational studies,** as included in most syntheses, provide **low quality** evidence. Certainty was further downgraded due to inconsistency in effects

One review of reviews and one scientific statement that reported on the use of general built environment strategies to increase overall PA were identified (king et al., 2019, Omura et al., 2020). Both concluded that there is evidence for the effectiveness of built environment strategies, such as street connectivity, mixed land-use, and walking and cycling infrastructure and walkability to increase total PA levels in children, adults, and older adults. Importantly, both noted the importance of combined strategies to maximize impact. Given wide variation across single studies in the types of strategies employed, and context in which they were implemented, authors concluded it was not possible to conclude the most effective or cost-effective strategy or combination of strategies to employ.

Five syntheses that explored the impact of public transit on total PA were identified (Hirsch et al., 2018, Mayne et al., 2015, Rissel et al., 2012, Xiao et al., 2019). A wide range of public transit initiatives were included within the reviews such as increasing the number of stops on existing routes, creation of rapid transit options, and creation of new public transit infrastructure. Across studies, investments in public transport increase usage, and increase transportation-related activity; the effect on total PA levels was mixed. One meta-analysis of 5 studies found that rapid transit resulted in a decrease of 80.4 min/week of total PA (Hirsch et al., 2018), while a meta-analysis of 9 studies found new public transport increased both light-moderate PA and MVPA of 1.76 MET hours/week and 0.33 MET hours/week respectively (Xiao et al., 2019). Across reviews, authors note that females, and those that live near public transit stops may benefit most from the interventions.

Three reviews specifically reported on the impact of walking and cycling infrastructure on both walking or cycling behaviour and total PA (Mölenberg et al., 2019, Karmeniemi et al., 2018, Tcymbal et al., 2020). While findings were consistent that cycling infrastructure (e.g., cycling lanes and city-wide networks) increased cycling behaviour at a population-level(16), the impact on total PA across reviews was mixed. Thus, it is not certain whether cycling lanes promote PA behaviours in those who were not previously active or result in increased usage amongst those who are already active.

Two reviews reported on the effects of school-based active transport interventions, namely those that focused on increasing walking and cycling to and from school in children and decreasing car trips (Jones et al., 2019, Volla-Gonzalez, 2018). One meta-analysis found that these interventions increased both travel related PA (SMD: 0.78, 95% CI: 0.11, 1.46) and MVPA (SMD: 0.72, 95% CI: 0.30, 1.73) over the course of a week amongst primary school children (Jones et al., 2019). A second review that included primary and secondary school-based interventions noted mixed and inconsistent results (Villa-Gonzalez et al., 2018).

None of the included reviews reported on cost or cost-effectiveness of active transport interventions. Across reviews, very few studies reported on differential effects across diverse populations. One review of cycling infrastructure noted there were no differences in effects by

demographics or SES. Two reviews noted that the benefits of active transport interventions may be larger for females.

Active Urban Design

Key Findings

- Population density, built form, and land-use mix may increase PA among adults; while neighborhood green and open spaces and aesthetics may increase PA among adults and older adults, particularly when safety is improved
- Road street design, access to facilities and amenities, and walkability/facility index probably increase PA among all age groups.
- There is very limited evidence assessing the impact of active urban design interventions on sedentary behaviour; more primary studies and syntheses to inform decision making are needed.
- There is very limited evidence from one cost-effectiveness review of a small number of studies that community trails are the most cost-effective interventions; however, more primary cost-effectiveness studies and cost-effectiveness syntheses are needed to support decision making.
- More primary studies and syntheses exploring the impact of active urban design interventions among diverse populations in differing contexts are needed.

A total of 19 syntheses (six scientific statements or umbrella reviews, and 13 systematic reviews) that reported on the effectiveness of policies or interventions to increase PA through active urban design were identified. One of the included syntheses reported on the impacts on sedentary time, and one reported on cost-effectiveness. Most (n =15) focused on the general population or adults, while two focused exclusively on children and youth, and two on older adults. Active urban design interventions can be broadly defined. For the purposes of this review, interventions were defined as built environment strategies which aimed to increase overall and leisure-time PA; these could also include infrastructure aimed to increase active transportation (e.g., walking paths); thus, some overlap in evidence between Active Transport and Active Urban Design interventions is present. Outcomes were categorized in line with categories of built environment determinants proposed by Nordbø et al., and include: population measures (e.g., population density), built form measures (e.g., residential density, total building density, urban-rural status of home address), land-use measures (e.g., land-use, land-cover, land-use mix), road/street environment measures (e.g., road/street patterns and connectivity, traffic exposure and safety, pedestrian infrastructure), facility and amenity measure (e.g., distance to facilities and/or amenities, count or proportion of facilities and/or amenities, topography connected to accessibility of facilities and/or amenities), neighbourhood green and open space measures (e.g., distance to, count, proportion, and/or type of green and open space, structures surrounding parks), composite measures (e.g., walkability index, facility and amenity index), and aesthetic measures (Nordbø, 2018).

Table 5: GRADE Summary of Findings for Active Urban Design interventions

Intervention	Outcome	Studies included		Overall certainty in evidence (GRADE)	Key findings
		Study design	n		
Active urban design: population measures	Physical activity	Syntheses	3	⊕⊕◯◯ Low[1]	Population density **may be associated with increased physical activity**, particularly in adults.
Active urban design: built form	Physical activity	Syntheses	6	⊕⊕◯◯ Low[1]	Built form features **may be associated with increased physical activity** in adults.
Active urban design: land-use	Physical activity	Syntheses	9	⊕⊕◯◯ Low[1]	Land-use mix **may be associated with increased physical activity** in adults.
Active urban design: road/street environment	Physical activity	Syntheses	15	⊕⊕⊕◯ Moderate[2]	Road/street environment improvements are **probably associated with increased PA**
Active urban design: facility and amenities	Physical activity	Syntheses	9	⊕⊕⊕◯ Moderate[3]	Access to facilities and amenities for PA are **probably associated with increased PA**.
Active urban design: neighbourhood green and open space	Physical activity	Syntheses	11	⊕⊕◯◯ Low[1]	Access to neighbourhood green and open space **may be associated with increased PA** in adults and older adults.
	Sedentary time	Syntheses	1	⊕◯◯◯ Very low[4]	The evidence is **very uncertain** about the association between neighbourhood green and open space and sedentary time.
Active urban design: walkability, facility/amenity index	Physical activity	Syntheses	9	⊕⊕⊕◯ Moderate[2]	Neighbourhood walkability is **probably associated with increased PA**.
Active urban design: aesthetics	Physical activity	Syntheses	5	⊕⊕◯◯ Low[1]	Neighbourhood aesthetics **may be associated with increased PA**.

[1]In the GRADE approach to quality of evidence, **observational studies,** as included in most of the syntheses, provide **low quality** evidence. No further up or downgrades were made.
[2]In the GRADE approach to quality of evidence, **observational studies,** as included in most of the syntheses, provide **low quality** evidence, and this assessment was upgraded to **moderate** based on the large effect observed.
[3]In the GRADE approach to quality of evidence, **observational studies,** as included in most of the syntheses, provide **low quality** evidence, and this assessment was upgraded to **moderate** based on the dose-response relationship.
[4]In the GRADE approach to quality of evidence, **observational studies,** as included in most of the syntheses, provide **low quality** evidence, and this assessment was downgraded to **very low** based on inconsistency in effects.

Three included reviews reported on the associations between measures of population density and total PA; one review including 51 longitudinal studies and natural experiments found a positive association between density and PA (Karmeniemi et al., 2018), while a review of longitudinal and cross-sectional studies in Australian adults (Zapata-Diomedi et al., 2016), and

youth found no association (Nordbø et al., 2020). Given differences in study design and risk of bias across syntheses, we conclude that population density may be positively associated with PA, particularly in adults.

The search identified six syntheses that assessed built form features (residential density, building density, and urbanization) in the general population (Omura et al., 2020, Bird et al., 2018, Barnett et al., 2017), older adults (Barnett et al., 2017, van Cauwenberg et al., 2018) and children (Nordbø et al., 2020). A scientific statement from the American Heart Association recommends a combination of built form or land-use features with road/street environment design to increase physical activity (Omura et al., 2020), consistent with a 2016 umbrella review (Bird et al., 2018). A systematic review based on mostly cross-sectional studies of only European adults found no association between residential density and urbanization and PA(24). No association was reported in reviews of older adults (Barnett et al., 2017, van Cauwenberg et al., 2018) or children/youth (Nordbø et al., 2020).

Land-use, most commonly land-use mix was reported in 9 syntheses (Puggina et al., 2018, Heath et al., 2012, Mozaffarian et al., 2012, Omura et al., 2020, Karmeniemi et al., 2018, Zapata-Diomedi et al., 2016, Nordbø et al., 2020, van Holle et al., 2012, van Cauwenberg et al., 2018). The American Heart Association Physical Activity Committee, and Council, as well as "DEDIPAC" consortium conclude that there is limited but suggestive evidence that land-use mix is associated with increased PA (Puggina et al., 2018, Mozaffarian et al., 2012, Omura et al., 2020). These findings are consistent with two reviews of natural experiments/longitudinal studies (Karmeniemi et al., 2018), and studies focused only on the Australian context (Zapata-Diomedi et al., 2016) which both found positive associations between land-use mix and PA in adults. This is in contrast to a 2011 review of European adults (van Holle et al., 2012), which included almost all cross-sectional studies. Two reviews of older adults (van Cauwenberg et al., 2018), and children/youth found no association (Nordbø et al., 2020).

Road/street environment measures were explored in 15 syntheses. All six scientific statements and umbrella reviews concluded that measures such as street connectivity and pedestrian infrastructure were associated with increased total PA (Puggina et al., 2018, Heath et al., 2012, King et al., 2019, Mozaffarian et al., 2012, Omura et al., 2020, Bird et al., 2018); these findings were in agreement with a 2018 review of longitudinal studies (Karmeniemi et al., 2018) and a 2017 review of built environment (BE) interventions, with particularly strong evidence for pedestrian infrastructure (Smith et al., 2017). This in contrast to four reviews that noted mixed or inconsistent evidence on measures of road/street environment, in particular safety features; of note the quality of single studies in these reviewers appear lower or were not appraised (Tcymbal et al., 2020, Zapata-Diomedi et al., 2016, van Holle et al., 2012, Stappers et al., 2018). One synthesis found inconsistent associations between road/street environment and PA in youth (Nordbø et al., 2020). Amongst older adults, strong positive associations were found for physical activity and safety, and pedestrian friendly infrastructure, but inconsistent findings for street connectivity in two syntheses (Barnett et al., 2017, van Cauwenberg et al., 2018).

Findings were consistent across two scientific statements (King et al., 2019, Omura et al.,2020), four reviews of the general population (Karmeniemi et al., 2018, Zapata-Diomedi et al., 2016, van Holle et al., 2012, Smith et al., 2017), two reviews focused on older adults (Barnett et al.,

2017, van Cauwenberg et al., 2018) and one review focused on youth (Nordbø et al., 2020), that access to facilities and amenities for physical activity, such as distance to facilities, number of facilities and ease of access are positively associated with increased PA.

One scientific statement (Omura et al., 2020), one umbrella review (Bird et al., 2018) and two systematic reviews of adults Zapata-Diomedi et al., 2016) concluded that neighborhood green space and open space was associated with increased PA, particularly when combined with favorable land-use and road/street environment features. This contrasted with four reviews that noted mixed findings (Mayne et al., 2015, Zapata-Diomedi et al., 2016, Smith et al., 2017, Hunter et al., 2015); like findings from road/street environment features, the studies included in reviews that found mixed associations were of lower methodological quality or were not appraised. In both reviews that focused on older adults, access to neighbourhood green or open spaces were strongly associated with increased PA (Barnett et al., 2017, van Cauwenberg et al., 2018); however, in one review focused on children no association was found (Nordbø et al., 2020). A single review reported on the association between urban green space and decreases in sedentary time; mixed findings were reported across 12 included studies (Hunter et al., 2015).

The relationship between walkability index and physical activity was reported in eight reviews; all reported a positive association in adults (Mozaffarian et al., 2012, Karmeniemi et al., 2018, Tcymbal et al., 2020, Zapata-Diomedi et al., 2016, Bird et al., 2018, van Holle et al., 2012), older adults (Barnett et al., 2017) (Barnett et al., 2017) and children (McGrath et al., 2015).

Neighbourhood aesthetic features and the association with PA was reported in five syntheses. Findings were consistent amongst reviews of adults (Bird et al., 2018, Mozaffarian et al., 2019, van Holle et al., 2012) and older adults (van Holle et al., 2012), that neighbourhood aesthetics are positively associated with PA, while one review focused on youth found no relationship (Nordbø et al., 2020).

Only one review was identified that reported on cost-effectiveness of active urban design features. In a review of 5 RCTs and 9 economic forecasting studies, pedestrian infrastructure and neighbourhood green/open spaces had large budget impact effects and were deemed to be cost-effective. Pedestrian infrastructure interventions, in particular the creation of a community-trail, were deemed to be the most cost-effective investments (Laine et al., 2014).

Across reviews, very few studies reported on differential effects among diverse populations. One review specifically sought to explore the effects of sex/gender on built environment interventions, however very limited evidence was available. Road/street environment and built form features appeared to have a strong association with PA in females, while neighbourhood green/open spaces appear to be more strongly associated with PA in males (Tcymbal et al., 2020). Pedestrian infrastructure was also more strongly associated with PA in girls aged 9-15 than boys, although associations between walkability were stronger in boys (McGrath et al., 2015). Another review aimed to summarize the effects of built environment interventions by ethnicity and socioeconomic status. Only four studies explored effects by these variables and found inconsistent findings for the association with PA (Smith et al., 2017).

Sport and Recreation for All

Key Findings

- Access to indoor and outdoor recreation facilities and no-cost community PA classes and programs may be associated with increased PA; however, magnitude of effect or relative effects of different types is unknown.
- Secondary data analyses to support a conclusion that sport and recreation for all interventions may be beneficial for underserved populations were not conducted.
- There is no evidence reporting the impact of sport and recreation for all interventions on sedentary behaviour; more primary studies and syntheses are needed to inform decision making.
- Syntheses on the cost-effectiveness of sport and recreation for all interventions are needed.
- More primary studies and syntheses exploring the impact of sport and recreation for all interventions among diverse populations in differing contexts are needed.

Four syntheses were identified that reported on the effectiveness of sport and recreation for all interventions to increase total physical activity; none reported on sedentary time. Sport and recreation for all interventions are those that provide freely accessible opportunities for individuals to participate in sport and recreation activities.

Table 6: GRADE Summary of Findings for Sport and Recreation for All

Intervention	Outcome	Studies included		Overall certainty in evidence (GRADE)	Key findings
		Study design	n		
Sport and recreation for all	Physical activity	Syntheses	4	⊕⊕◯◯ Low[1]	Sport and recreation for all **may result in increases in PA for those who participate**, however the magnitude of the effect is unknown.
[1]In the GRADE approach to quality of evidence, **observational studies,** as included in most syntheses, provide **low quality** evidence. No additional up or downgrades were made.					

Three scientific statements and one systematic review reported on the effect of sport and recreation for all, concluding that access to indoor and outdoor recreational facilities (King et al., 2019, Mozaffarian et al., 2012), and no-cost community physical activity classes or programs (Heath et al., 2012, Umstattd et al., 2019) are associated with increased PA in those who participate. The committees also concluded that these may be particularly beneficial for underserved populations, and those who experience barriers to reaching recommended PA levels, however these conclusions are not supported by secondary data analysis. The magnitude of the effect expected, and the types of programs that are most effective were not identified.

Remaining ISPAH Domains

This review synthesized the evidence on four of the eight ISPAH domains, namely, whole-of-school, active transport, active urban design and sport and recreation for all. For the remaining four domains: healthcare-delivered; public education including mass media; workplace; and community-wide interventions, evidence was identified but not synthesized. However, some key messages from this evidence are described here.

Within the search, four reviews of reviews or scientific statements were identified that reported on the effects of interventions within multiple domains of the ISPAH framework (Puggina et al., 2018, Heath et al., 2012, King et al., 2019, Mozaffarian et al., 2012); one reported on healthcare-delivered interventions (Heath et al., 2012), three on public education including mass media (Puggina et al., 2018, Heath et al., 2012, Mozaffarian et al., 2012), three on workplace-based interventions (Heath et al., 2012, King et al., 2019, Mozaffarian et al., 2012); and two on community-wide interventions (Heath et al., 2012, Mozaffarian et al., 2012). Cost and cost-effectiveness were not reported in these reports, nor were differential effects among diverse populations.

The Lancet Physical Activity Series Working Group concluded in 2012 that there was insufficient evidence to support healthcare-provider based PA counselling on its own, however provider-based screening and referral to community supports can increase PA (2).

Both the American Heart Association Council, and the "DEDIPAC" Consortium concluded that there was limited and insufficient evidence to support the role of public education through mass media to increase total population-level PA outcomes (1, 4). This contrasts with the Lancet Physical Activity Series Working group, who concluded that mass media campaigns are a "promising practice", especially when directly linked to community-based programs (Heath et al., 2012).

Both the Lancet Physical Activity Series Working Group and American Heart Association found evidence to support the use of comprehensive, multi-component workplace wellness programs to increase PA (Heath et al., 2012, Mozaffarian et al., 2012). The 2018 US Physical Activity Guidelines Advisory Committee found limited and inconsistent evidence for the role of workplace-based educational or motivational interventions to reduce sedentary behaviour, but medium-large effects were seen for changes to the work environment, such as standing workstations, especially when combined with behavioural support (King et al., 2019).

Finally, findings were consistent between the 2018 US Physical Activity Guideline Advisory Committee and the Lancet Physical Activity Series Working group with respect to community-wide interventions. Multi-component community-wide policies may result in increases in PA, however they must include sufficient contact with the majority of the population to be effective at the population-level and must not only focus on motivating individuals, but also reducing environmental and structural

barriers to PA at the institutional and environmental level (Heath et al., 2012, King et al., 2019). Few examples of these exist in the literature.

Discussion

This rapid review sought to identify policy and program interventions that improve physical activity and/or reduce sedentary behaviour as a means of reducing cancer incidence in Canada. This review is organized according to the domains identified in the ISPAH framework, with results limited to the following four domains: whole-of-school; active transport; active urban design; and sport and recreation for all. Among these four domains there is variation in the availability of evidence syntheses. Several reviews relevant to whole-of-school and active urban design were available, and only a few reviews relevant for active transport and sport and recreation for all. The certainty of the findings ranges from moderate to very low; therefore caution is advised in applying these findings to decision making.

Overall, a number of interventions have been shown to increase physical activity. Increased physical activity were reported across all age groups, and particularly for multi-faceted interventions; meaning interventions that included combinations of strategies tended to report increased physical activity more often that single component interventions. This held true for whole-of-school, active transport, and active urban design interventions. The evidence for sedentary behaviour is extremely limited with almost no evidence syntheses reporting on this outcome. When sedentary behaviour was reported, results tended to be mixed.

There are some notable gaps in the evidence base across the four ISPAH domains addressed in this review. Generally, the evidence is extremely limited or non-existent on the impact of interventions on diverse populations and in diverse settings. Similarly, the evidence on the cost-effectiveness of interventions is extremely limited. Future research should evaluate the impact of policy interventions on physical activity and sedentary behaviour on diverse populations and in varying contexts and settings.

Further consideration of the impact of the COVID-19 pandemic on physical activity and sedentary behaviours across all age groups, gender and sociodemographic factors is also needed. One study exploring the impact of public health measures on outdoor time and screen time among children in Canada found that children, particularly those under age 5 experienced significantly reduced outdoor time, and females and those over age 5 experienced significantly increased screen time (Li et al., 2021). A second study of children aged 5-11 in Canada found similar results with 53% of parents indicating closures of playgrounds resulted in reduced play at parks, 54% indicating decreased play in public spaces, and significantly increased time watching TV (59%), playing video games (56%), and using screen-based devices (76%) (McCormack et al., 2020). Among a national sample of children and youth in Canada in 2020, more than 80% were not meeting physical activity guidelines and 89% had higher screen time than recommended, with youth rates most severely impacted (Moore, 2020).

Among Canadian adults, one study reported a 20% decrease in those meeting international guidelines for moderate to physical activity per day from pre-COVID-19 levels to during the early months of the pandemic (Rhodes et al., 2020). Another sample of Canadian adults found 40% of previously-inactive adults became less active and 22% of previously-active individuals became less active (Lesser et al., 2020).

These data illustrate physical activity among multiple age groups was reduced during the COVID-19 pandemic. In addition to the strategies identified as effective in this review, additional strategies to support people to revert to previous, higher levels of physical activity may be necessary. It may also be necessary to develop new guidance on how to stay active given potentially ongoing public health measures such as physical distancing and face masking.

While there are many well-known benefits to physical activity, its relationship to cancer risk may be less widely known. Limited evidence exploring knowledge and perceptions of the relationship between physical activity and cancer risk is available.

The findings of this review shed light on a suite of policy actions that could be implemented as strategies to increase physical activity and reduce sedentary behaviours. While some guidance on actions that are supported by evidence are identified, it is not known for whom these interventions work best, or if they will widen health inequities rather than reduce them. Research that reports intervention effects for diverse populations and in varying settings, along with cost-effectiveness studies and syntheses, is needed in order to support evidence-informed decision making related to cancer prevention.

Table 7: Whole-of-school interventions

Reference	Primary objective of review	Search date (Date range of included studies)	Review Inclusion criteria	Number of included studies related to schools (Total, by design) and sample size	PROGRESS-Plus-identified populations	Results	Subgroup analyses	Quality of included studies	Review quality
Neil-Sztramko, S., Caldwell, H., & Dobbins, M. (2021). School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database of Systematic Reviews 9*(9): CD007651.	To summarize studies of school-based interventions to increase MVPA and fitness in children and adolescents.	Jun 2020 (1989-2020)	Population: Children and adolescents aged 6-18 years Intervention: Multi-component school-based Outcome: Measured PA	89 RCTs total PA: 33 RCTs, n = 20,614 SB: 16 RCTs, n = 11,914	Ethnicity NR in 40 of the 89 studies	Multi-component interventions probably result in small increases in MVPA among children and adolescents (MD 2.42 minutes/d, 95% CI=0.62 to 4.22; 16 studies). Multi-component interventions may result in small decreases in sedentary time (MD -4.60 minutes/d, 95% CI=-9.08 to -0.12; 11 studies).	-	MVPA - moderate certainty evidence Sedentary time - low certainty evidence	10/10

Woods, C.B., Volf, K., Kelly, L., Casey, B., Gelius, P., Messing, S., … P.E.N. Consortium. (2021). The evidence for the impact of policy on physical activity outcomes within the school setting: A systematic review. *Journal of Sport and Health Science 10*(3): 263-276.	To summarize studies of effectiveness of school-based policies to increase PA.	Nov 2019 (1999-2020)	Population: Children, adolescents, and teachers Intervention: Whole-school PA policy Outcome: Reported PA or proxy measure (e.g., fitness) or changes in physical and social environment to support PA	25 studies total 10 studies on multi-component PA policies: •1 RCT •2 quasi-experimental •4 pre-post studies •2 cross-sectional •1 qualitative Total n = NR	Primary school, n = 7 Secondary school, n = 3	60% of studies found positive impact of policy on overall PA, 20% were inconclusive and 20% did not measure PA.	-	Scores ranged 42%-92%, most rated >60%	6/10
Jones, R.A., Blackburn, N.E., Woods, C., Byrne, M., van Nassau, F., & Tully, M.A. (2019). Interventions promoting active transport to school in children: A systematic review and meta-analysis. *Preventive Medicine 123*: 232-241.	To summarize studies of effectiveness of school-based interventions to increase PA and reduce sedentary time.	Jun 30, 2017 (1997-2017)	Population: Children aged 5-11 years Intervention: School-based interventions Outcome: Measured PA	57 studies total; 18 multi-component: •5 RCTs •5 quasi-experimental •8 descriptive Total n = NR	NR	66% (n = 12) reported positive effect on PA or MVPA; 28% (n=5) reported no effect; 6% (n=1) found negative association between intervention and MVPA. 25% (n = 1) found positive effect on SB; 50% (n = 2) found no effect and 25% (n = 1) found a negative effect of interventions on SB.	Subgroup analysis by sex inconclusive.	•RCTs: mean quality rating 45% •Quasi-experimental: mean quality rating 50% •Descriptive: mean quality rating 83% •Mixed method: quality rating 50%	7/10

McHugh, C.,Hurst, A.,Bethel, A.,Lloyd, J.,Logan, S.,Wyatt, K. (2020). The impact of the World Health Organization Health Promoting Schools framework approach on diet and physical activity behaviours of adolescents in secondary schools: A systematic review. *Public Health 182*: 116-124.	To summarize studies of effectiveness of interventions using the World Health Organization Health Promoting Schools (HPSs) to increase PA and improve diet in young people aged 11-18 years.	May 2018 (1998-2016)	Population: Secondary students, aged 11-18 years Intervention: Interventions incorporating components of the World Health Organization Health Promoting Schools Framework Outcome: Reported PA, reported diet	8 cluster RCT: •3 reporting on PA •5 reporting on PA and nutrition n (range) = 462-25,000	• 4 studies reported ethnicity • 6 studies reported SES	Within the Health Promoting Schools Framework, 3 studies focused that primarily on increasing individual PA levels through classroom activities and during existing physical education classes had positive result. 5 studies that evaluated intervention for PA and diet were inconclusive.	-	High quality: 1 study Moderate/high quality: 3 study Low quality: 4 studies	10/10

King, A.C., Whitt-Glover, M.C., Marquez, D.X., Buman, M.P., Napolitano, M.A., Jakicic, J., ... 2018 Physical Activity Guidelines Advisory, Committee. (2019). Physical Activity Promotion: Highlights from the 2018 Physical Activity Guidelines Advisory Committee Systematic Review. *Medicine and Science in Sport and Medicine* *51*(6): 1340-1353.	1) What interventions are effective for increasing regular physical activity at different levels of impact? 2) What interventions are effective for reducing sedentary behavior?	Date NR (2011-2016)	Population: General Intervention: Promotion of PA Outcome: Reported PA	11 articles focused on schools •5 systematic reviews •2 meta-analyses •2 expert reports Total n = NR	NR	Evidence of effectiveness of multiple-component programs occurring during school hours aimed at PA across the school day in primary school-age (typically ages 5 to 12 years) and adolescent youth.	-	Moderate-strong	7/10

van de Kop, J.H., van Kernebeek, W.G., Otten, R.H.J., Toussaint, H.M., & Verhoeff, A.P. (2019). School-based physical activity interventions in prevocational adolescents: A systematic review and meta-analyses. *The Journal of Adolescent Health 65*(2): 185-194.	To determine the effectiveness of school-based interventions to increase PA.	Nov 28, 2018 (2002 – 2018)	Population: Adolescents aged 12-17 years Intervention: School-based, lasting minimum 6 weeks Outcome: Reported PA	40 RCTs Total sample size 32,696	• 5 studies included females only • Study samples were mainly underserved, multiethnic prevocational adolescents	Composite outcome of PA (total, MVPA, leisure-time, etc.): SMD=0.19 (95% CI=0.12, 0.27), I^2 = 91%. Multi-component interventions were most effective. Factors that improved the effect were: • Intra-curricula PA, SMD=0.43 (95% CI=0.19, 0.68) • Involvement of school staff in intra-curricular intervention, SMD=0.37 (95% CI=0.16, 0.58) • Tailored intra-curricular intervention, SMD=0.35 (95% CI=0.13, 0.58)	Girls (n = 16 studies), SMD: 0.10 (95% CI=.01, .19; I^2 = 69%). Boys (n = 11 studies), SMD: 0.14.95% CI=06, .34; I^2 = 86.	High risk of bias: 20 studies Low risk of bias: 20 studies	7/10

Puggina, A., Aleksovska, K., Buck, C., Burns, C., Cardon, G., Carlin, A., ... DEDIPAC Consortium. (2018). Policy determinants of physical activity across the life course: a 'DEDIPAC' umbrella systematic literature review. *European Journal of Public Health 28*(1):105-118.	To determine the effectiveness of policy determinants of PA across the life course.	Apr 2016 (2006-2015)	Population: Any age Intervention: Policy determinants of PA Outcome: PA, exercise, or sport Design: Systematic review	1 Review on school-related PA policies Total n = NR	NR	60% of studies found a positive relationship between PA policy and children's PA (Probable evidence).	-	Moderate quality	8/10

Russ, L.B., Webster, C.A., Beets, M.W., & Phillips, D.S. (2015). Systematic Review and Meta-Analysis of Multi-Component Interventions Through Schools to Increase Physical Activity. *Journal of Physical Activity & Health 12*(10): 1436-46.	To summarize studies of school-based multi-component interventions to increase daily PA in USA schools.	Aug 2013 (1997-2013)	Population: Students aged 5-18 Intervention: Any school-based with ≥2 components Outcome: Reported PA	14 Studies •11 RCTs •1 quasi-experimental •1 pre-post •1 cross-sectional Total sample size 51,560	NR	Pooled effect size g=0.11 (95% CI=0.03, 0.19). Total daily PA increased with number of components in intervention. •2 components g=0.06 (8 studies) •3 components g=0.19 (5 studies) •4 components g=0.29 (1 study) PA during school, PA before-and-after school and staff wellness had greatest impact on increasing effect size.	For boys, g=0.09 (95% CI=-0.10, 0.28). For girls, g=0.11 (95% CI=-0.02, 0.23).	NR	7/10

Heath, G.W., Parra, D.C., Sarmiento, O.L., Andersen, L.B., Owen, N., Goenka, S., ... Lancet Physical Activity Series Working Group. (2012). Evidence-based intervention in physical activity: lessons from around the world. *Lancet 380*(9838): 272-81.	To summarize studies of interventions to promote PA.	Jan-Jul 2011 (2000-2011)	Population: Any Intervention: Population-level PA promotion	5 reviews focused on schools •1 reviews of reviews •1 meta-analyses •3 narrative reviews Total sample size NR	•2 included studies of minority and low SES populations	Comprehensive school-based strategies that encompass physical education, classroom activities, after-school sports, and active transport can increase PA in young people. Reported core components for effective school-based interventions are as follows: •increased number (five sessions of at least 45 min/week) or improved quality of classes, •increased PA during break and at other times, •capacity building and staff training, •changes in the curricula, •provision of equipment and materials, and •adjustment of interventions to target specific populations.	-	NR	6/10

Omura, J.D., Carlson, S.A., Brown, D.R., Hopkins, D.P., Kraus, W.E., Staffileno, B.A., ... Council on Clinical Cardiology. (2020). Built Environment Approaches to Increase Physical Activity: A Science Advisory from the American Heart Association. *Circulation 142*(11): e160-e166.	To summarize studies of effectiveness of population interventions to increase PA, improve diet and reduce tobacco use.	Date NR (2004-2012)	Population: General Intervention: Population-level policies Outcome: NR	16 studies looked at PA alone: •2 systematic reviews; 1 including a meta-analysis •6 RCTs •5 non-RCTs •1 quasi-experimental •2 observational, cross-sectional 9 studies looked at PA and diet together: •3 systematic reviews •3 RCTs •3 non-RCTs Sample size range: 417 - 3006	•1 RCT looked at females, aged 6-12 •1 RCT included low-income school aged children •1 RCT looked at schools with children receiving federally subsidized meals and ethnicity •1 non-randomized control trial stratified by ethnicity	Multicomponent interventions focused on improving diet and PA, including specialized educational curricula, trained teachers, supportive school policies, a formal PE program, healthy food and beverage options, and a parental/family component are effective to improve increase PA.	-	IIa A evidence: based on multiple RCTs, weight of evidence is in favour of efficacy; it is reasonable to perform this action	6/10
Abbreviations: • CI: Confidence Interval • HSP: Health Promoting Schools* • MD: Mean difference • MVPA: Moderate to vigorous physical activity • NR: Not reported • PA: Physical activity • RCT: Randomized Controlled Trial • SB: Sedentary behaviour • SES: Socio-economic Status • SMD: Standardized mean difference									

Table 8: Active urban design interventions

Reference	Primary objective of review	Search date (Date range of included studies)	Inclusion criteria	Number of included studies related to active urban design (Total, by design) and sample size	PROGRESS-Plus-identified populations	Results	Subgroup analyses	Quality of included studies	Review quality
Scientific statements and reviews of reviews, general population (n = 6)									
Omura, J.D., Carlson, S.A., Brown, D.R., Hopkins, D.P., Kraus, W.E., Staffileno, B.A., ... Council on Clinical Cardiology. (2020). Built Environment Approaches to Increase Physical Activity: A Science Advisory from the American Heart Association. *Circulation 142*(11): e160-e166.	To summarize studies on effectiveness of combined BE approaches to increase PA.	Jun 2014 (1980-2014)	Population: General Intervention: Creation or modification of BE Outcome: PA outcomes	90 Studies: • 16 longitudinal • 74 cross-sectional Total n= NR	NR	Task force recommends combining ≥1 BE strategies to increase PA: • pedestrian or bicycle transportation systems (e.g., street pattern design and connectivity, pedestrian infrastructure, cycling infrastructure and/or public transit infrastructure and access) **and** • land use and environmental design BE strategies (mixed land use, increasing residential density, proximity to community or neighbourhood destinations, parks, and recreation facility access).	-	NR	5/10
King, A.C., Whitt-Glover, M.C., Marquez, D.X., Buman, M.P., Napolitano, M.A., Jakicic, J., ... 2018 Physical Activity Guidelines Advisory, Committee. (2019). Physical Activity Promotion: Highlights from the 2018 Physical Activity Guidelines Advisory Committee Systematic Review. *Medicine and Science in Sport and Medicine 51*(6): 1340-1353.	To determine the effectiveness of interventions to increase PA at different levels of intensity and to reduce sedentary behaviour.	2016 (2011-2016)	Population: Children, adults, seniors Intervention: interventions to promote PA and reduce SB Outcome: Any PA	• 1 SR (600 studies) 2 Scientific statements	NR	Evidence of effectiveness for increasing PA in children, adults, and seniors with: • Road/street environment infrastructure, and • Facilities/amenities.	None	Moderate-strong	7/10

Bird, E.L., Ige, J.O., Pilkington, P., Pinto, A., Petrokofsky, C., & Burgess-Allen, J.. (2018). Built and natural environment planning principles for promoting health: an umbrella review. *BMC Public Health 18*(1): 930.	To summarize reviews of the effect of BE and natural environment on health.	Apr 2016 (2005-2016)	Population: General Intervention: Neighbourhood design, housing, food environment, natural and sustainable environment, transport Outcome: Reported health	117 Syntheses • 111 systematic reviews • 6 stakeholder documents Sample size range NR	NR	The following factors were associated with increased PA: • Built form (Provision of diverse housing, compact neighbourhoods) • Road/street environment (walking/cycling infrastructure, traffic calming, street connectivity, public realm improvements (e.g., lighting), transit) • Neighbourhood green/open spaces (access and accessibility) • Walkability, and • Aesthetics (parks, air quality).	None	High quality: 1 Moderate-high: 11 Moderate: 25 Low-moderate: 14 Low: 9 NR: 52	7/10
Puggina, A., Aleksovska, K., Buck, C., Burns, C., Cardon, G., Carlin, A., ... DEDIPAC Consortium. (2018). Policy determinants of physical activity across the life course: a 'DEDIPAC' umbrella systematic literature review. *European Journal of Public Health 28*(1):105-118.	To determine the effectiveness of policy determinants of PA across the life course.	Apr 2016 (2006-2015)	Population: General Intervention: Policy determinants of PA Outcome: PA, exercise or sport Design: Systematic review	14 reviews of cohort and cross-sectional studies Sample size range NR	• 1 review included females in rural settings only • 1 review included Black individuals only	Limited suggestive evidence for association between PA and: • Land-use Road/street environment.	-	Strong quality: 1 study Moderate quality: 11 studies Weak quality: 2 studies	8/10
Heath, G.W., Parra, D.C., Sarmiento, O.L., Andersen, L.B., Owen, N., Goenka, S., ... Lancet Physical Activity Series Working Group. (2012). Evidence-based intervention in physical activity: lessons from around the world. *Lancet 380*(9838): 272-81.	To summarize studies of interventions to promote PA.	Jan-Jul 2011 (2000-2011)	Population: General Intervention: Population-level PA promotion Outcome: Reported PA	100 Reviews, specific to active urban design NR • 5 reviews of reviews • 19 meta-analyses • 76 narrative reviews Sample size range NR	• 42 of all studies in minority and low SES populations	PA can be effectively promoted by changes in policy of street-scale urban design and land use to support PA in small areas of a few blocks.	None	NR	6/10

Mozaffarian, A., Afshin, A., Benowitz, N.L., Bittner, V., Daniels, S.R., Franch, H.A., … American Heart Association Council on Epidemiology and Prevention. (2012). Population approaches to improve diet, physical activity, and smoking habits: a scientific statement from the American Heart Association. *Circulation 126*(12): 1514-63.	To summarize studies of effectiveness of population interventions to increase PA, improve diet and reduce tobacco use.	Date NR (2007-2012)	Population: General Intervention: Population-level policies Outcome: NR	NR	• NR	Based on randomized and non-randomized evidence is less well established but may be considered for: • Land-use • Road/street environment (improved sidewalk/street design, traffic safety, personal safety) • Walkability, and • Aesthetics.	None	Class IIb B	6/10
Systematic review, general population (n = 9)									
Tcymbal, A., Demetriou, Y., Kelso, A., Wolbring, L., Wunsch, K., Wasche, H., … Reimers, A.K.. (2020). Effects of the built environment on physical activity: a systematic review of longitudinal studies taking sex/gender into account. *Environmental Health and Preventive Medicine 25*(1): 75.	To summarize studies on effectiveness of BE determinants to increase PA and investigate differences between sexes/genders.	Mar 12, 2020 (2000-2020)	Population: General Intervention: Creation or modification of community BE Outcome: Reported PA	36 Studies: • 25 quasi-experimental • 11 longitudinal/ cohort Sample size range NR	• 3 studies included females only • 10 studies included children and adolescents only	General and Recreational PA; positive associations found for: • Neighbourhood green/open spaces • Walkability No association between total PA and: • Road/street environment.	F: Stronger effect of road/street environment, built form M: Stronger effect of neighbourhood and green/open spaces	Average quality rating: 0.83/1.0	5/10

Kärmeniemi, M., Lankila, T., Ikäheimo, T., Koivumaa-Honkanen, H., & Korpelainen, R. (2018). The Built Environment as a Determinant of Physical Activity: A Systematic Review of Longitudinal Studies and Natural Experiments. *Annals of Behavioral Medicine 52*(3): 239-251.	To summarize studies on effectiveness of BE determinants to increase PA.	Dec 2015 (2003-2015)	Population: General Intervention: Creation or modification of community BE Outcome: Reported PA	51 Studies: • 31 natural experiments • 20 prospective cohorts Sample size range 169-1906	38 studies conducted in urban settings, 6 in rural or suburban settings	Consistent positive associations between PA and: • Population density • Road/street environment • Land-use • Facilities/amenities • Neighbourhood green/open space, and • Walkability.	None	Average quality: 0.78/1.0 (range 0.59-0.91) for natural experiments, 0.87 (range 0.73-1.0) for cohort studies	7/10
Stappers, N.E.H., Van Kann, D.H. H., Ettema, D., De Vries, N.K., & Kremers, S.P.J. (2018). The effect of infrastructural changes in the built environment on physical activity, active transportation and sedentary behavior - A systematic review. *Health & Place 53*: 135-149.	To summarize studies on effectiveness of BE determinants to increase PA, active transit and decrease sedentary behaviour.	Feb 2018 (2005-2017)	Population: Adults Intervention: Modification of community BE Outcome: Reported transit-related PA	19 Studies: • 15 quasi-experimental • 2 natural experiments • 2 cross-sectional Sample size range NR	NR	Mixed results were found for the effect of road/street environment features and PA, specifically: • On- and off-road walking/cycling trails, and • Infrastructural changes that affect the total infrastructural system (e.g., implementation of traffic free bridges or informal boardwalk, busway with parallel walking and/or cycling trails).	None	Critical risk of bias: 9 studies Serious risk of bias: 7 studies Moderate risk of bias: 3 studies	7/10

Smith, M., Hosking, J., Woodward, A., Witten, K., MacMillan, A., Field, A., ... Mackie, H. (2017). Systematic literature review of built environment effects on physical activity and active transport - an update and new findings on health equity. *International Journal of Behavior Nutrition and Physical Activity 14*(1): 158.	To summarize reviews of the effectiveness of BE to increase PA, with considerations for cost and differential effects by ethnicity and socioeconomic status.	Jun 2015 (1979-2015)	Population: General Intervention: Any BE interventions Outcome: Reported PA	28 Studies • 13 longitudinal • 15 cross-sectional Sample size range NR	NR	Moderate evidence for association between PA and: • Road/street environment (walking/cycling infrastructure), and • Facilities/amenities (density, access). Weak evidence for association between increased PA and: • Road/street environment (greenways, traffic free bridges and boardwalks, access to public transit, street connectivity), and • Neighbourhood green/open spaces (park renovations, retrofitting, seating removal, accessibility).	4 studies explored effects by SES, race/ethnicity inconsistent findings for PA	Strong quality: 1 study Moderate quality: 6 studies Weak quality: 21	7/10
Zapata-Diomedi, B. & Veerman, J.L. (2016). The association between built environment features and physical activity in the Australian context: a synthesis of the literature. *BMC Public Health 16*: 484.	To summarize Australian studies of the effectiveness of BE to increase PA.	Mar 15, 2015 (2009-2015)	Population: General, residing in Australia Intervention: Creation or modification of community BE Outcome: Reported PA	23 Studies • 2 quasi-experimental • 2 longitudinal • 19 cross-sectional Median sample size 2194, range 320-203,883	NR	The following factors had consistent evidence of association with increased PA: • Land-use • Facilities/amenities, and • Walkability. No consistent was found for: • Population density • Road/street environment, and • Neighbourhood green/open space.	None	Good quality: 4 studies Fair quality: 10 studies Poor quality: 7 studies	8/10
Mayne, S.L., Auchincloss, A.H., & Michael, Y.L. (2015). Impact of policy and built environment changes on obesity-related outcomes: a systematic review of naturally occurring experiments. *Obesity Reviews 15*(5): 362-375.	To summarize studies of the effectiveness of policy and BE to improve obesity-related outcomes, including PA.	Jan 1, 2014 (2005-2013)	Population: General Intervention: Municipal or federal policy change, or creation or modification of community BE Outcome: Reported PA	37 Studies • 10 longitudinal • 27 cross-sectional Sample size range 51-72,173	NR	Unclear association between total PA and neighbourhood green/open space measures.	None	Strong design: 6 Intermediate design: 19 Weaker design: 12	5/10
Hunter, R.F., Christian, H., Veitch, J., Astell-Burt, T., Hipp, J.A., &	To summarize studies of the effectiveness of	Jul 2014 (2003-2014)	Population: General	12 Studies • 1 RCT	• Several studies conducted in	Mixed findings on the association between new urban green space and increased PA.	None	Low risk of bias: 1	7/10

Schipperijn, J. (2015). The impact of interventions to promote physical activity in urban green space: A systematic review and recommendations for future research. *Social Science & Medicine 124*: 246-56.	interventions for PA in urban green space.		Intervention: physical change in urban green space or intervention to promote use of green space Outcome: Reported and measured PA	• 11 quasi-experimental Sample size range 597-50,000	areas with majority low SES and ethnic minority groups	Mixed findings on the association between new urban green space and decreased sedentary time.		High risk of bias: 5 Unclear risk of bias: 6	
Laine, J., Kuvaja-Köllner, V., Pietilä, E., Koivuneva, M., Valtonen, H., & Kankaanpää, E. (2014). Cost-effectiveness of population-level physical activity interventions: a systematic review. *American Journal of Health Promotion 29*(2): 71-80.	To determine the cost-effectiveness of population-level interventions to increase PA.	May 2013 (1996-2012)	Population: General Intervention: Promoting new or maintaining PA Outcome: Reported PA	10 Studies • 1 systematic review including 5 RCTs • 9 economic modelling studies Sample size range 281-438,881	NR	Of 6 pedestrian infrastructure and neighbourhood green/open space interventions, 4 had large budget impact effect; ranging from 0.0045-1.843 METh gained/person/day at a cost of $0.06-2.327 cost per METh gained /person. Pedestrian infrastructure (community trail) was the most cost-effective to increase population-level PA, with a cost-effectiveness ratio of $.006/MET-h. This intervention was effective at 1.06 MET hours per person per day and its costs were low.	None	>10/15: 2 6-10/15: 6 <6/15: 1	7/10
Van Holle, V., Deforche, B., Van Cauwenberg, J., Goubert, L., Maes, L., Van de Weghe, N., & De Bourdeaudhuij, I. (2012). Relationship between the physical environment and different domains of physical activity in European adults: A systematic review. *BMC Public Health 12*:807.	To summarize Europe-specific evidence on the relationship between the physical environment and PA.	Aug 2011 (2000 – 2011)	Population: European adults, age 18-65 Intervention: physical environment Outcomes: PA	70 Total 69 Cross-sectional 1 Longitudinal	NR	Convincing probable association between total PA and: • Facilities/amenities • Walkability, and • Aesthetics. No evidence of association between PA and: • Built form (residential density, urbanization) • Land-use mix, and • Road/street environment (street connectivity, public transit access, pedestrian infrastructure, safety, traffic).	None	Not appraised	5/10
Results specific to children/youth (n = 2)									

Nordbø, E.C.A., Nordh, H., Raanaas, R.K., & Aamodt, G. (2020). Promoting activity participation and well-being among children and adolescents: a systematic review of neighborhood built-environment determinants. *JBI Evidence Synthesis 18*(3): 370-458.	To summarize studies on effectiveness of BE determinants to increase participation in PA, recreational and social activities, and improve well-being in childhood and adolescence.	Jun 10, 2018 (2010-2018)	Population: Youth aged 5-18 years Intervention: BE determinants Outcome: Reported PA	127 Studies: • 1 quasi-experimental • 14 longitudinal/ cohort • 111 cross-sectional • 1 case-control Sample size range 39-64,076	NR	Total PA (n = 46 studies) • Consistent positive relationships between facility/amenity index and PA, and • Inconsistent relationships population density, built form, land-use mix, road/street environment, neighbourhood green/open space, walkability and aesthetics and PA. Leisure-time PA (n = 22 studies) • Inconsistent relationships between population density, built form, land-use, road/street environment, facilities/amenities, neighbourhood/green space, walkability, facility and amenity index, and aesthetics.	-	Good quality: 27.6% Fair quality: 57.4% Poor quality: 15%	8/10
McGrath, L.J., Hopkins, W.G., & Hinckson, E.A. (2015). Associations of objectively measured built-environment attributes with youth moderate-vigorous physical activity: A systematic review and meta-analysis. *Sports Medicine 45*(6): 841-65.	To determine the effectiveness of BE interventions to increase PA in youth.	Apr 2013 (2005-2013)	Population: Youth ages 5-17 Intervention: Creation or modification of community BE Outcome: Reported PA	23 Studies, some longitudinal but only cross-sectional data was included N=6175	NR	Walkability and walking amenities had trivial to moderate positive effects on youth MVPA. Play Space had trivial to small effects on youth MVPA.	Stronger associations in M vs. F, age 9-12 Walking infrastructure strong association for F vs. M, age 9-15	GIS studies, mean quality: 62+/-10% GPS studies:, mean quality: 52+/-14%	6/10

Results specific to older adults (n = 2)									
Van Cauwenberg, J., Nathan, A., Barnett, A., Barnett, D. W., Cerin, E., & Council on Environmental and Physical Activity (CEPA)-Older Adults Working Group. (2018). Relationships Between Neighbourhood Physical Environmental Attributes and Older Adults' Leisure-Time Physical Activity: A Systematic Review and Meta-Analysis. *Sports Medicine 48*(7): 1635-1660.	To determine the effectiveness of BE determinants in increasing PA among seniors age ≥ 65.	Dec 15, 2017 (2000-2017)	Population: Mean age ≥ 65 years or subgroup analysis for ages ≥ 65 years Intervention: Objective or perceived physical environmental attribute Outcome: Reported PA	72 Studies • 1 longitudinal • 71 cross-sectional Sample size range 44-69,253	• Seniors age ≥ 65 years • No studies included low or lower-middle SES • 43 studies in urban settings, 1 in rural, 23 in mixed and 5 NR	Increased PA strongly associated with: • Facilities/amenities (availability of recreational facilities (p=0.01), and • Neighbourhood green/open spaces (p=0.04). No evidence of association between PA and: • Built form (residential density/urbanization, 15 studies), and • Road/street environment (street connectivity, 5 studies, crime/personal safety, 15 studies, traffic/pedestrian safety, 6 studies).	None	High quality: 15% Moderate quality: 53% Low quality: 32%	8/10
Barnett, D.W., Barnett, A., Nathan, A., Van Cauwenberg, J., Cerin, E., & Council on Environmental and Physical Activity (CEPA)-Older Adults Working Group. (2017). Built environmental correlates of older adults' total physical activity and walking: a systematic review and meta-analysis. *International Journal of Behavior Nutrition and Physical Activity 14*(1): 103.	To summarize reviews of the effectiveness of BE to increase PA in seniors and explore differences by type of PA and BE attribute measurement.	Sep 2016 (2001-2016)	Population: Mean age ≥ 65 Intervention: Creation or modification of community BE Outcome: Reported and measured PA	100 Studies • 1 quasi-experimental • 5 longitudinal • 94 cross-sectional Sample size range 44-69,253	• Age ≥ 65 years • Females 35% of total sample • 56% studies in urban settings, 3% in rural, 32% in mixed	The following factors had strong evidence of association with increased PA: • Road/street environment (crime-related personal safety (p<0.001), walk-friendly infrastructure (p=0.009), access to public transit (p=0.016)) • Facilities/amenities (access to destinations (p<0.01), recreational facilities (p<0.01)) • Neighbourhood green/open space (p=0.002) • Walkability (p<0.001) • Aesthetics (p=0.004). No significant association was found for: • Built form (residential density/urbanization) • Land-use mix • Street connectivity.	None.	High quality: 9% Moderate quality: 55% Low quality: 36%	7/10

Abbreviations:

- BE: Built environment
- NR: Not reported
- METh: Metabolic equivalent task hours
- MVPA: Moderate to vigorous physical activity
- PA: Physical activity
- SES: Socio-economic status
- SR: Systematic review

Table 9: Active transport interventions

Reference	Primary objective of review	Search date (Date range of included studies)	Review Inclusion criteria	Number of included studies related to active transport (Total, by design) and sample size	PROGRESS-Plus-identified populations	Results	Subgroup analyses	Quality of included studies	Review quality
General built environment (BE) interventions or characteristics to increase active transport (n = 2)									
Omura, J.D., Carlson, S.A., Brown, D.R., Hopkins, D.P., Kraus, W.E., Staffileno, B.A., ... Council on Clinical Cardiology. (2020). Built Environment Approaches to Increase Physical Activity: A Science Advisory from the American Heart Association. *Circulation 142*(11): e160-e166.	To summarize studies on effectiveness of combined BE approaches to increase PA.	Jun 2014 (1980-2014)	Population: General Intervention: Creation or modification of BE Outcome: PA outcomes	90 Studies: •16 longitudinal •74 cross-sectional Total n= NR	NR	Task force recommends combining ≥1 BE strategies to increase PA • pedestrian or bicycle transportation systems (e.g., street pattern design and connectivity, pedestrian infrastructure, cycling infrastructure and/or public transit infrastructure and access) and • land use and environmental design BE strategies (mixed land use, increasing residential density, proximity to community or neighbourhood destinations, parks, and recreation facility access).	-	NR	5/10

King, A.C., Whitt-Glover, M.C., Marquez, D.X., Buman, M.P., Napolitano, M.A., Jakicic, J., ... 2018 Physical Activity Guidelines Advisory, Committee. (2019). Physical Activity Promotion: Highlights from the 2018 Physical Activity Guidelines Advisory Committee Systematic Review. *Medicine and Science in Sport and Medicine 51*(6): 1340-1353.	To determine effectiveness of interventions to increase PA at different levels of intensity and to reduce sedentary behaviour.	2016 (2011-2016)	Population: Children, adults, seniors Intervention: interventions to promote PA and reduce SB Outcome: Any PA	• 3 SRs (12-42 studies) • 1 meta-analysis (42 studies) • 2 scientific statements Total n = NR	NR	Evidence of effectiveness for BE characteristics and infrastructure (e.g., street connectivity, a mix of commercial, residential, and public land uses, Safe Routes to Schools, overall walkability) to support active transport increasing PA in children, adults, and seniors.	-	Moderate-strong	7/10

Public transit interventions (n = 5)									
Tcymbal, A., Demetriou, Y., Kelso, A., Wolbring, L., Wunsch, K., Wasche, H., … Reimers, A.K.. (2020). Effects of the built environment on physical activity: a systematic review of longitudinal studies taking sex/gender into account. *Environmental Health and Preventive Medicine 25*(1): 75.	To summarize studies on effectiveness of BE determinants to increase PA and investigate differences between sexes/genders.	Mar 12, 2020 (2000-2020)	Population: General Intervention: Creation or modification of community BE Outcome: Reported PA	36 Studies: •25 quasi-experimental •11 longitudinal/ cohort Sample size range NR	•3 studies included females only •10 studies included children and adolescents only	Investments in public transit had an overall positive effect on PA.	No difference between M/F	Average quality rating: 0.83/1.0	5/10
Xiao, C., Goryakin, Y., & Cecchini, M. (2019). Physical Activity Levels and New Public Transit: A Systematic Review and Meta-analysis. *American Journal of Preventive Medicine 56*(3): 464-473.	To determine effectiveness of new public transit, such as light rail transit, busways, and subways, to increase PA.	Jul 2018 (2013-2018)	Population: General Intervention: Creation or modification of local public transit Outcome: PA	9 Quasi-experimental studies n = 4249	NR	New public transport associated with increase of 1.06 MET hours/week (95% CI=0.12, 2.01, 5 studies, I^2=74.1%) • Light-moderate PA increased 1.76 MET hours/week (95% CI=0.19, 3.32, 4 studies, I^2=73.6%), • MVPA increased 0.33 MET hours/week (95% CI=-0.71, 1.38, 4 studies, I^2=61.6%).	-	Moderate quality: 6 studies Weak quality: 3 studies	6/10

Hirsch, J.A., DeVries, D.N., Brauer, M., Frank, L.D., & Winters, M. (2018). Impact of new rapid transit on physical activity: A meta-analysis. *Preventive Medicine Reports 10*: 184-190.	To summarize studies on effectiveness of new rapid transit interventions to increase PA.	May 2017 (2007-2017)	Population: General Intervention: Rapid transit systems that operate on separate guideway (e.g., light rail transit, bus rapid transit, rail rapid transit) Outcome: Measured PA	5 Studies •1 controlled longitudinal •3 uncontrolled longitudinal •1 cross-sectional Total n = NR	3 studies had >60% females	Introduction of rapid transit systems associated with a decrease of 80.4. mins/week total PA (95% CI=157.9, -2.9) • Transport-related PA increased 6.7 mins/week (95% CI=-10.1, 23.5).	Increased PA within subgroups: •Females with lower education (1 study) •Individuals least active at baseline (2 studies) •Individuals living in closest proximity to transit station (1 study)	Serious risk of bias: 4 studies Critical risk of bias: 1 study	8/10
Mayne, S.L., Auchincloss, A.H., & Michael, Y.L. (2015). Impact of policy and built environment changes on obesity-related outcomes: a systematic review of naturally occurring experiments. *Obesity Reviews 15*(5): 362-375.	To summarize studies of the effectiveness of policy and BE to improve obesity-related outcomes, including PA.	Jan 1, 2014 (2005-2013)	Population: General Intervention: Municipal or federal policy change, or creation or modification of community BE Outcome: Reported PA	7 studies reported on active transport, 2 reported total PA •2 longitudinal •5 repeated cross-sectional Sample size range 51-72,173	NR	Two studies assessed change in total PA due to new public transit; only one found expected results. Results of other studies did not assess total PA.	-	Strong: 6 studies Intermediate: 19 studies Weak: 12 studies	5/10

Rissel, C., Curac, N., Greenaway, M., & Bauman, A. (2012). Physical activity associated with public transport use--a review and modelling of potential benefits. *International Journal of Environmental Research and Public Health 9*(7): 2454-78.	To summarize studies on PA among adults who use public transit.	Jan 2012 (2005-2011)	Population: Adults Intervention: Use of public transit Outcome: PA	27 Studies; 9 measured PA objectively • 2 experimental • 1 longitudinal • 21 cross-sectional • 2 design NR Total n = NR	1 study included Black females only	Positive association for PA and public transit use, evidence is limited.	-	NR	5/10
Walking and cycling infrastructure (n = 3)									
Tcymbal, A., Demetriou, Y., Kelso, A., Wolbring, L., Wunsch, K., Wasche, H., ... Reimers, A.K.. (2020). Effects of the built environment on physical activity: a systematic review of longitudinal studies taking sex/gender into account. *Environmental Health and Preventive Medicine 25*(1): 75.	To summarize studies on effectiveness of BE determinants to increase PA and investigate differences between sexes/genders.	Mar 12, 2020 (2000-2020)	Population: General Intervention: Creation or modification of community BE Outcome: Reported PA	36 Studies: • 25 quasi-experimental • 11 longitudinal/ cohort Sample size range NR	• 3 studies included females only • 10 studies included children and adolescents only	General PA: New routes for walking/cycling: no positive effect, similar for both sexes/genders.	No difference between M/F	Average quality rating: 0.83/1.0	5/10

Mölenberg, F.J.M., Panter, J., Burdorf, A., & van Lenthe, F.J. (2019). A systematic review of the effect of infrastructural interventions to promote cycling: strengthening causal inference from observational data. *The International Journal of Behavioural Nutrition and Physical Activity 16*(1): 93.	To summarize studies on effectiveness of BE strategies on cycling and PA, and to examine variation by study methods.	Jun 2019 (1987-2019)	Population: Age >16 years Intervention: BE for cycling Outcome: Reported cycling activity	29 Interventions (31 papers) • 14 controlled • 15 uncontrolled Total n = NR	NR	While studies found overall effect of cycling infrastructure on cycling behaviour, of 7 studies that evaluated changes in PA, 2 found increases in PA while 5 found no difference following installation of cycling infrastructure (e.g., cycling lanes, city-wide cycling networks).	• One study found no differential effects by demographics or SES • One study found change larger in no car households • One study found effects greater in females	NR	8/10
Kärmeniemi, M., Lankila, T., Ikäheimo, T., Koivumaa-Honkanen, H., & Korpelainen, R. (2018). The Built Environment as a Determinant of Physical Activity: A Systematic Review of Longitudinal Studies and Natural Experiments. *Annals of Behavioral Medicine 52*(3): 239-251.	To summarize studies on effectiveness of BE determinants to increase PA.	Dec 2015 (2003-2015)	Population: General Intervention: Creation or modification of community BE Outcome: Reported PA	51 Studies: • 31 natural experiments • 20 prospective cohorts Sample size range 169-1906	38 studies were conducted in urban settings, 6 in rural or suburban settings	New infrastructure for cycling/walking associated with increased PA in 9/16 studies.	• None	Average quality: 0.78/1.0 (0.59–0.86)	7/10

School active transport interventions (n = 2)									
Jones, R.A., Blackburn, N.E., Woods, C., Byrne, M., van Nassau, F., & Tully, M.A. (2019). Interventions promoting active transport to school in children: A systematic review and meta-analysis. *Preventive Medicine 123*: 232-241.	To determine effectiveness of active transport interventions, based on the Active Living by Design Community Action Model, on PA and fitness in primary school children.	Aug 2018 (2007-2017)	Population: Age 4–11 years for >50% of sample Intervention: School-based active travel Outcome: Active transport activity or physical fitness	17 Studies • 4 RCTs • 1 cluster RCT • 3 controlled trials • 8 quasi-experimental • 1 controlled cohort analytic study N = 550 (in meta-analysis)	NR	School active transport interventions associated with: • Increase in overall weekly MVPA (SMD=0.72; 95% CI=-0.30, 1.73; N=390; I^2=95%), • Increase in travel-related PA (SMD=0.78; 95% CI=0.11, 1.46; N=550; I^2=92%).	-	Weak	9/10
Villa-Gonzalez, E., Barranco-Ruiz, Y., Evenson, K.R., & Chillón, P. (2018). Systematic review of interventions for promoting active school transport. *Preventive Medicine 111*: 115-134.	To update summary of effectiveness of interventions for active school transport.	Dec 2016 (2010-2016)	Population: Age 5-18 years Intervention: Strategies for active school transport Outcome: Active transport to or from school	23 Studies • 3 RCTs • 19 quasi-experimental • 1 qualitative Total n= NR	NR	School active transport interventions that measured overall PA: • 4 studies found increases in overall PA; • 3 study found no effect.	-	Moderate: 2 studies Weak: 21 studies	8/10

Abbreviations:

- BE: Built environment
- CI: Confidence Interval
- MET: Metabolic equivalent task
- M/F: Male/Female
- MVPA: Moderate to vigorous physical activity
- NR: Not reported
- PA: Physical activity
- RCT: Randomized controlled trial
- SB: Sedentary behaviour
- SMD: Standard mean difference
- SR: Systematic reviews

Table 10: Sport and recreation for all

Reference	Primary objective of review	Search date (Date range of included studies)	Inclusion criteria	Number of included studies related to sport and recreation (Total, by design) and sample size	PROGRESS-Plus-identified populations	Results	Subgroup analyses	Quality of included studies	Review quality
King, A.C., Whitt-Glover, M.C., Marquez, D.X., Buman, M.P., Napolitano, M.A., Jakicic, J., ... 2018 Physical Activity Guidelines Advisory, Committee. (2019). Physical Activity Promotion: Highlights from the 2018 Physical Activity Guidelines Advisory Committee Systematic Review. *Medicine and Science in Sport and Medicine 51*(6): 1340-1353.	To determine effectiveness of interventions to increase PA at different levels of intensity and to reduce sedentary behaviour.	2016 (2011-2016)	Population: Children, adults, seniors Intervention: interventions to promote PA and reduce SB Outcome: Any PA	• 3 SR (12-90 studies) • 1 Scientific statement Sample size NR	NR	Access to indoor recreational facilities (e.g., gyms or fitness centres) and/or outdoor facilities or outlets is associated with increased PA in both children and adults.	-	Moderate-strong	7/10

Umstattd Meyer, M.R., Bridges, C.N., Schmid, T.L., Hecht, A.A., & Pollack Porter, K.M. (2019). Systematic review of how Play Streets impact opportunities for active play, physical activity, neighborhoods, and communities. *BMC Public Health 19*(1): 335.	To summarize studies on effectiveness of Play Streets interventions to increase PA in children and adolescents.	Dec 2017 (2012-2017)	Population: Children and adolescents. Intervention: Play Streets, Play Streets-style, Open Streets/Ciclovía intervention where streets were closed to vehicle traffic and accessible at no cost. Outcome: Reported PA	6 Studies: • 2 quasi-experimental • 4 cross-sectional • Sample size range 20-1116	• 1 study include 75% female participants	Some evidence that Play Streets increases PA in under-resourced communities. Limited evidence for effective implementation and related impacts.	-	Low risk of bias: 55.5% Unclear risk of bias: 33.3% High risk of bias: 11.1%	5/10
Heath, G.W., Parra, D.C., Sarmiento, O.L., Andersen, L.B., Owen, N., Goenka, S., … Lancet Physical Activity Series Working Group. (2012). Evidence-based intervention in physical activity: lessons from around the world. *Lancet 380*(9838): 272-81.	To summarize studies of interventions to promote PA.	Jan-Jul 2011 (2000-2011)	Population: General Intervention: Population-level PA promotion Outcome: Reported PA	100 reviews total, number specific to sport and recreation NR Sample size NR	• 42 included studies of minority and low SES populations	No-cost community PA classes, often in public places (e.g., parks, school yards, community centres, worksites, and sports facilities) are promising.	Authors conclude these may be particularly useful for underserved populations (women, older adults, low SES) to decrease disparities, but no secondary analysis.	NR	6/10

Mozaffarian, A., Afshin, A., Benowitz, N.L., Bittner, V., Daniels, S.R., Franch, H.A., ... American Heart Association Council on Epidemiology and Prevention. (2012). Population approaches to improve diet, physical activity, and smoking habits: a scientific statement from the American Heart Association. *Circulation 126*(12): 1514-63.	To summarize studies of effectiveness of population interventions to increase PA, improve diet and reduce tobacco use.	Date NR (2007-2012)	Population: General Intervention: Population-level policies Outcome: NR	NR	NR	Based on randomized and non-randomized studies, weight of evidence supports accessibility of recreation and exercise spaces and facilities (e.g., building of parks and playgrounds, increasing operating hours, use of school facilities during non-school hours).	-	Class IIa B	6/10
Abbreviations: • NR: Not reported • PA: Physical activity • SB: Sedentary behaviour • SES: Socio-economic status • SR: Systematic review									

Table 11: Reviews Identified for ISPAH Domains not Synthesized: Healthcare-provided, Public Education including Mass Media and Community-Wide

Reference	Primary objective of review	Search date (Date range of included studies)	Inclusion criteria	Number of included studies (Total, by design) and sample size	PROGRESS-Plus-identified populations	Results	Subgroup analyses	Quality of included studies	Review quality
Reviews of reviews or scientific statements on healthcare-delivered interventions (n = 1)									
Heath, G.W., Parra, D.C., Sarmiento, O.L., Andersen, L.B., Owen, N., Goenka, S., ... Lancet Physical Activity Series Working Group. (2012). Evidence-based intervention in physical activity: lessons from around the world. *Lancet 380*(9838): 272-81.	To summarize studies of interventions to promote PA.	Jan-Jul 2011 (2000-2011)	Population: General Intervention: Population-level PA promotion Outcome: Reported PA	18 Reviews • 1 meta-analyses • 17 narrative reviews Sample size range NR	5 included studies of minority and low SES populations	Insufficient evidence to support healthcare-provider-based PA counselling on its own. Screening and advice followed by telephone or community support for PA does increase patients'; mean effect size = 0.16	-	NR	6/10
Reviews of reviews or scientific statements on public education, including mass media (n = 3)									
Puggina, A., Aleksovska, K., Buck, C., Burns, C., Cardon, G., Carlin, A., ... DEDIPAC Consortium. (2018). Policy determinants of physical activity across the life course: a 'DEDIPAC' umbrella systematic literature review. *European Journal of Public Health 28*(1):105-118.	To determine the effectiveness of policy determinants of PA across the life course.	April 2016 (2006-2015)	Population: General Intervention: Policy determinants of PA Outcome: PA, exercise or sport Design: Systematic review	1 review of cohort and cross-sectional studies relevant to mass media Total sample size NR	NR	There is limited and inconclusive evidence for mass media campaigns to increase overall PA levels.	-	Moderate	8/10
Heath, G.W., Parra, D.C., Sarmiento, O.L., Andersen, L.B., Owen, N., Goenka, S., ... Lancet Physical Activity Series Working Group. (2012). Evidence-based intervention in physical activity: lessons from around the world. *Lancet 380*(9838): 272-81.	To summarize studies of interventions to promote PA.	Jan-Jul 2011 (2000-2011)	Population: General Intervention: Population-level PA promotion Outcome: Reported PA	100 reviews total, number specific to mass media NR Sample size range NR	42 of all included studies of minority and low SES populations	Mass media campaigns are a promising practice, especially when linked to specific community programs.	-	NR	6/10

Mozaffarian, A., Afshin, A., Benowitz, N.L., Bittner, V., Daniels, S.R., Franch, H.A., … American Heart Association Council on Epidemiology and Prevention. (2012). Population approaches to improve diet, physical activity, and smoking habits: a scientific statement from the American Heart Association. *Circulation 126*(12): 1514-63.	To summarize studies of effectiveness of population interventions to increase PA, improve diet and reduce tobacco use.	Date NR (2007-2012)	Population: General Intervention: Population-level policies Outcome: NR	NR	NR	Based on randomized and non-randomized studies, efficacy is less well established for sustained, focused media and educational campaigns, using multiple modes, to promote PA. Based on randomized and non-randomized studies, efficacy is less well established for shorter-term community-based media and educational programs that target multiple cardiovascular risk factors and behaviors simultaneously.	-	Class IIb B	6/10
Reviews of reviews or scientific statements on workplace-based interventions (n = 3)									
King, A.C., Whitt-Glover, M.C., Marquez, D.X., Buman, M.P., Napolitano, M.A., Jakicic, J., … 2018 Physical Activity Guidelines Advisory, Committee. (2019). Physical Activity Promotion: Highlights from the 2018 Physical Activity Guidelines Advisory Committee Systematic Review. *Medicine and Science in Sport and Medicine 51*(6): 1340-1353.	To determine the effectiveness of interventions to increase PA at different levels of intensity and to reduce sedentary behaviour.	2016 (2011-2016)	Population: Children, adults, seniors Intervention: Creation or modification of BE for active transport Outcome: Self-reported transport-related PA	112 reports total; 4 related to workplaces • 2 systematic reviews • 2 meta-analyses Total sample size NR	NR	Workplace interventions that focus on education or motivation show only small and inconsistent effects on reducing SB. Interventions that target change to workstations showed medium to large effects on SB. Effects are larger when environmental changes are combined with behavioural support.	-	Moderate-strong	7/10
Heath, G.W., Parra, D.C., Sarmiento, O.L., Andersen, L.B., Owen, N., Goenka, S., … Lancet Physical Activity Series Working Group. (2012). Evidence-based intervention in physical activity: lessons from around the world. *Lancet 380*(9838): 272-81.	To summarize studies of interventions to promote PA.	Jan-Jul 2011 (2000-2011)	Population: General Intervention: Population-level PA promotion Outcome: Reported PA	100 reviews total. 5 specific to workplaces • 1 meta-analyses • 4 narrative reviews Sample size range NR	42 of all included studies of minority and low SES populations, number specific to workplaces NR	Multicomponent interventions to incorporate PA into daily routines, including goal setting, social support, behavioural reinforcement, problem solving, and/or relapse prevention, delivered in groups or by email, internet, mail and/or telephone can increase PA. Interventions should include an assessment of current PA, readiness to change, tailored plan, and links to community programs through healthcare provider or health promoter. Mean effect size = 0.21	-	NR	6/10

Mozaffarian, A., Afshin, A., Benowitz, N.L., Bittner, V., Daniels, S.R., Franch, H.A., … American Heart Association Council on Epidemiology and Prevention. (2012). Population approaches to improve diet, physical activity, and smoking habits: a scientific statement from the American Heart Association. *Circulation 126*(12): 1514-63.	To summarize studies of effectiveness of population interventions to increase PA, improve diet and reduce tobacco use.	Date NR (2007-2012)	Population: General Intervention: Population-level policies Outcome: NR	NR	NR	Based on multiple RCTs, weight of evidence is in favour of comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components. Based on randomized and non-randomized studies, weight of evidence supports: • Structured worksite programs that encourage PA and provide time for PA during work hours • Improving stairway access and appeal, potentially in combination with "skip-stop" elevators that skip floors • Adding new or updating worksite fitness centers Based on expert consensus, the efficacy is less well established for employer tax incentives for worksite wellness programs.	-	Class IIa-b, Level A-C	6/10

Reviews of reviews or scientific statements on community-wide interventions (n = 2)								
King, A.C., Whitt-Glover, M.C., Marquez, D.X., Buman, M.P., Napolitano, M.A., Jakicic, J., … Tennant, B.L. (2019). Physical Activity Guidelines Advisory, Committee Physical Activity Promotion: Highlights from the 2018 Physical Activity Guidelines Advisory Committee Systematic Review. *Medicine and Science in Sport and Medicine 51*(6): 1340-1353.	To determine the effectiveness of interventions to increase PA at different levels of intensity and to reduce sedentary behaviour.	2016 (2011-2016)	Population: Children, adults, seniors Intervention: interventions to promote PA and reduce SB Outcome: Any PA	112 reports total; 4 related to community-wide interventions • 2 systematic reviews • 1 meta-analysis • 1 scientific statement Total sample size NR	NR	There is evidence of effectiveness of community-wide interventions that use intensive contact with the majority of the populations; few interventions have achieved sufficient contact to produce meaningful results. .	-	Moderate-strong	7/10
Heath, G.W., Parra, D.C., Sarmiento, O.L., Andersen, L.B., Owen, N., Goenka, S., … Lancet Physical Activity Series Working Group. (2012). Evidence-based intervention in physical activity: lessons from around the world. *Lancet 380*(9838): 272-81.	To summarize studies of interventions to promote PA.	Jan-Jul 2011 (2000-2011)	Population: General Intervention: Population-level PA promotion Outcome: Reported PA	100 review total, 14 on community-wide interventions • 1 reviews of reviews • 1 meta-analyses • 12 narrative reviews Sample size range NR	8 included studies of minority and low SES populations	Community-wide policies and planning combined with multicomponent efforts in communities to promote PA are potentially effective. Plans and policies should focus on reducing environmental and structural barriers to PA, may be promoted through media, and incorporate incentives at individual, corporate, local and regional levels. These motivate individual behaviour change but also intervene at the institutional and environmental level.	-	NR	6/10

Abbreviations:

- NR: Not reported
- PA: Physical activity
- RCT: Randomized controlled trial
- SB: Sedentary behaviour
- SES: Socio-economic status

References

Barnett, D.W., Barnett, A., Nathan, A., Van Cauwenberg, J., Cerin, E., & Council on Environmental and Physical Activity (CEPA)-Older Adults Working Group. (2017). Built environmental correlates of older adults' total physical activity and walking: a systematic review and meta-analysis. *International Journal of Behavior Nutrition and Physical Activity 14*(1): 103.

Bird, E.L., Ige, J.O., Pilkington, P., Pinto, A., Petrokofsky, C., & Burgess-Allen, J.. (2018). Built and natural environment planning principles for promoting health: an umbrella review. *BMC Public Health 18*(1): 930.

Brenner, D.R., Weir, H.K., Demers, A.A., Ellison, L.F., Louzado, C., Shaw, A., … Smith, L.M. (2020). Projected estimates of cancer in Canada in 2020. *Canadian Medical Association Journal 192*(9): E199-E205.

Canadian Society for Exercise Physiology. (2021). *24-Hour Movement Guidelines*.

Cochrane Methods Equity. (2021). *PROGRESS-Plus*.

Cochrane Training. (2021). *Cochrane Handbook for Systematic Reviews of Interventions*.

Friedenreich, C.M., Barberio, A.M., Pader, J., Poirier, A.E., Ruan, Y., Grevers, X., … ComPARe Study Team. (2019). Estimates of the current and future burden of cancer attributable to lack of physical activity in Canada. *Preventive Medicine 122*: 65-72.

Heath, G.W., Parra, D.C., Sarmiento, O.L., Andersen, L.B., Owen, N., Goenka, S., … Lancet Physical Activity Series Working Group. (2012). Evidence-based intervention in physical activity: lessons from around the world. *Lancet 380*(9838): 272-81.

Health Evidence™ . (2005). *Quality Assessment Tool – Review Articles*.

Hirsch, J.A., DeVries, D.N., Brauer, M., Frank, L.D., & Winters, M. (2018). Impact of new rapid transit on physical activity: A meta-analysis. *Preventive Medicine Reports 10*: 184-190.

Hunter, R.F., Christian, H., Veitch, J., Astell-Burt, T., Hipp, J.A., & Schipperijn, J. (2015). The impact of interventions to promote physical activity in urban green space: A systematic review and recommendations for future research. *Social Science & Medicine 124*: 246-56.

International Society for Physical Activity and Health. (2021). *Resources*.

Jones, M., Defever, E., Letsinger, A., Steele, J., & Mackintosh, K.A. (2019). A mixed-studies systematic review and meta-analysis of school-based interventions to promote

physical activity and/or reduce sedentary time in children. *Journal of Sport and Health Science 9*(1): 3-17.

Jones, R.A., Blackburn, N.E., Woods, C., Byrne, M., van Nassau, F., & Tully, M.A. (2019). Interventions promoting active transport to school in children: A systematic review and meta-analysis. *Preventive Medicine 123*: 232-241.

Kärmeniemi, M., Lankila, T., Ikäheimo, T., Koivumaa-Honkanen, H., & Korpelainen, R. (2018). The Built Environment as a Determinant of Physical Activity: A Systematic Review of Longitudinal Studies and Natural Experiments. *Annals of Behavioral Medicine 52*(3): 239-251.

King, A.C., Whitt-Glover, M.C., Marquez, D.X., Buman, M.P., Napolitano, M.A., Jakicic, J., … Tennant, B.L. (2019). Physical Activity Guidelines Advisory, Committee Physical Activity Promotion: Highlights from the 2018 Physical Activity Guidelines Advisory Committee Systematic Review. *Medicine and Science in Sport and Medicine 51*(6): 1340-1353.

Kruk, J. (2013). Physical activity and its relation to cancer risk: Updating the evidence. *Asian Pacific Journal of Cancer Prevention 14*(7): 3993-4003.

Laine, J., Kuvaja-Köllner, V., Pietilä, E., Koivuneva, M., Valtonen, H., & Kankaanpää, E. (2014). Cost-effectiveness of population-level physical activity interventions: a systematic review. *American Journal of Health Promotion 29*(2): 71-80.

Lesser, I. A. & Nienhuis, C. P. (2020). The Impact of COVID-19 on Physical Activity Behavior and Well-Being of Canadians. *International journal of environmental research and public health*, *17*(11), 3899. https://doi.org/10.3390/ijerph17113899

Li, X., Vanderloo, L.M., Maguire, J.L., Keown-Stoneman, C.D.G., Aglipay, M., Anderson, L.N., Cost, K.T., … TARGet Kids! Collaboration. (2021). Public health preventive measures and child health behaviours during COVID-19: A cohort study. *Canadian Journal of Public Health 112*: 831-842.

Mahmood, B., Bhatti, J.A., Leon, A., & Gotay, C. (2019). Leisure Time Physical Activity Levels in Immigrants by Ethnicity and Time Since Immigration to Canada: Findings from the 2011–2012 Canadian Community Health Survey. *Journal of Immigrant and Minority Health 21*: 801-810.

Mayne, S.L., Auchincloss, A.H., & Michael, Y.L. (2015). Impact of policy and built environment changes on obesity-related outcomes: a systematic review of naturally occurring experiments. *Obesity Reviews 15*(5): 362-375.

McCormack, G.R., Doyle-Baker, P.K., Petersen, J.A., & Ghoneim, D. (2020). Parent anxiety and perceptions of their child's physical activity and sedentary behaviour during the COVID-19 pandemic in Canada. *Preventive Medicine Reports 20*: 101275.

McGrath, L.J., Hopkins, W.G., & Hinckson, E.A. (2015). Associations of objectively measured built-environment attributes with youth moderate-vigorous physical activity: A systematic review and meta-analysis. *Sports Medicine 45*(6): 841-65.

McHugh, C.,Hurst, A.,Bethel, A.,Lloyd, J.,Logan, S.,Wyatt, K. (2020). The impact of the World Health Organization Health Promoting Schools framework approach on diet and physical activity behaviours of adolescents in secondary schools: A systematic review. *Public Health 182*: 116-124.

Mölenberg, F.J.M., Panter, J., Burdorf, A., & van Lenthe, F.J. (2019). A systematic review of the effect of infrastructural interventions to promote cycling: strengthening causal inference from observational data. *The International Journal of Behavioural Nutrition and Physical Activity 16*(1): 93.

Moore, S.A., Faulkner, G., Rhodes, R.E., Brussoni, M., Chulak-Bozzer, T., Ferguson, L.J., … Tremblay, M.S. (2020). Impact of the COVID-19 virus outbreak on movement and play behaviours of Canadian children and youth: a national survey. *International Journal of Behavioral Nutrition and Physical Activity 17*(85).

Mozaffarian, A., Afshin, A., Benowitz, N.L., Bittner, V., Daniels, S.R., Franch, H.A., … American Heart Association Council on Epidemiology and Prevention. (2012). Population approaches to improve diet, physical activity, and smoking habits: a scientific statement from the American Heart Association. *Circulation 126*(12): 1514-63.

Neil-Sztramko, S.E., Belita, E., Traynor, R.L., Clark, E., Hagerman, L., & Dobbins, M. (2021). Methods to support evidence-informed decision-making in the midst of COVID-19: creation and evolution of a rapid review service from the National Collaborating Centre for Methods and Tools. *BMC Medical Research Methodology 21*(231).

Neil-Sztramko, S., Caldwell, H., & Dobbins, M. (2021). School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database of Systematic Reviews 9*(9): CD007651.

Nordbø, E.C.A., Nordh, H., Raanaas, R.K., & Aamodt, G. (2020). Promoting activity participation and well-being among children and adolescents: a systematic review of neighborhood built-environment determinants. *JBI Evidence Synthesis 18*(3): 370-458.

Nordbø, E.C.A., Nordh, H., Raanaas, R.K., & Aamodt, G. (2018). *GIS-derived measures of the built environment determinants of mental health and activity participation in childhood and adolescence: A systematic review*. *Landscape and Urgab Planning 177*: 19-37.

Omura, J.D., Carlson, S.A., Brown, D.R., Hopkins, D.P., Kraus, W.E., Staffileno, B.A., … Council on Clinical Cardiology. (2020). Built Environment Approaches to Increase Physical Activity: A Science Advisory from the American Heart Association. *Circulation 142*(11): e160-e166.

ParticipACTION. (2021). *Glossary*.

Prince, S.A., Roberts, K.C., Reed, J.L., Biswas, A., Colley, R.C., & Thompson, W. (2020, September 16). *Daily physical activity and sedentary behaviour across occupational classifications in Canadian adults*. Statistics Canada.

Puggina, A., Aleksovska, K., Buck, C., Burns, C., Cardon, G., Carlin, A., … DEDIPAC Consortium. (2018). Policy determinants of physical activity across the life course: a 'DEDIPAC' umbrella systematic literature review. *European Journal of Public Health 28*(1):105-118.

Rhodes, R. E., Liu, S., Lithopoulos, A., Zhang, C. Q., & Garcia-Barrera, M. A. (2020). Correlates of Perceived Physical Activity Transitions during the COVID-19 Pandemic among Canadian Adults. *Applied psychology. Health and well-being*, *12*(4), 1157–1182.

Rissel, C., Curac, N., Greenaway, M., & Bauman, A. (2012). Physical activity associated with public transport use--a review and modelling of potential benefits. *International Journal of Environmental Research and Public Health 9*(7): 2454-78.

Rock, C.L., Thomson, C., Gansler, T., Gapstaur, S.M., McCullough, M.L., Patel, A.V., … Doyle, C. (2020). American Cancer Society guideline for diet and physical activity for cancer prevention. *A Cancer Journal for Clinicians 70*(4): 245-271.

Russ, L.B., Webster, C.A., Beets, M.W., & Phillips, D.S. (2015). Systematic Review and Meta-Analysis of Multi-Component Interventions Through Schools to Increase Physical Activity. *Journal of Physical Activity & Health 12*(10): 1436-46.

Smith, M., Hosking, J., Woodward, A., Witten, K., MacMillan, A., Field, A., … Mackie, H. (2017). Systematic literature review of built environment effects on physical activity and active transport - an update and new findings on health equity. *International Journal of Behavior Nutrition and Physical Activity 14*(1): 158.

Stappers, N.E.H., Van Kann, D.H. H., Ettema, D., De Vries, N.K., & Kremers, S.P.J. (2018). The effect of infrastructural changes in the built environment on physical activity, active transportation and sedentary behavior - A systematic review. *Health & Place 53*: 135-149.

Statistics Canada. (2020, November 26). *Table 1 Leading causes of death in Canada, 2019*.

Statistics Canada. (2019, April 17). *Tracking physical activity levels of Canadians, 2016 and 2017*.

Tcymbal, A., Demetriou, Y., Kelso, A., Wolbring, L., Wunsch, K., Wasche, H., … Reimers, A.K.. (2020). Effects of the built environment on physical activity: a systematic review of longitudinal studies taking sex/gender into account. *Environmental Health and Preventive Medicine 25*(1): 75.

Umstattd Meyer, M.R., Bridges, C.N., Schmid, T.L., Hecht, A.A., & Pollack Porter, K.M. (2019). Systematic review of how Play Streets impact opportunities for active play, physical activity, neighborhoods, and communities. *BMC Public Health 19*(1): 335.

Van Cauwenberg, J., De Bourdeaudhuij, I., De Meester, F., Van Dyck, D., Salmon, J., Clarys, P., & Deforche, B. (2011). Relationship between the physical environment and physical activity in older adults: A systematic review. *Health & Place 17*(2): 458-69.

Van Cauwenberg, J., Nathan, A., Barnett, A., Barnett, D. W., Cerin, E., & Council on Environmental and Physical Activity (CEPA)-Older Adults Working Group. (2018). Relationships Between Neighbourhood Physical Environmental Attributes and Older Adults' Leisure-Time Physical Activity: A Systematic Review and Meta-Analysis. *Sports Medicine 48*(7): 1635-1660.

van de Kop, J.H., van Kernebeek, W.G., Otten, R.H.J., Toussaint, H.M., & Verhoeff, A.P. (2019). School-based physical activity interventions in prevocational adolescents: A systematic review and meta-analyses. *The Journal of Adolescent Health 65*(2): 185-194.

Van Holle, V., Deforche, B., Van Cauwenberg, J., Goubert, L., Maes, L., Van de Weghe, N., & De Bourdeaudhuij, I. (2012). Relationship between the physical environment and different domains of physical activity in European adults: A systematic review. *BMC Public Health 12*:807.

Villa-Gonzalez, E., Barranco-Ruiz, Y., Evenson, K.R., & Chillón, P. (2018). Systematic review of interventions for promoting active school transport. *Preventive Medicine 111*: 115-134.

Watt, J. & Colley, R.C. (2021, September 17). *Youth—but not adults—reported less physical activity during the COVID-19 pandemic*. Statistics Canada.

Wild, C.P., Weiderpass, E., & Stewart, B.W. (Eds.). (2020). *World Cancer Report: Cancer Research for Cancer Prevention. Lyon, France: International Agency for Research on Cancer*.

Woods, C.B., Volf, K., Kelly, L., Casey, B., Gelius, P., Messing, S., … P.E.N. Consortium. (2021). The evidence for the impact of policy on physical activity outcomes within the school setting: A systematic review. *Journal of Sport and Health Science 10*(3): 263-276.

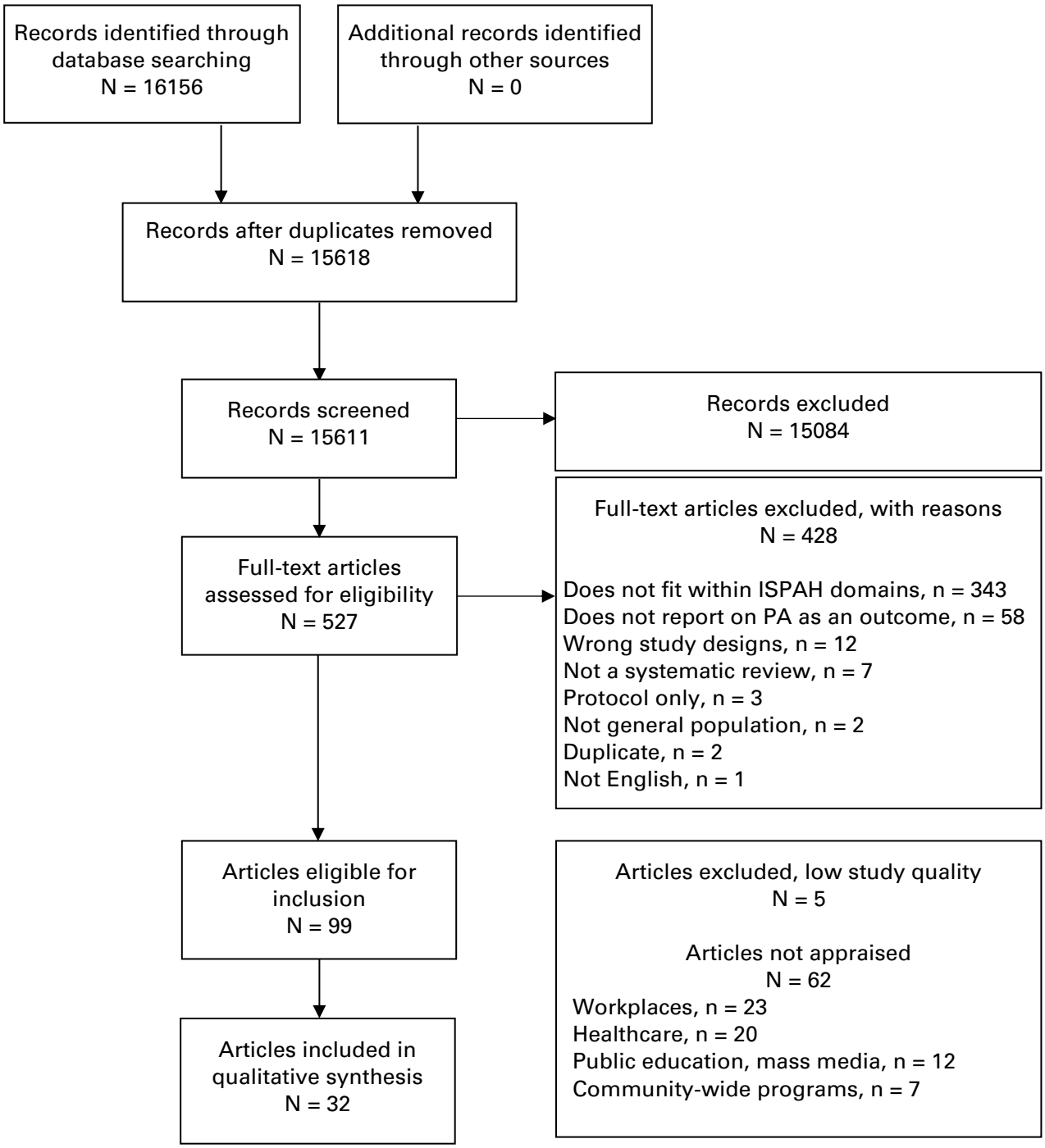
World Cancer Research Fund. (2018). Physical activity and the risk of cancer.

World Health Organization. (2021). *Physical Activity*.

Xiao, C., Goryakin, Y., & Cecchini, M. (2019). Physical Activity Levels and New Public Transit: A Systematic Review and Meta-analysis. *American Journal of Preventive Medicine 56*(3): 464-473.

Zapata-Diomedi, B. & Veerman, J.L. (2016). The association between built environment features and physical activity in the Australian context: a synthesis of the literature. *BMC Public Health 16*: 484.

Figure 1: PRISMA 2009 Flow Diagram



Appendix 1: Full search strategy

On August 23, 2021, the following databases were searched using the search terms and parameters below.

Database	Search parameters
Medline	*Search below*
PsychInfo	*Same as Medline search*
CINAHL	1. (MH "Physical Activity") OR AB(Exercis* OR "physical* activit*" OR "physical* inactiv*" OR sedentary OR recreation* OR sport* OR "physical education" OR walk* OR "active transport*" OR "active transit" OR pedestrian* OR ((Bik* or bicycl* or cycl* or walk*) and (path* or lane* or trail*)) OR cycleway OR woonerf OR sidewalk OR footpath) 2. "clinical trial" OR (control and (study or group*) or (time and factors) or program or "comparative stud*" or "evaluation studies") OR intervention* OR trial OR investigat* OR random OR control OR experimental OR compar* OR matched OR blind OR examine OR "comparative study" OR "randomized controlled trial" 3. (MH "Meta Analysis") OR AB("meta-analysis" OR "meta analysis" OR "systematic review" OR "umbrella review" OR "review of reviews") 4. 1 AND 2 AND 3
Sociological Abstracts	noft(Exercis* OR "physical* activit*" OR "physical* inactiv*" OR sedentary OR recreation* OR sport* OR "physical education" OR walk* OR "active transport*" OR "active transit" OR pedestrian* OR ((Bik* or bicycl* or cycl* or walk*) and (path* or lane* or trail*)) OR cycleway OR woonerf OR sidewalk OR footpath) **AND** noft("clinical trial" OR (control and (study or group*) or (time and factors) or program or "comparative stud*" or "evaluation studies") OR intervention* OR trial OR investigat* OR random OR control OR experimental OR compar* OR matched OR blind OR examine OR "comparative study" OR "randomized controlled trial") **AND** noft("meta-analysis" OR "meta analysis" OR "systematic review" OR "umbrella review" OR "review of reviews") Filters: 2011-01-01 – 2021-08-23
ERIC	noft(Exercis* OR "physical* activit*" OR "physical* inactiv*" OR sedentary OR recreation* OR sport* OR "physical education" OR walk* OR "active transport*" OR "active transit" OR pedestrian* OR ((Bik* OR bicycl* OR cycl* OR walk*) AND (path* OR lane* OR trail*)) OR cycleway OR woonerf OR sidewalk OR footpath) **AND** noft("clinical trial" OR (control AND (study OR group*) OR (time AND factors) OR program OR "comparative stud*" OR "evaluation studies") OR intervention* OR trial OR investigat* OR random OR control OR experimental OR compar* OR matched OR blind OR examine OR "comparative study" OR "randomized controlled trial") **AND** noft("meta-analysis" OR "meta analysis" OR "systematic review" OR "umbrella review" OR "review of reviews") Filters: 2011-01-01 – 2021-08-23
Applied Social Sciences Index and Abstracts	noft(Exercis* OR "physical* activit*" OR "physical* inactiv*" OR sedentary OR recreation* OR sport* OR "physical education" OR walk* OR "active

	transport*" OR "active transit" OR pedestrian* OR ((Bik* OR bicycl* OR cycl* OR walk*) AND (path* OR lane* OR trail*)) OR cycleway OR woonerf OR sidewalk OR footpath) **AND** noft("clinical trial" OR (control AND (study OR group*) OR (time AND factors) OR program OR "comparative stud*" OR "evaluation studies") OR intervention* OR trial OR investigat* OR random OR control OR experimental OR compar* OR matched OR blind OR examine OR "comparative study" OR "randomized controlled trial") **AND** noft("meta-analysis" OR "meta analysis" OR "systematic review" OR "umbrella review" OR "review of reviews") Filters: 2011-01-01 – 2021-08-23
Worldwide Political Science Abstracts	noft(Exercis* OR "physical* activit*" OR "physical* inactiv*" OR sedentary OR recreation* OR sport* OR "physical education" OR walk* OR "active transport*" OR "active transit" OR pedestrian* OR ((Bik* OR bicycl* OR cycl* OR walk*) AND (path* OR lane* OR trail*)) OR cycleway OR woonerf OR sidewalk OR footpath) **AND** noft("clinical trial" OR (control AND (study OR group*) OR (time AND factors) OR program OR "comparative stud*" OR "evaluation studies") OR intervention* OR trial OR investigat* OR random OR control OR experimental OR compar* OR matched OR blind OR examine OR "comparative study" OR "randomized controlled trial") **AND** noft("meta-analysis" OR "meta analysis" OR "systematic review" OR "umbrella review" OR "review of reviews") Filters: 2011-01-01 – 2021-08-23
Health Evidence	1. Exercis* OR "physical* activit*" OR "physical* inactiv*" OR sedentary OR recreation* OR sport* OR "physical education" OR walk* OR "active transport*" OR "active transit" OR pedestrian* OR ((Bik* or bicycl* or cycl* or walk*) and (path* or lane* or trail*)) OR cycleway OR woonerf OR sidewalk OR footpath **Date = Published from 2011 to 2021** 2. Date = Published from 2011 to 2021 Topic Area = Physical Activity

Ovid MEDLINE(R)

#	Query
1	Exercise/ or Exercise.ti,ab,kw.
2	"physical* activ*".ti,ab,kw.
3	"physical* inactiv*".ti,ab,kw.
4	Sedentary Behavior/ or sedentary.ti,ab,kw.
5	Recreation/ or recreation*.ti,ab,kw.
6	exp Sports/ or sport*.ti,ab,kw.
7	physical education.ti,ab,kw.
8	walk*.ti,ab,kw. or Walking/
9	("active transport*" or "active transit").ti,ab,kw.
10	Pedestrians/ or Pedestrian*.ti,ab,kw.

11	((Bik* or bicycl* or cycl* or walk*) and (path* or lane* or trail*)).ti,ab,kw.
12	Cycleway*.ti,ab,kw.
13	Woonerf*.ti,ab,kw.
14	Sidewalk*.ti,ab,kw.
15	footpath*.ti,ab,kw.
16	or/1-15
17	16 not Active Transport, Cell Nucleus/
18	exp clinical trial/ or exp evaluation studies as topic/
19	((control and (stud* or group*)) or (time and factor*) or program* or "comparative stud*" or "evaluation stud*").mp.
20	intervention*.mp.
21	trial*.tw.
22	investigat*.tw.
23	random*.tw.
24	control*.tw.
25	experimental.tw.
26	compar*.tw.
27	matched.tw.
28	blind.tw.
29	examine*.tw.
30	comparative study.sh.
31	randomized controlled trial.pt.
32	or/18-31
33	"meta analysis" or meta-analysis).ti,ab,kw. or Meta-Analysis/ or "umbrella review".ti,ab,kw. or "review of reviews".ti,ab,kw.
34	"systematic review".ti,ab,kw. or "Systematic Review"/
35	33 or 34
36	17 and 32 and 35
37	limit 36 to (english language and humans and yr="2011-current")