

STATE OF EVIDENCE:
The Built Environment And Health
2011-2015



Provincial Population & Public Health

December 2011

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1.0 Executive Summary

Introduction

The Built Environment Health Promotion Strategy is one of many health promotion initiatives being developed by the Population and Public Health portfolio within Alberta Health Services (AHS). A synthesis of existing evidence on population level, health promotion through the built environment was needed to inform strategy development.

Methods

To capture and review the large body of available scientific literature, two systematic literature reviews were conducted. The first was a promising practices review, where information from recently published

intervention studies was synthesized. The second was an appraisal of recently published systematic reviews. Findings from both reviews were synthesized to develop recommendations and conclusions.

Results

In total, 46 literature reviews and 26 intervention articles from the promising practices review were included in the final analysis. Articles were classified as under themes and ranked according to **Table 1** below.

Table 1: Built Environment Literature Review

Author (Year)	Article Type	Scientific Merit	Certainty of Effectiveness	Potential for Population Impact	Overall Ranking
<i>Community Recreation (Land Use)</i>					
Heath et al. ^{1,2}	Review	Moderate	-	-	Moderate
Kaczynski & Henderson ⁸¹	Review	Moderate	-	-	Moderate
Limstrand ³	Review	Moderate	-	-	Moderate
McCormack et al. ⁴	Review	Moderate	-	-	Moderate
Cohen et al. ⁵	Intervention	-	Low	High	Promising
Eyler et al. ⁶	Intervention	-	Mid	High	Very Promising
McCarthy ⁷	Intervention	-	Mid	High	Very Promising
Tester & Baker ⁸	Intervention	-	Mid	Low	Less Promising
<i>Playgrounds (Land Use)</i>					
Brink et al. ⁹	Intervention	-	High	Mid	Very Promising
Colabianchi et al. ¹⁰	Intervention	-	High	Mid	Very Promising
Dobbins et al. ¹¹	Intervention	-	Mid	High	Very Promising
Dyment ¹²	Intervention	-	Mid	Mid	Promising
Dyment & Bell ^{13,14}	Intervention	-	High	High	Most Promising
<i>Gardens (Land Use)</i>					
Alaimo et al. ¹⁵	Intervention	-	Mid	Mid	Promising
Parmer et al. ¹⁶	Intervention	-	Mid	Mid	Promising



Author (Year)	Article Type	Scientific Merit	Certainty of Effectiveness	Potential for Population Impact	Overall Ranking
<i>Food Retail Access (Land Use)</i>					
Brug et al. ¹⁷	Review	Low	-	-	Low
Cunradi ¹⁸	Review	Low	-	-	Low
Fraser et al. ¹⁹	Review	Low	-	-	Low
Larson et al. ²⁰	Review	Moderate	-	-	Moderate
Treuhart & Karpyn ²¹	Review	Low	-	-	Low
Cummins et al. ²²	Intervention	-	Mid	Mid	Promising
<i>Housing (Land Use)</i>					
Lindberg et al. ^{23, 24}	Review	Moderate	-	-	Moderate
Barton et al. ²⁵	Intervention	-	Mid	Mid	Promising
Johnson et al. ²⁶	Intervention	-	Low	Mid	Less Promising
<i>Crime Prevention (Land Use)</i>					
Cozens et al. ²⁷	Review	Low	-	-	Low
Foster & Gilles-Corti ²⁸	Review	Low	-	-	Low
Cozens & Love ²⁹	Intervention	-	Low	Mid	Less Promising
Saville ^{30, 31}	Intervention	-	Mid	High	Very Promising
<i>Mental Health (Land Use)</i>					
Abraham et al. ³²	Review	Moderate	-	-	Moderate
Mair et al. ³³	Review	Moderate	-	-	Moderate
Renalds et al. ³⁴	Review	Moderate	-	-	Moderate
Truong ³⁵	Review	High	-	-	High
<i>Rural Land Use (Land Use)</i>					
Frost et al. ⁸²	Review	Moderate	-	-	Moderate
Sandercock et al. ³⁶	Review	Moderate	-	-	Moderate
<i>Driving Environments (Transportation)</i>					
Beyer et al. ³⁷	Review	High	-	-	High
Elvik et al. ³⁸	Review	High	-	-	High
<i>Elder Driving (Transportation)</i>					
Bohr ³⁹	Review	High	-	-	High
<i>Crash Prevention Interventions (Transportation)</i>					
Aarts & van Schagen ⁴⁰	Review	Low	-	-	Low
Aeron-Thomas & Hess ⁴¹	Review	High	-	-	High
Blais & Dupont ⁴²	Review	Low	-	-	Low
Bunn et al. ⁴³	Review	High	-	-	High
Pilkinton & Kinra ⁴⁴	Review	High	-	-	High
Wilson et al. ⁴⁵	Review	High	-	-	High
<i>Proximity to Traffic (Transportation)</i>					
Boothe & Shendell ⁴⁶	Review	Moderate	-	-	Moderate
Clark & Stansfeld ⁴⁷	Review	Low	-	-	Low
Lipfert & Wyzga ⁴⁸	Review	Low	-	-	Low
Wier et al. ⁴⁹	Intervention	-	Low	High	Promising

Author (Year)	Article Type	Scientific Merit	Certainty of Effectiveness	Potential for Population Impact	Overall Ranking
<i>Active School Transport (Transportation)</i>					
Anderson et al. ⁵⁰	Review	Low	-	-	Low
Faulkner et al. ⁵¹	Review	Moderate	-	-	Moderate
Lee et al. ⁵²	Review	Low	-	-	Low
Lee & Zhu ⁵³	Review	Low	-	-	Low
Pont et al. ⁵⁴	Review	High	-	-	High
Eyler et al. ⁵⁵	Intervention	-	High	High	Most Promising
Vaughn et al. ⁵⁶	Intervention	-	Low	High	Promising
<i>Adult Active Transport (Transportation)</i>					
Hosking et al. ⁵⁷	Review	High	-	-	High
Panter & Jones ⁵⁸	Review	Moderate	-	-	Moderate
Shephard ⁵⁹	Review	Low	-	-	Low
Schuurman et al. ⁶⁰	Intervention	-	Low	Low	Least Promising
<i>Cycling (Transportation)</i>					
Pucher et al. ⁶¹	Review	Moderate	-	-	Moderate
Reynolds et al. ⁶²	Review	Moderate	-	-	Moderate
Jensen et al. ^{63, 64}	Intervention	-	Low	Mid	Less Promising
<i>Elevator or Stair Design (Building Design/Design Features)</i>					
Nicoll & Zimring ⁶⁴	Intervention	-	Mid	Mid	Promising
<i>Obesity Prevention</i>					
Booth et al. ⁶⁵	Review	Low	-	-	Low
Casagrande et al. ⁶⁶	Review	Low	-	-	Low
Khan et al. ⁶⁷	Review	Mid	-	-	Mid
Papas et al. ⁶⁸	Review	Moderate	-	-	Moderate
Sallis & Glanz ⁶⁹	Review	Low	-	-	Low
Townshend & Lake ⁷⁰	Review	Moderate-Low	-	-	Moderate-Low
Kramer et al. ⁷¹	Intervention	-	Mid	Mid	Promising
Kim et al. ⁷²	Intervention	-	Mid	High	Very Promising
Roof & Glandon ⁷³	Intervention	-	Low	Mid	Less Promising
de Silva-Sanigorski et al. ⁷⁴	Intervention	-	Low	Mid	Less Promising
<i>Overarching Approaches</i>					
Lees & Redman ⁷⁵	Intervention	-	Low	High	Promising



Conclusions

Based on the identified literature, several conclusions were developed to inform The Built Environment Health Promotion Strategy.

Increasing Opportunities for Physical Activity in the Community and at School

1. The availability of recreation facilities, including parks and trails, increases physical activity. Parks with multiple components, maintained condition, increased social environments and positive aesthetics as well as those that were safe, accessible, or renovated were more likely to be visited.
2. Opportunities to increase use of school grounds include school ground greening, renovation and provision of shaded areas.
3. Among adults living in rural settings, physical activity was associated with the presence of trails and parks as well as pleasant aesthetics.

Facilitating Healthy Eating

1. Gardening programs are a promising strategy to increase fruit and vegetable consumption in adults and children.
2. There may be inequitable access to healthy food options, including reduced access to supermarkets and increased density of fast food outlets. Additional research is needed to investigate whether access to healthy food options is predictive of fruit and vegetable consumption, diet related disease, or weight status.

Safe Housing

1. Additional formative research and field evaluation is needed to determine the effectiveness of housing interventions,

however, early evidence exists to suggest that housing improvements may increase respiratory health.

2. Preliminary projects indicate that comprehensive implementation of SafeGrowth principles in communities may improve perceptions of crime. Additional research is needed to assess incidence of crime.

Mental Health Promotion

1. There is strong evidence to suggest a relationship between urbanicity and depressive symptoms.

Prevention of Traffic Crashes and Associated Injuries

1. To increase the visibility of signs to older drivers, font, text colour and background colour are important considerations.
2. Red-light cameras, speed cameras, street lighting, and area-wide traffic calming measures are effective at reducing traffic collisions and associated injuries.

Proximity to Traffic

1. Scientifically rigorous synthesis of existing evidence is needed to better understand the relationship between proximity to traffic and health or predictors of health.

Active Transport among Children and Adults

1. Among children, active school transport may increase physical activity. Close presence of community recreation spaces, proximity to schools, supportive infrastructure and safety are the strongest predictors of active school transport.

2. Programming to facilitate active school transport has strong community uptake. The success of active school transport programming may be influenced by the infrastructure, policies and environment surrounding schools. These factors should be considered and addressed in the development of AST programming.
3. Supportive infrastructures are correlated with increased active transport. Among cyclists, bicycle facilities, including cyclist specific lanes and end of trip facilities, increased rates of cycling and also reduced risk for injury.

Obesity Prevention

1. There is evidence to suggest a relationship between components of the built environment, including land use mix and walkability, and obesity.
2. The *Community Health Living Index* shows promise as a tool to encourage community-based obesity prevention programming.
3. Building design may be used to promote stair use with skip-stop elevators. Additional research is needed to determine if building designs can alter attitudes towards stair use as a positive, health promoting behaviour.

Increasing the Success of Interventions related to the Built Environment

1. Stakeholder involvement, community ownership and self-determination and a goal-oriented approach may increase the successful implementation and uptake of health promotion interventions related to the built environment.





2.0 Introduction

The Built Environment Health Promotion Strategy is one of many health promotion initiatives being developed by the Population and Public Health portfolio within Alberta Health Services (AHS). A Steering Committee comprised of directors and managers with interest in the built environment are providing oversight and direction for strategy development. It was agreed that a synthesis of existing evidence on population level, health promotion through the built environment was needed to inform strategy development.

To capture and review the large body of available scientific literature, two systematic literature reviews were conducted. The first was a promising practices review, where information from recently published intervention studies was synthesized. The second was an appraisal of recently published systematic reviews. Findings from both reviews were synthesized to develop recommendations and conclusions. Both reviews were informed by five narrative (non-systematic) literature reviews relating the built environment to five modifiable risk factors for

morbidity and mortality: physical activity, injury, nutrition, environmental hazards, and ultraviolet radiation (UVR) completed by the working group members.



The AHS areas currently collaborating to develop the strategy include: Public Health and Innovation Decision Support; Health Promotion, Disease and Injury Prevention areas of Chronic Disease Prevention, Healthy Public Policy and Injury Prevention; as well as input and engagement from other areas including, Environmental Health, Nutrition and Food Services and Environmental and Occupational Exposures.

3.0 Research Questions

For the promising practices review, the research questions were:

1. What practices, programs or interventions currently exist that modify the following risk factors for morbidity and mortality through the built environment: nutrition, physical activity, injury, ultra-violet radiation exposure, and environmental hazard exposure?
2. What is the level of promise of these programs?

For the synthesis appraisal of literature reviews, the research questions were:

1. What literature reviews exist that explore the relationship between land use, transportation and building design as components of the built environment and health outcomes?
2. What is the scientific rigour of this evidence?



4.0 Methods

4.1 Promising Practices Review

A systematic synthesis approach was used to identify existing programs, practices, activities, or interventions that related the built environment to modifiable risk factors for morbidity and mortality (physical activity, nutrition, injury, environmental hazards and UVR) of interest to Alberta Health Services. The objective of this review was to identify areas where sufficient evaluative or outcome data exists for population level intervention. Therefore, specific focus was on literature with an actionable or evaluative component.

4.1.1 Search Strategy: Promising Practices Review

Independent searches were conducted to identify articles relating to each risk factor. Articles for injury, environmental hazards, and UVR were obtained from comprehensive narrative reviews, previously completed by a Built Environment working group within AHS. The Steering Committee concluded after consideration of these topic areas that sufficient evidence had been captured and further search was not required, however, recommended further appraisal of the evidence. Although narrative reviews for physical activity and nutrition had also been completed, these topic areas were supplemented with additional systematic searches. Two distinct searches were completed in consultation with a librarian: one to identify articles addressing physical activity and the built environment and a second to identify articles addressing nutrition and the built environment.

To identify articles addressing physical activity and the built environment, the Medline and PsycINFO databases were searched using two constructs: physical activity (search terms: “physical activity” or “active living” or exercise or fitness or “level of service” or mov* or “active transport” or walkab*) and built environment (search terms: "built environment" or "physical environment" or design* or planning or built or build or structur* or environment* or architecture or "community design" or "urban development" or "land use" or "urban design" or zon* or "urban planning" or "community design" or "environmental health" or communit* or neighborhood or sprawl). Each construct was searched independently and then combined. The search was limited to articles published between 2008 and 2010, inclusive.

To identify articles addressing nutrition and the built environment, the Medline and PsycINFO databases were searched for two constructs: nutrition (search terms: nutrition or diet or obesity or overweight or farm* or "community garden" or permaculture or agriculture or "food access" or "food security" or "food insecurity" or "food scarcity" or "fruit consumption" or "vegetable consumption" or "food tax" or "food outlet" or grocery) and built environment (search terms: "built environment" or "physical environment" or design* or planning or built or build or structur* or environment* or architecture or "community design" or "urban development" or "land use" or "urban design" or zon* or "urban planning" or "community design" or "environmental health" or communit* or neighborhood or sprawl). Each

construct was searched independently and then combined. The search was limited to articles published between 2008 and 2010, inclusive.

4.1.2 Selection Strategy: Promising Practices Review

Articles identified from each search, as well as those articles compiled from the previously completed narrative reviews, were screened based first on their title, then abstract, then full text by a single reviewer. Article titles and abstracts were screened to identify articles that were relevant to the pre-determined topics. Full text of the articles were then screened and selected based on pre-determined inclusion and exclusion criteria (**Table 2**). A second reviewer verified inclusion decisions.

4.1.3 Data Management & Extraction: Promising Practices Review

A database was developed to ensure that necessary data from each article was consistently and objectively extracted. Further, the database allowed consistent appraisal and scoring of each article by reducing the potential for human error in recording scores. Information extracted from each article included: citation, sample size, study design, topic area, key findings, outcomes and intervention description. In addition, critical appraisal results for each article were captured.

Table 2: Inclusion and exclusion criteria applied to articles retrieved in the promising practices review

	Inclusion	Exclusion
Population Location	<ul style="list-style-type: none"> Any population or sub-population Human or human relevant research Articles published in Canada, USA, UK or Australia Articles published from 2005 forward* 	<ul style="list-style-type: none"> Non-human research Articles published outside of these countries Articles published prior to 2005*
Intervention Indicator	<ul style="list-style-type: none"> Modifies or addresses a component of the built environment Has action on or to the built environment or has potential to affect the built environment Is actionable (program, practice, activity, pilot, intervention) 	<ul style="list-style-type: none"> Does not address the built environment Does not act upon the built environment or has no potential to influence the built environment Not actionable, including descriptive studies or population opinion surveys, position papers, or expert opinions
Outcomes	<ul style="list-style-type: none"> Relates to the modifiable risk factors of interest: <ol style="list-style-type: none"> Physical Activity Nutrition UV Radiation Injury Environmental Hazards Relates to mental health 	<ul style="list-style-type: none"> Relates to health domains outside of the five health domains identified.
Other	<ul style="list-style-type: none"> English language All study designs, except review articles 	<ul style="list-style-type: none"> Non-English language articles Review articles

*2008 for articles related to nutrition or physical activity.



4.1.4 Critical Appraisal: Promising Practices Review

Each included article was appraised by the research team for scientific rigour, community involvement, and program characteristics. Both quantitative and qualitative studies were included.

Scientific rigour was appraised using previously developed scales designed for use within systematic reviews⁷⁶⁻⁷⁸. Quantitative studies were assessed in three broad categories: selection bias, information bias and confounding (**Appendices**) using 18 criteria and were also categorized by study design. Level I study designs included experimental studies (randomized controlled trials with random allocation); Level II study designs included quasi-experimental studies (without random allocation and/or blinding); and Level III study designs including cohort, case-control, and observational studies. Qualitative studies were appraised in three categories: reflexivity, credibility and transferability (**Appendices**) using 14 criteria. For both quantitative and qualitative studies, each criterion equated to a single point, allowing articles to be categorized as having high, mid or low scientific rigour using tertiles to divide the total possible scores into one of the three categories.

All articles were assessed for the level of community participation in the intervention. Community participation was assessed using a three point scale (zero to two) developed specifically for this promising practices review and included an assessment of community knowledge, participation and/or leadership.

In order to assess program characteristics, each initiative's logic and reach were appraised. Program logic was determined based on

whether the article provided sufficient rationale or suggestion that the program would influence the indicator of interest and that a link existed between the indicator, program and outcome. Program reach was based on whether the initiative impacted at least 500 people. Each program then received a score for program characteristics ranging from zero to two based on whether they had none, one or both program logic and reach.

Finally, the outcomes of the program or initiative were considered to identify whether the program impacted the health or modifiable risk factors for health via the built environment. As such, the reviewer considered whether the articles' relevant outcomes were positive, neutral, negative or unknown. Both process and indicator outcomes were considered and weighted equally.

4.1.5 Reviewer & Training: Promising Practices Review

A single reviewer completed the selection and appraisal of each article. A second reviewer verified scores during the synthesis of evidence. All reviewers received training on all scales. The project lead verified a sample of reviewer appraisals to ensure accuracy. Discrepancies were resolved by discussion between the first and second reviewers. In addition, a third content expert was involved in discussions and the senior scientist was consulted as needed. Discussions were focused on referencing exact statements in the article that indicated whether a point be awarded to the article.

4.1.6 Determining Level of Promise

In order to determine the level of promise of a program or initiative, several factors were considered in identifying a programs' *potential promise*. To have high scientific rigour alone,

would not warrant a program to be considered promising, as this would disregard the program's effectiveness, logic, reach and level of community involvement. As such, for the purpose of our review, programs were classified from least to most promising, considering their scientific rigour, effectiveness (outcomes), program characteristics and community involvement.

A program's promise was determined using a series of tables, adapted from the work of McNeil et al.^{79, 80}. Initially the programs' *Certainty of Effectiveness* was determined by plotting its scientific rigour and outcomes in a table (**Table 3**). Based on this table, each program received a score of low, mid or high for *Certainty of Effectiveness*.

Next, the programs' *Potential for Population Impact* was determined by plotting program

characteristics and community involvement in a table (**Table 4**). Based on this table, each program received a score of low, mid or high for *Potential for Population Impact*.

Finally, a programs' ranking for *Certainty of Effectiveness* and *Potential for Population Impact* were plotted in **Table 5** to determine *Level of Promise*.

For the purposes of this review, all programs were included in data analysis, synthesis, and in the development of recommendations and conclusions. However, only programs that were ranked as promising, very promising, or most promising were used in the development of recommendations for use by Alberta Health Services.

Table 3: Determination of *Certainty of Effectiveness*⁷⁹

		Outcomes			
		Negative	Neutral	Positive	Unknown
Scientific Rigour	High	Low	Mid	High	Mid
	Mid	Low	Low	Mid	Low
	Low	Low	Low	Low	Low

Table 4: Determination of *Potential for Population Impact*⁷⁹

		Program Characteristics (N=2 logic and reach)		
		0	1	2
Community Participation	High	Low	Low	High
	Mid	Low	Mid	High
	Low	Low	Mid	Mid

Table 5: *Level of Promise*⁷⁹

		Potential for Population Impact		
		Low	Mid	High
Certainty of Effectiveness	High	Promising	Very Promising	Most Promising
	Mid	Less Promising	Promising	Very Promising
	Low	Least Promising	Less Promising	Promising



4.2 Appraisal of Literature and Systematic Reviews

In order to reduce the potential for content gaps and account for the large body of available literature, the Steering Committee recommended that an appraisal of systematic reviews be included with a focus on three components of the built environment: land use, transportation and building design or design features. By using an alternative search strategy to the previous reviews, the committee felt this approach would ensure salient topic areas would be identified.

4.2.1 Search Strategy: Appraisal of Literature and Systematic Reviews

To ensure that all relevant systematic reviews were identified, three separate searches were conducted- one for each component of the built environment. The Cochrane Database of Systematic Reviews, Medline, PsycINFO and Web of Science databases were searched. In addition, the Multisearch database was searched; this database is a comprehensive compilation of journals from multiple disciplines including: communication and culture, education, engineering, environmental design, humanities, kinesiology, law, medicine, nursing, psychology, sciences, social sciences and social work.

Databases were searched using three search constructs: (1) land use (search terms: zon* or land or "built environment" or ordinance or "land use"); (2) transportation (search terms: transport* or walk* or pedestrian* or run* or bik* or bicycl* or jog* or bus* or transit or car or vehicle or automobile or auto or infrastructure or train or road* or trail* or sidewalk* or "built environment"); and (3) building design or design features (search

terms: structure or infrastructure or "building design" or feature* or architecture or blueprint or "environmental design" or stair* or build* or facilit* or "building code" or "built environment"). Searches were limited to systematic or synthesis reviews, meta-analyses, or literature reviews to exclude studies involving primary data collection. Further the search results were limited to articles written in English and published between 2005 and 2010.

4.2.2 Selection Strategy: Appraisal of Literature and Systematic Reviews

Titles of the articles identified from each search strategy were independently screened and selected for further consideration by two reviewers, blind to each other's selections. Articles considered potentially relevant by either reviewer were subject to further review. A single reviewer then considered abstracts and full texts for potential inclusion based on predetermined inclusion and exclusion criteria (Table 6). A second reviewer verified that all included articles were topically relevant and met all inclusion criteria during data synthesis.

4.2.3 Data Management & Extraction: Appraisal of Literature and Systematic Reviews

A database was developed to capture the information extracted from each review article. Further, the database allowed consistent appraisal and scoring of each article by reducing potential for human error in recording the scores. Information extracted from each article included the following: citation, topic area, key

Table 6: Detailed inclusion and exclusion criteria for the appraisal of systematic reviews.

	Inclusion	Exclusion
Population Location	<ul style="list-style-type: none"> Any population or sub-population Human or human relevant research Articles published in Canada, USA, UK or Australia Articles published from 2005 forward 	<ul style="list-style-type: none"> Non-human research Articles published outside of these countries Articles published prior to 2005
Intervention Indicator	<ul style="list-style-type: none"> Modifies or addresses a component of the built environment or has <u>potential</u> to affect the built environment 	<ul style="list-style-type: none"> Does not act on or address the built environment and has no potential to influence the built environment
Outcomes	<ul style="list-style-type: none"> Relates to any health outcome and contains data on that health outcome 	<ul style="list-style-type: none"> Does not relate to health or contains no health data
Other	<ul style="list-style-type: none"> English language Review articles 	<ul style="list-style-type: none"> Articles written in non-English languages Non-review articles

findings, outcomes and appraisal information. Appraisal information included the appraisal for scientific rigour, community involvement, study outcomes, and program logic or reach.

4.2.4 Critical Appraisal & Analysis: Appraisal of Literature and Systematic Reviews

A single reviewer completed the primary appraisal of all systematic reviews; a second reviewer verified the results during data synthesis. The approach to appraising systematic reviews was based on the work of Flynn et al.⁷⁶. Systematic reviews were appraised in six appraisal categories: research question, search strategy, selection strategy, validity assessment, data extraction and combination of findings. To ensure consistent and objective appraisal of each review article, predetermined criteria were identified for each category (**Appendices**).

Articles were ranked as low, moderate or high based on the absence of major flaws in four of the six appraisal categories. Articles satisfactory in all four categories (research question, search strategy, selection strategy, and validity assessment) were ranked as having high

scientific rigour. Articles satisfactory in two or three were ranked as having moderate scientific rigour. Articles satisfactory in one or fewer categories were ranked as having low scientific rigour. Articles were also appraised on data extraction, combination of findings, and whether their conclusions were supported methodologically; however, these factors did not influence the articles' overall ranking.

Included articles were grouped by content area (land use, transportation and building design). Within each of these content areas, themes were identified and articles were further grouped into themes. As all themes were not mutually exclusive, articles could be placed in multiple groups. Agreement between articles was then considered and quantified within each theme.

While the results of the appraisal of systematic reviews were analyzed independently, the more salient synthesis involved combining the findings from the promising practices review and the appraisal of systematic reviews. This synthesis was important to ensure that the findings were based on all of the literature available for review.



4.3 Approach to Developing Conclusions and Recommendations

The findings from both intervention articles (promising practices review) and review articles (appraisal of literature and systematic reviews) were combined to synthesize the results and develop conclusions and recommendations. A qualitative approach, with a focus on content analysis and theming, was used to develop topic area clusters around which to develop conclusions and recommendations. Given the larger scope of the systematic review appraisal, the themes developed during the data synthesis in this review were used as a foundation for

theming. The promising practices were then sorted into these themes. Articles that did not relate to existing themes were considered separately. The strength of the conclusions and recommendations was based upon the level of evidence available within that cluster as well as the scientific rigour and promise of available evidence. Recommendations based on this evidence review can be found in the PHASE 1-Provincial Population & Public Health: Built Environment Health Promotion Strategy.

5.0 Findings

5.1 Articles Identified

A total of 321 articles describing interventions were considered for potential inclusion in the promising practices review (Section 3.1.1). Of these, 130 articles were identified from the narrative reviews regarding environmental hazards (n=45), UVR (n=31), and injury prevention (n=54). A total of 40, 659 and 15,741 articles respectively were retrieved from the new searches for physical activity and nutrition. There were 96 unique articles related to physical activity and 95 articles related to nutrition identified for potential inclusion (Figure 1). Of the 321 articles, 26 were included.

For the appraisal of systematic and literature reviews, 3,776 articles were retrieved from the electronic search strategy. Of these, 119 full texts were reviewed and considered for their potential inclusion. An additional 36 full texts were identified via the search strategies employed in the review of promising practices. These articles were excluded in the review of promising practices and considered for potential inclusion here. In total, 155 full texts were retrieved and 46 of these were included and appraised (Figure 2).

Figure 1: Number of articles retrieved in the appraisal of literature and systematic reviews

Physical Activity <i>Included: 9</i>	Retrieved: 40,659 Articles Title Screening: (40,257 Excluded) 402 Remaining Articles Abstract Screening: (278 Excluded) 124 Remaining Articles (18 Review Articles Excluded) 96 Remaining Articles Unique Articles Reviewed: 96
Nutrition <i>Included: 6</i>	Retrieved: 15, 641 Articles Title Screening: (15,364 Excluded) 277 Remaining Articles Abstract Screening: (231 Excluded) 46 Remaining Articles 44 Additional Articles from Narrative Review 5 Additional Articles from Reference Lists Unique Articles Reviewed: 95
Environmental Hazards <i>Included: 2</i>	Retrieved: Unknown Unique Articles Reviewed: 45
Ultraviolet Radiation <i>Included: 5</i>	Retrieved: Unknown Unique Articles Reviewed: 31
Injury Prevention <i>Included: 4</i>	Retrieved: Unknown Unique Articles Reviewed: 54

Figure 2: Number of articles retrieved in promising practices literature review

Systematic Reviews Total Full Text: 155 Review Articles <i>Included: 46</i>	Retrieved: 3776 Title: (3625 Excluded) 151 Remaining Articles Abstract: (32 Excluded) 119 Remaining Articles Articles from Promising Practices Review: 36 Additional Articles
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5.2 Descriptive Characteristics

In total, 46 literature reviews and 26 intervention articles from the promising practices review were included in the final analysis. Articles were classified as relating to one of three categories: land use,

transportation, or building design/design features. Within each component of the built environment, themes were identified; articles within each thematic area are detailed in **Table 7**.

Table 7: Articles' thematic content area and ranking

Author (Year)	Article Type	Scientific Merit	Certainty of Effectiveness	Potential for Population Impact	Overall Ranking
<i>Community Recreation (Land Use)</i>					
Heath et al. ^{1, 2}	Review	Moderate	-	-	Moderate
Kaczynski & Henderson ⁸¹	Review	Moderate	-	-	Moderate
Limstrand ³	Review	Moderate	-	-	Moderate
McCormack et al. ⁴	Review	Moderate	-	-	Moderate
Cohen et al. ⁵	Intervention	-	Low	High	Promising
Eyler et al. ⁶	Intervention	-	Mid	High	Very Promising
McCarthy ⁷	Intervention	-	Mid	High	Very Promising
Tester & Baker ⁸	Intervention	-	Mid	Low	Less Promising
<i>Playgrounds (Land Use)</i>					
Brink et al. ⁹	Intervention	-	High	Mid	Very Promising
Colabianchi et al. ¹⁰	Intervention	-	High	Mid	Very Promising
Dobbinson et al. ¹¹	Intervention	-	Mid	High	Very Promising
Dyment ¹²	Intervention	-	Mid	Mid	Promising
Dyment & Bell ^{13, 14}	Intervention	-	High	High	Most Promising
<i>Gardens (Land Use)</i>					
Alaimo et al. ¹⁵	Intervention	-	Mid	Mid	Promising
Parmer et al. ¹⁶	Intervention	-	Mid	Mid	Promising
<i>Food Retail Access (Land Use)</i>					
Brug et al. ¹⁷	Review	Low	-	-	Low
Cunradi ¹⁸	Review	Low	-	-	Low
Fraser et al. ¹⁹	Review	Low	-	-	Low
Larson et al. ²⁰	Review	Moderate	-	-	Moderate
Treuhaft & Karpyn ²¹	Review	Low	-	-	Low
Cummins et al. ²²	Intervention	-	Mid	Mid	Promising
<i>Housing (Land Use)</i>					
Lindberg et al. ^{23, 24}	Review	Moderate	-	-	Moderate
Barton et al. ²⁵	Intervention	-	Mid	Mid	Promising
Johnson et al. ²⁶	Intervention	-	Low	Mid	Less Promising
<i>Crime Prevention (Land Use)</i>					
Cozens et al. ²⁷	Review	Low	-	-	Low
Foster & Gilles-Corti ²⁸	Review	Low	-	-	Low
Cozens & Love ²⁹	Intervention	-	Low	Mid	Less Promising
Saville ^{30, 31}	Intervention	-	Mid	High	Very Promising

Author (Year)	Article Type	Scientific Merit	Certainty of Effectiveness	Potential for Population Impact	Overall Ranking
<i>Mental Health (Land Use)</i>					
Abraham et al. ³²	Review	Moderate	-	-	Moderate
Mair et al. ³³	Review	Moderate	-	-	Moderate
Renalds et al. ³⁴	Review	Moderate	-	-	Moderate
Truong ³⁵	Review	High	-	-	High
<i>Rural Land Use (Land Use)</i>					
Frost et al. ⁸²	Review	Moderate	-	-	Moderate
Sandercock et al. ³⁶	Review	Moderate	-	-	Moderate
<i>Driving Environments (Transportation)</i>					
Beyer et al. ³⁷	Review	High	-	-	High
Elvik et al. ³⁸	Review	High	-	-	High
<i>Elder Driving (Transportation)</i>					
Bohr ³⁹	Review	High	-	-	High
<i>Crash Prevention Interventions (Transportation)</i>					
Aarts & van Schagen ⁴⁰	Review	Low	-	-	Low
Aeron-Thomas & Hess ⁴¹	Review	High	-	-	High
Blais & Dupont ⁴²	Review	Low	-	-	Low
Bunn et al. ⁴³	Review	High	-	-	High
Pilkinton & Kinra ⁴⁴	Review	High	-	-	High
Wilson et al. ⁴⁵	Review	High	-	-	High
<i>Proximity to Traffic (Transportation)</i>					
Boothe & Shendell ⁴⁶	Review	Moderate	-	-	Moderate
Clark & Stansfeld ⁴⁷	Review	Low	-	-	Low
Lipfert & Wyzga ⁴⁸	Review	Low	-	-	Low
Wier et al. ⁴⁹	Intervention	-	Low	High	Promising
<i>Active School Transport (Transportation)</i>					
Anderson et al. ⁵⁰	Review	Low	-	-	Low
Faulkner et al. ⁵¹	Review	Moderate	-	-	Moderate
Lee et al. ⁵²	Review	Low	-	-	Low
Lee & Zhu ⁵³	Review	Low	-	-	Low
Pont et al. ⁵⁴	Review	High	-	-	High
Eyler et al. ⁵⁵	Intervention	-	High	High	Most Promising
Vaughn et al. ⁵⁶	Intervention	-	Low	High	Promising
<i>Adult Active Transport (Transportation)</i>					
Hosking et al. ⁵⁷	Review	High	-	-	High
Panter & Jones ⁵⁸	Review	Moderate	-	-	Moderate
Shephard ⁵⁹	Review	Low	-	-	Low
Schuurman et al. ⁶⁰	Intervention	-	Low	Low	Least Promising
<i>Cycling (Transportation)</i>					
Pucher et al. ⁶¹	Review	Moderate	-	-	Moderate
Reynolds et al. ⁶²	Review	Moderate	-	-	Moderate
Jensen et al. ^{63, 64}	Intervention	-	Low	Mid	Less Promising



Author (Year)	Article Type	Scientific Merit	Certainty of Effectiveness	Potential for Population Impact	Overall Ranking
<i>Elevator or Stair Design (Building Design/Design Features)</i>					
Nicoll & Zimring ⁶⁴	Intervention	-	Mid	Mid	Promising
<i>Obesity Prevention</i>					
Booth et al. ⁶⁵	Review	Low	-	-	Low
Casagrande et al. ⁶⁶	Review	Low	-	-	Low
Khan et al. ⁶⁷	Review	Mid	-	-	Mid
Papas et al. ⁶⁸	Review	Moderate	-	-	Moderate
Sallis & Glanz ⁶⁹	Review	Low	-	-	Low
Townshend & Lake ⁷⁰	Review	Moderate-Low	-	-	Moderate-Low
Kramer et al. ⁷¹	Intervention	-	Mid	Mid	Promising
Kim et al. ⁷²	Intervention	-	Mid	High	Very Promising
Roof & Glandon ⁷³	Intervention	-	Low	Mid	Less Promising
de Silva-Sanigorski et al. ⁷⁴	Intervention	-	Low	Mid	Less Promising
<i>Overarching Approaches</i>					
Lees & Redman ⁷⁵	Intervention	-	Low	High	Promising

5.3 Land Use

A total of 18 systematic reviews and 16 intervention articles were identified that related to the effects of land use on health outcomes. Of these, four systematic reviews^{1, 3, 4, 81} and four intervention articles^{5, 7, 8, 55} related to community recreation. Five intervention articles related to playgrounds⁹⁻¹³. Two intervention articles addressed gardens^{15, 16}. Four systematic reviews examined associations between mental health and the built environment³²⁻³⁵. Rural land use was addressed in two systematic reviews^{36, 82}. Access to healthy food and food retailers was explored in five systematic reviews¹⁷⁻²² and one intervention article²². One systematic review²³ and two intervention articles^{25, 26} considered the health impacts of housing. Finally, two systematic reviews^{27, 28} and two intervention articles^{29, 30} addressed crime prevention.

5.3.1 Community Recreation

As physical activity is protective against chronic disease, researchers and practitioners have aimed to increase community-based opportunities for fitness^{1, 2}. One systematic review identified population level interventions to increase recreation and aimed to determine if they had strong or sufficient or strong evidence from the literature to support implementation^{1, 2}. Authors determined the strength of evidence (insufficient, sufficient, or strong) by considering the number of available studies, suitability of the selected study design, quality of study execution, consistency of results between studies and effect sizes, where calculated¹. There was strong evidence to support the development of places to be physically active or increasing access to existing places, combined with outreach^{1, 2}. There was sufficient evidence for urban design and land use policies acting at a street or community level^{1, 2}.

Another systematic review examined environmental associations with physical activity⁸¹. Statistically significant and positive associations were identified between physical activity and the presence of parks or recreation facilities in 80% of identified studies⁸¹. Physical activity in adolescents was positively correlated with nearby parks, playgrounds or sports facilities; access to sports equipment; type, condition, features, or improvements to recreation; general accessibility; safe roads; and perceived safety³.

The evidence presented has established that the availability of parks increases physical activity. Furthering this evidence, a review of qualitative research explored park features that may further facilitate use. Participants were more likely to use parks with multiple components, maintained condition, increased social environments and positive aesthetics as well as those that were safe and accessible⁴.

Table 8: Heath et al.^{1,2}

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
		F	F	Y	Moderate
Key Finding(s)	Community (12 studies) and street level (six studies) policies regarding urban design or land use were effective at increasing physical activity and therefore authors concluded that there was sufficient evidence for implementation. Such policies may include: zoning regulations or building codes. In both cases, all studies identified findings that would support the authors' conclusion; however, p-values and average outcome measurements were not provided. Development of spaces for physical activity or increased access to existing spaces was determined to have strong evidence for population level increases in physical activity.				

Legend: Y= Yes, F= With Flaws

Table 9: Kaczynski, A.T. & Henderson, K.A.⁸¹

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	F	F		Moderate
Key Finding(s)	Of 50 included articles, 20 identified statistically significant, positive associations between physical activity and parks and recreation facilities and an additional 20 reported statistically significant mixed associations. However, an additional 9 articles reported insignificant associations and 1 reported a statistically significant negative association.				

Legend: Y= Yes, F= With Flaws

Table 10: Limstrand, T.³

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	F	F	F		Moderate
Key Finding(s)	Eight of nine included studies identified a positive correlation between youth physical activity (YPA) and presence of sports facilities. Nine of 10 included studies identified a positive correlation between YPA and availability of parks and recreation facilities. All of six included studies identified positive associations between YPA and access to sports equipment. The study did not report statistically significance of original data or summary statistics (where applicable).				

Legend: Y= Yes, F= With Flaws

**Table 11:** McCormack et al.⁴

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	F	F	Y	Moderate
Key Finding(s)	Of 21 included studies, 13 articles included assessment of park features, 11 included assessment of park condition, 14 considered park accessibility, 14 considered park aesthetics, and 19 considered park safety. All five park characteristics were found to be associated with park use.				

Legend: Y= Yes, F= With Flaws

Table 12: Tester, J. & Baker, R.⁸

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	Low	Less Promising
Description	Two parks, located in low-income communities and used primarily for field sports, were renovated in 2006. Artificial turf, fencing, lighting and picnic benches were added in both parks. Further, in both parks, uneven dirt fields were replaced. In Garfield Square (Park A), permanent soccer goals were added and in Silver Terrace (Park B), a walkway encompassing the park, was restored.		
Key Findings	Increases were seen in the mean number of children ($p<0.001$), teens ($p<0.008$) and adults ($p<0.000$) after the park renovations. Further, at a control park, the mean number of children decreased ($p<0.000$). Of note, there was an increase in the number of teens using the control park ($p<0.000$). There were accompanying increases in sedentary, moderate and vigorous physical activity in both males and females at the renovated parks ($p<0.00$).		

Table 13: Cohen et al.⁵

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Low	High	Promising
Description	Renovations were completed over a two-year period at a skateboarding park and a senior center.		
Key Findings	Use of the renovated skate park was six times higher than a control park ($p<0.001$). There was no statistically significant difference in the use of the renovated senior center in comparison to baseline measurements or a control center ($p=0.05$).		

An intervention study also examined how to increase park use. Renovation of parks used primarily for field sports in low-income neighbourhoods increased park visits by children, teens and adults⁸. However, there was also an increase in the number of teens visiting a control park⁸; it is possible that with children and adults spending more time at the renovated areas, some teens migrated to a newly vacant space. Physical activity was identified to have increased for both males and females in the renovated parks⁸.

Another intervention highlighted the need for programming to accompany renovations to community recreation facilities⁵. While renovations increased use of a skate park by youth living near the facility, the renovation was accompanied with an increase in staffing and hours of operation at the site⁵. Conversely, use of the renovated seniors' centre decreased. However, programming for seniors was reduced and the fees for usage increased after the renovation⁵. Despite concerns regarding methodology, this study highlights the need for policies and programs that encourage and facilitate participation.

Self-report data suggests that physical activity increases with the development of walking and cycling trails ⁷. One evaluation of a new bridge for vehicle, cycle and pedestrian traffic indicated that bridge users self-reported increased physical activity ⁷. However, this evaluation only surveyed individuals using the new bridge; therefore, it is unknown whether physical activity increased at a population level with the development of the bridge.

With recognition that new or improved trails can significantly increase physical activity, a

qualitative case study explored policies that contributed to the successful development of six new trails ⁶. Interviews with key program contracts identified that all six projects required local and state policy support ⁶. State policies allowed land acquisition in two projects. Four of six projects used federal policies to obtain funding through the Transportation Enhancement Program ⁶. In addition, federal design standards influenced all six projects by mandating design requirements, including accessibility for disabled populations ⁶.

Table 14: McCarthy, G ⁷

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	High	Very Promising
Description	A 2.71 mile (12 foot wide) bridge was built to connect Charleston to Mount Pleasant over the Cooper River in South Carolina for vehicle, cyclist, and pedestrian traffic. The new bridge replaced two bridges, which did not offer pedestrian and cyclist access.		
Key Findings	66.7% of path users self reported that their physical activity levels increased since the path had opened.		

Table 15: Eyler et al. ⁶

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	High	Very Promising
Description	Trails were developed in six locations: North Carolina, South Carolina, Missouri, Massachusetts, Seattle and Hawaii. Interviews with individuals involved with the development of the trails were conducted to better understand the role of policy in built environment projects.		
Key Findings	Municipal, state and federal policies were all considered significant central feature in interviews. Federal policies were considered important for funding and trail design. State policies allowed two projects to obtain land for trail development. Local policies were considered the most substantial contributor.		

Take Home Message: Community Recreation

The availability of recreation facilities, including parks and trails, increases physical activity. Parks with multiple components, maintained condition, increased social environments and positive aesthetics as well as those that were safe, accessible or renovated were more likely to be visited.



5.3.2 Playgrounds

Some community recreation opportunities are designed specifically for children and youth. Several programs have focused on increasing children's use of school recreation facilities. Increased utilization of renovated schoolyards by both adults and children was identified in two very promising programs^{9, 10}.

Concern regarding UVR exposure led to the installation of shade sails in Australian school grounds with limited shade availability¹¹. After installation, it was identified that significantly more students used shaded areas than unshaded counterparts, suggesting that shade structures are used and may be protective against UVR exposure among students¹¹.

School greening involves the redesign of school grounds to include natural elements, such as trees, shrubs, ponds or rock amphitheaters^{13, 14}. Two articles reported on a mixed methods survey of parents, teachers, and administrators in Canadian schools participating in greening projects^{13, 14}. School greening increased physical activity levels and diversity of play in children^{13, 14}. While the qualitative survey component ranked high for scientific rigour, the quantitative component was ranked low for scientific rigour^{13, 14}. Based on the qualitative review, school greening programs were ranked as most promising; however, additional evaluation with direct outcome measures would substantiate current findings.

Table 16: Brink et al.⁹

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	High	Mid	Very Promising
Description	The <i>Learning Landscapes Program</i> renovated elementary school playgrounds that were in disrepair based on the needs and desires of the local community. They aimed to create participatory play areas that encouraged outdoor play, learning, and physical activity.		
Key Findings	Renovated school playgrounds were more heavily utilized than unrenovated counterparts as evidenced by higher mean student sightings during observation periods (2.23 student sightings compared to 1.74 during the observation period; $p < 0.001$). Children playing in renovated grounds had higher rates of energy expenditure in comparison to unrenovated counterparts ($p < 0.002$).		

Table 17: Colabianchi et al.¹⁰

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	High	Mid	Very Promising
Description	The <i>School Grounds as Community Parks</i> project provided renovations to school grounds including new playground equipment, an outdoor learning garden, as well as safety and site improvements. Renovated school grounds were compared to matched, control school grounds for rates of utilization.		
Key Findings	The mean number of adults (0.37 compared to 0.21; $p = 0.01$) and children (1.98 compared to 1.41; $p = 0.04$) using renovated playgrounds was higher than unrenovated counterparts. No significant differences were identified in the mean number of individuals engaging in moderate or vigorous physical activity between renovated or control playgrounds ($p = 0.05$).		

Table 18: Dobbinson et al. ¹¹

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	High	Very Promising
Description	In 2005, purpose built shade sails were installed on Australian school grounds with limited shade availability.		
Key Findings	An average of 2.67 additional students used shaded areas in comparison to unshaded comparison sites from pre to post test differences (p=0.011).		

Table 19: Dymont, J.E. & Bell, A.C. ¹³ & Bell, A.C. & Dymont, J.E. ¹⁴

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	High	High	Most Promising
Description	Through the <i>Learning Grounds</i> program, school grounds are redesigned to include natural elements, such as trees, shrubs, ponds or rock amphitheaters in combination with more typical turf, asphalt and play structures.		
Key Findings	A majority of respondents reported that school greening promoted more active play (82% of respondents), better integration of physical activity into school routine (77% of respondents) and more diverse play activities (85% of respondents).		

Table 20: Dymont, J.E. ¹²

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	Mid	Very Promising
Description	Through the <i>Learning Grounds</i> program, school grounds are redesigned to include natural elements, such as trees, shrubs, ponds, or rock amphitheaters in combination with more typical turf, asphalt, and play structures.		
Key Findings	Respondents indicate an increase in students': engagement in learning (90% of respondents), ability to retain knowledge (72% of respondents), and ability to think more creatively (77% of respondents). However, only 39% of respondents felt this was reflected in performance measures, such as mastery of curriculum or standardized testing. Many respondents (73%) indicated an increase in prosocial behaviour. Respondents indicated increases in collaborative play and diversity of play by 73% and 76% respectively.		

A second project surveyed teachers, students and administrators from Toronto schools participating in school greening ¹². Student learning, prosocial behaviour, and play increased in comparison to pre-intervention levels ¹². The quantitative survey components were ranked low for scientific rigour, however,

qualitative components were ranked as mid scientific rigour. With a mid scientific rigour score, the project was considered to be very promising. Additional research, which included indicator outcomes, would further the evidence available on school greening.

Take Home Message: Playgrounds

Opportunities to increase use of school grounds include school ground greening, renovation and provision of shaded areas.



5.3.3 Gardens

Fruit and vegetable consumption has been associated with reduced risk for cardiovascular disease^{83, 84}, cancer^{85, 86}, and ischemic stroke⁸⁷. Two intervention articles were identified that considered the effect of school or community gardens on fruit and vegetable consumption^{15, 16}. Both programs were ranked as promising and demonstrate that participation in gardening programs increases fruit and vegetable consumption^{15, 16}.

The first program surveyed adults to compare fruit and vegetable consumption between those with household participation in a community garden and those without participation¹⁵. Household level participation in community

gardening was identified as a promising practice to increase fruit and vegetable consumption¹⁵.

The second program provided elementary school children with a school gardening experience along with classroom education on nutrition and food¹⁶. Control groups were provided with standard health education or with the enhanced classroom education¹⁶. In comparison to standard health education or enhanced classroom education, students with a gardening experience demonstrated statistically significant increases in: food knowledge, produce taste preference, and selection of produce¹⁶.

Table 21: Alaimo et al.¹⁵

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	Mid	Promising
Description	Community gardeners were surveyed by telephone to assess levels of fruit and vegetable consumption in comparison to adults not participating in community garden projects.		
Key Findings	Adults with a household member participating in a community garden program were 1.4 times more likely to consume fruits and vegetables daily and 3.5 times more likely to consume at least five servings per day. Further, 32.4% of participant households reported meeting the five daily servings guideline in comparison with only 17.8% of non-participant households (p<0.05).		

Table 22: Parmer et al.¹⁶

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	Mid	Promising
Description	A school gardening experience in conjunction with classroom nutrition education was provided to elementary school students. Control groups received either education alone or standard practice (no education or gardening experience).		
Key Findings	Among children participating in a school gardening program, knowledge of food groups (p<0.001), taste for fruits and vegetables (p<0.005) and selection of fruits and vegetables in school lunches (p<0.01) increased. Of note, children participating in the education program only, also demonstrated increased knowledge of food groups and taste preference, although this increase was less than that of the children who also had the gardening experience.		

Take Home Message: Gardens

Gardening programs are a promising strategy to increase fruit and vegetable consumption in adults and children.

5.3.4 Food Retail Access

Given the previously articulated link between fruit and vegetable consumption with morbidity and mortality^{83, 84, 85, 86, 87}, several studies have focused on examining population access to healthy food options. One moderately ranked systematic review found that supermarkets provide the highest availability to healthy food choices in comparison to smaller stores or convenience stores²⁰. Indeed, supermarkets were found to have the widest selection of fresh fruits and vegetables at the lowest costs²⁰. Of note, authors completed a narrative synthesis of findings; as such, the consistency between studies' findings and the strength or

statistical significance associations was not reported²⁰

Despite this evidence to suggest that availability of supermarkets could increase healthy food consumption, a natural experiment did not find an increase in fruit or vegetable consumption with the introduction of a large food retailer²². Of note, use of the supermarket was inconsistent between community members²². Among the intervention group, there was a decline in the prevalence of self-reported poor psychological health, suggesting that there may be some health value in access to larger scale food retailers²².

Table 23: Larson et al.²⁰

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	F	F	F		Moderate
Key Finding(s)	Access to supermarkets, rather than convenience stores, was linked to healthier diets. Supermarkets were found to have greater availability of fresh foods at lower costs than convenience stores. There was some evidence to suggest that limited access to fast food restaurants also contributed to healthful diets. The strength or statistical significance of findings was not reported. Further, the number of studies with comparable findings was not consistently reported.				

Legend: Y= Yes, F= With Flaws

Table 24: Cummins et al.²²

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	Mid	Promising
Description	A large scale food retailer was introduced in a deprived, low-income Scottish community in Glasgow, U.K.		
Key Finding(s)	Statistically significant increases in fruit and vegetable consumption were identified in the control group (increase of 0.44 portions/day; p=0.003); however, a comparable increase was not identified in the intervention group (increase of 0.29 portions/day; p=0.07), suggesting that the intervention had no effect on overall fruit and vegetable consumption. There was a 12.13% decrease in the prevalence of self-reported poor psychological health among individuals in the intervention group (p=0.017) that was not observed in control comparisons (change= -.84%; p=0.85). Of note, unadjusted, adjusted and quadratic term regression models failed to yield statistically significant improvements (p values > 0.05).		



This program ranked as promising with moderate levels of effectiveness and population impact as well as some potentially positive health benefits; however, additional evaluation is needed to better understand the impact of increased access to healthful foods.

One systematic review, conducted in the United States, found limited access to healthy foods in low-income, ethnically distinct or rural locations; associations between access to and consumption of healthy foods; and associations between access to healthy foods and reduced diet-related disease (obesity, overweight, diabetes, or cardiovascular disease) ²¹.

In another systematic review, fast food outlet density was associated with neighbourhood deprivation (decreased socioeconomic status), offering additional evidence to suggest inequitable access to healthy food choices ¹⁹. Associations between fast food density and weight were inconsistent ¹⁹. Indeed, only studies with self-reported weight measures identified statistically significant associations between weight and fast food density ¹⁹. Of note, authors did not report the magnitude of statistically significant associations.

Table 25: Treuhaft, S. & Karpyn, A ²¹

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
		F	F		Low
Key Finding(s)	A majority, 113 of 132, identified articles addressed equitable access to food. 97 (86%) of these identified inequitable access, while 14 (12%) showed mixed results and 2 (2%) found equitable access. 14 studies investigated relationships between access to and consumption of healthy foods; of these 13 (93%) identified a correlation between greater access and healthier eating. Of 17 studies examining access to healthy foods and diet-related illness, 15 (88%) identifying either positive or mixed associations. Indeed, access to supermarkets was found to be associated with lower BMI and reduced rates of obesity, diabetes or diet related death in 5 adult studies and 2 adolescent studies. The level of statistical significance and magnitude of effect was not consistently reported for the included studies.				

Legend: Y= Yes, F= With Flaws

Table 26: Fraser et al. ¹⁹

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
		F	F		Low
Key Finding(s)	In total, 12 of 14 included studies identified significant associations between socioeconomic status and availability of fast food outlets. Of 12 studies looking at self-reported or measured weight status, only 6 identified significant associations with fast food outlet availability. Magnitude and significance levels of results within the included studies was not reported.				

Legend: Y= Yes, F= With Flaws

Table 27: Brug et al.¹⁷

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
					Low
Key Finding(s)	Healthful eating may be influenced by social perceptions of acceptable, appropriate and desirable eating habits. Authors' do not report on the number of identified articles, consistency of findings between identified articles, magnitude of effects or statistical significance of findings. Of note, many included studies are the authors' own publications.				

Legend: Y= Yes, F= With Flaws

Table 28: Cunradi, C.B.¹⁸

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
		F	F		Low
Key Finding(s)	Through a review of both theoretical and empirical evidence, authors identified that couples living in socially disorganized neighbourhoods are at increased risk for intimate partner violence. Increased density of alcohol outlets may be linked with male to female intimate violence. Of note, original data from included studies was inconsistently reported. Further, the number of included studies, their results and levels of statistical significance were not reported.				

Legend: Y= Yes, F= With Flaws

Despite evidence suggesting inequitable access to healthful foods may influence food choice, another systematic review investigated whether social norms may have a greater impact on food choice in comparison to environmental factors¹⁷.

While a majority of research focused on access to healthy foods, one systematic review examined the geographic availability of alcohol outlets and their association with intimate partner violence. Socially disorganized neighbourhoods and increased density of

alcohol outlets were identified to increase the potential for partner violence¹⁸. Due to limitations in the described methodology, the review was ranked as having low scientific rigour, and therefore additional research may be required to better understand how the built environment may contribute to partner violence. The number of identified theoretical and empirical studies, levels of statistical significance, consistency of findings between studies, and magnitude of effects were not reported, reducing the usability of findings.

Take Home Message: Food Retail Access

There may be inequitable access to healthy food options, including reduced access to supermarkets and increased density of fast food outlets. Additional research is needed to investigate whether access to healthy food options is predictive of fruit and vegetable consumption, diet related disease, or weight status.



5.3.5 Housing

Chronic disease has been associated with poor housing conditions including dampness, disrepair and poor ventilation^{25, 88}. A systematic review of neighbourhood level housing interventions identified opportunities for additional field evaluation or formative research^{23, 24}. Of relevance to the built environment, relocation to low poverty neighbourhoods and demolition of distressed public housing were identified as requiring additional field evaluation^{23, 24}. Formative research is needed to further investigate the effect of universal

housing, crime prevention through environmental design (CPTED), smart growth, residential proximity to traffic, zoning, density bonuses and neighbourhood greening²³. No housing interventions that relate to the built environment had sufficient evidence for implementation.

Two projects considered the impact of housing improvements on respiratory health^{25, 26}. Both projects identified improvements in respiratory health as a result of interventions to either the interior or exterior of the housing unit^{25, 26}.

Table 29: Lindberg et al.²³ & Jacobs et al.²⁴

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
		Y	F	Y	Moderate
Key Finding(s)	Two interventions, relocation to low poverty neighbourhoods and demolition of distressed public housing, required additional field evaluation. Authors cite publications evaluating two programs in the United States (<i>Moving to Opportunity</i> and <i>Yonkers Scattered-Site Public Housing Program</i>) where individual participating in housing mobility programs identified improved health outcomes, including reduced obesity as well as increased perceived safety and mental health. Authors also cite inconsistent findings relating housing mobility to youth educational outcomes. Of note, publication results, magnitudes and levels of significance were not consistently reported.				

Legend: Y= Yes, F= With Flaws

Table 30: Barton et al.²⁵

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	Mid	Promising
Description	Housing upgrades were conducted in Devon County (United Kingdom) to assess the effect on general or disease-specific health of residents in the first year following intervention. Upgrades included re-roofing, full central heating, rewiring, ventilation systems, double glazed doors, cavity wall and roof insulation.		
Key Findings	Non asthma related chest problems (p=0.005) and combined asthma symptoms scores (p=0.007) were significantly lower among improved housing residents. No statistically significant differences were observed in self-reported rates of asthma, rheumatism, angina or bronchitis between residents of upgraded and control housing (p=0.05).		

Table 31: Johnson et al.²⁶

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Low	Mid	Less Promising
Description	Targeted interventions were provided to reduce most common indoor allergens to reduce asthma symptoms among asthmatic children (2-17 years of age). Interventions were household specific and determined based on a home assessment of the indoor environment.		
Key Findings	Compared to pre-intervention levels, coughing ($p<0.005$), breathing problems ($p<0.05$) and allergy attacks ($p<0.01$) were reduced in children.		

Take Home Message: Housing

Additional formative research and field evaluation is needed to determine the effectiveness of housing interventions; however, early evidence exists to suggest that housing improvements may improve respiratory health.

5.3.6 Crime Prevention

Crime prevention through environmental design (CPTED) is a construct that suggests that with effective design and consideration of social factors can reduce the incidence and fear of crime as well as increase quality of life²⁷. One literature review summarized some existing evaluations of CPTED. As the review did not include all CPTED evaluations, the results may be biased towards the included evidence²⁷. This literature review ranked as having low scientific rigour due to a lack of information regarding the methods used.

Another literature review considered the impact of neighbourhood characteristics, including those pertaining to built environments, on physical activity. Of relevance to the built environment, studies considered street lighting and infrastructure to improve surveillance with inconsistent results²⁸. This review does not provide conclusive evidence to

indicate that street lighting or surveillance will promote walking.

Despite a need for methodologically sound synthesis of CPTED research, one evaluation of a SmartGrowth project ranked as very promising. Due to elevated crime rates in the San Romanoway apartment complex, home to more than 4000 Toronto residents, SafeGrowth modifications to the complex were completed²⁸. In the San Romanoway complex, changes included refurbishment of foyers, removal of entrapment areas, development of community gardens and a playground, improvement of lighting, as well as creation of active gathering spaces²⁸. Resident surveys conducted every two years, as well as focus groups, were conducted and suggest improvements in actual and perceived rates of crime and safety.

**Table 32:** Cozens et al. ²⁷

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
					Low
Key Finding(s)	Authors do not report number of included articles, consistency of findings between articles, or the magnitude and statistical significance of findings; therefore it was not possible to report on empirical findings. Based on the authors' text, 16 articles with empirical data are cited to provide support for comprehensive CPTED strategies. Given the authors' explicit purpose of providing supportive evidence, findings cannot be meaningfully applied without subsequent research.				

Legend: Y= Yes, F= With Flaws

Table 33: Foster, S. & Gilles-Corti, B. ²⁸

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	F	F			Low
Key Finding(s)	Two studies considered the impact of street features that would increase surveillance and promote walking in neighbourhoods with mixed results. An additional 21 articles considered the impact of street lighting on the prevalence of walking. Of these studies, only one study found a statistically significant (p-value not reported) association between street lighting and physical activity. This significance was not retained in a regression model adjusted against other environmental factors (factors not reported). Two other studies also found significance when considered lighting combined with overall neighbourhood safety; however, they were unable to determine the how much physical activity was attributable to street lighting (p-values not reported).				

Legend: Y= Yes, F= With Flaws

Another project examined the perceived and measured safety of pedestrian access ways (PAWs) in order to develop tools that would support local governments in managing PAWs ^{29, 28}. PAWs, part of the Western Australian infrastructure, were developed to increase connectivity for active commuters ²⁹. However, many PAWs are narrow and lack necessary surveillance; as such, the local government is moving towards closing PAWs ²⁹. This project identified that despite perceived associations with crime, very few PAWs were subject to high levels of crime or antisocial behaviour ²⁹. Although this article was ranked low for scientific rigour due to limited information

regarding the methods used, the findings may suggest a need for additional investigation into crime associated with PAWs.

The identified evidence highlights a need for methodologically sound synthesis of research and evaluation of CPTED to better understand its effect. Of note, much of the discussed research is conducted by advocates of CPTED, which further emphasizes the need for rigorous methods to reduce potential for biased findings. Methodologically sound systematic reviews are needed to synthesize existing evidence and identify meaningful opportunities for future research regarding CPTED.

Table 34: Cozens, P. & Love, T ²⁹

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Low	Mid	Less Promising
Description	The project was designed to inform local governments with practical guidance and data regarding PAWs.		
Key Findings	Authors' suggest that few PAWs are subject to high levels of crime, despite fears of crime. Detailed quantitative and statistical findings were not provided.		

Table 35: Saville, G ³⁰ & Rigakos et al. ³¹

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	High	Very Promising
Description	In response to elevated crime rates in the San Ramanoway apartment complex, several modifications to the complex were completed. Improvements included refurbished foyers, removal of entrapment areas, and increased lighting.		
Key Findings	A 21.1% reduction in break and enter crimes was reported ($p < 0.001$) as well as perceived improvements in vandalism, substance use in public places, teen loitering, youth gangs, graffiti, littering, noise, drug dealing, armed robbery, burglary, violent or sexual assault, family violence, theft and drug availability ($p < 0.001$).		

Take Home Message: Crime Prevention

Preliminary projects indicate that comprehensive implementation of SafeGrowth principles coupled with rigorous research and evaluation is needed to identify if there is an impact on the incidence of crime.

5.3.7 Mental Health

Any environment and the built environment in particular, may affect psychological wellbeing ³²⁻³⁵. One highly ranked systematic review considered the relationship between neighbourhood characteristics and mental health ³⁵. Of 29 identified studies, four pertained to the built environment and identified statistically significant associations with mental health, after adjusting for individual factors ³⁵. Higher levels of depression were identified in individuals living in dwellings

with high disadvantage scores ³⁵. In addition, urbanicity, as defined by population density, increased the risk for psychosis ³⁵.

Another systematic review examined environmental stressors, such as neighbourhood disorganization or deprivation, as triggers of depression or depressive symptoms ³³. Four of the included studies addressed associations between the built environment and depression; all four identified statistically significant associations ³³.

**Table 36: Truong, K.D. 35**

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	F	Y	Y	High
Key Finding(s)	Four articles were included that detailed three studies. All four articles identified statistically significant associations between depression or psychotic disorder and aspects of the built environment. Magnitude of these effects as well as their level of statistical significance was only reported for one of the four studies. This study identified that individuals living in higher levels (5 point scale, cut off not reported) or urbanicity were 1.57 times more likely to experience psychotic disorders (OR=1.57, CI=1.30-1.89, p-value not reported).				

Legend: Y= Yes, F= With Flaws

Table 37: Mair et al. 33

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
		Y	Y		Moderate
Key Finding(s)	Four studies related to the built environment and identified statistically significant associations. Among adult males, walkability was protective against depression (p=0.02), while adults living in poor quality built environments were 29-58% more likely to report recent depression and 36-64% more likely to report lifetime depression. Further, perception of neighbourhood was also found to be predictive of adolescent depression (p<0.001). After adjusting for individual socioeconomic status and internal characteristics of dwellings, deck access (OR=1.28; CI= 1.03-1.58) and recent construction (OR= 1.43; CI=1.06-1.91) were associated with depression. Overall, walkability, neighbourhood design and neighbourhood perception were identified predictors of depression; however, each aspect of the built environment was only considered in a single study, reducing the strength of the evidence presented.				

Legend: Y= Yes, F= With Flaws

Table 38: Abraham et al. 32

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	F	F		Moderate
Key Finding(s)	Investigators identified 21 studies that informed their results. It was not reported how many of these studies identified statistically significant associations. Landscape was suggested to facilitate: attention restoration, recovery from mental fatigue, recovery from stress and positive emotion. Original data or findings from included studies, levels of statistical significance or magnitudes of effect were not reported.				

Legend: Y= Yes, F= With Flaws

Using a qualitative approach, one systematic review explored landscapes as facilitators for health promoting activities³². Authors suggest that natural landscapes are more restorative than urban landscapes, citing preference for mountains or beaches to recuperate from mental fatigue³². These investigators indicate

that urban designs are critical for promoting physical activity, through development of walkable spaces and social wellbeing, as well as the development of communities that allow social integration³². Results from the systematic review were used to inform a communicative, consensus process with content experts.

Another moderately ranked systematic review identified seven articles that found a relationship between the built environment, social capital and mental wellbeing³⁴. Walkable

neighbourhoods and those with mixed land use increased social capital, which in turn increased mental health³⁴.

Table 39: Renalds et al.³⁴

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	F	F	Y		Moderate
Key Finding(s)	Of 23 identified studies, four investigated relationships between features of the built environment and social capital or mental health. Three articulated statistically significant associations (p-values not reported) between measures of walkability (mixed land use, traditional street design) and increased social cohesion. The fourth article identified statistically significant associations between trust or mental health and social cohesion (p-values not reported), but did not find statistically significant associations to measures of the built environment. Investigators did not report on the magnitude of effect or statistical significant of included studies.				

Legend: Y= Yes, F= With Flaws

Take Home Message: Mental Health

Evidence suggests a relationship between urbanicity and depressive symptoms.

5.3.8 Rural Land Use

Physical activity has been identified as protective against chronic disease and associated morbidity or mortality⁸². As rural populations may have unique needs and opportunities in comparison to urban counterparts, some research has focused specifically on rural settings. One literature review found that among adults in rural settings, physical activity was associated with pleasant aesthetics, presence of trails and availability of parks⁸². This review was ranked as having moderate scientific rigour as the search and selection strategies contained opportunities for bias. Further, as the review did not appraise the methodology of the included studies, it was not possible to determine the quality of available evidence.

Among children, physical activity levels are comparable between rural and urban settings³⁶. Indeed, of eighteen identified studies, only six found statistically significant differences in

physical activity between urban and rural children³⁶. The remaining twelve studies did not find differences in physical activity based on level of urbanicity. This review was ranked as having moderate scientific rigour due to concerns regarding the search strategy and lack of quality assessment of the included studies. Despite, finding that physical activity levels are comparable, authors noted that children are not getting enough exercise overall, suggesting a need to continue working with parents and communities to foster healthy environments that promote fitness³⁶.

The needs of rural communities in increasing physical activity seem comparable to the needs of urban dwellers. It is possible that while the needs are the same, the challenges in meeting and implementing these needs are varied and dependent on the local environment and terrain.

**Table 40:** Frost et al.⁸²

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	F	F		Moderate
Key Finding(s)	In rural settings, adult physical activity was associated with pleasant aesthetics (significant association in four of four studies), trails (significant association in four of six studies), and parks (significant association in three of six studies). Levels of statistical significance of results from the included studies were not consistently reported.				

Legend: Y= Yes, F= With Flaws

Table 41: Sandercock et al.³⁶

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	F	Y		Moderate
Key Finding(s)	Of 18 identified studies, 12 did not find statistically significant differences between the level of physical activity in rural, urban, or suburban locations (no p-values reported). Of the remaining 6 studies, 2 identified increased physical activity in rural settings, 2 identified increased physical activity in suburban settings and 1 identified reduced physical activity in rural settings. The final article indicated that children in 'towns' are more active than those in either urban or rural locations. The magnitude of differences and levels of statistical significance were not reported.				

Legend: Y= Yes, F= With Flaws

Take Home Message: Rural Land Use

Among adults, physical activity in rural settings was associated with the presence of trails, parks and pleasant aesthetics.

5.4 Transportation

A total of 22 systematic reviews and five intervention articles were identified in relation to transportation. These articles related to driving environments^{37, 38}, elder driving³⁹, vehicle crash prevention⁴⁰⁻⁴⁵, residential proximity to traffic^{46-48, 89}, active school transportation^{51-56, 90, 91}, active transportation in adults⁵⁷⁻⁶⁰, and cycling⁶¹⁻⁶³.

5.4.1 Driving Environments

Street lighting may improve a driver's ability to identify hazards and avoid them³⁷. Further, reduced contrast between the surrounding environment and headlights has been shown to enhance visual certainty³⁷. Others suggest that

with increased street lighting, drivers become relaxed and less focused, increasing the likelihood of a crash⁹². A systematic review designed to assess the impact of new or improved lighting on road traffic crashes was conducted in 2010³⁷. Across driving conditions, there were reported reductions in road traffic crashes, injuries, and fatalities³⁷. Total crashes were reduced by 55% (RR=0.45, 95% CI: 0.57-1.21) and total injury crashes were reduced by 22% (RR=0.78, 95% CI: 0.63-0.97) with the installation or improvement of street lighting³⁷. This systematic review ranked high in methodological rigour and provides strong evidence that increased street lighting may improve road safety in Alberta.

Porous asphalt is composed of approximately 20-25% air filled pores, creating an open structure in comparison to typically used dense asphalt concrete³⁸. This open structure reduces traffic noise and thermal conductivity; in addition, it drains road surface water more readily³⁸. A systematic review, conducted in 2005, identified six studies containing 18 estimates for the effect of porous asphalt on road safety under varying road conditions. Six estimates considered dry road surfaces, six estimates considered wet roads, and the remaining six did not specify the road conditions³⁸. Summary estimates within road conditions or across all road conditions were statistically insignificant³⁸.

The systematic review ranked high for methodologic rigour, however, authors noted that included studies contained scientific weaknesses³⁸ and suggested additional research in the topic area was needed considering mechanisms by which crashes may be reduced and improved measurement³⁸. Based on this systematic review, there is insufficient evidence to suggest that porous asphalt reduced road traffic crashes. However, given the other noted benefits, including improved road surface water drainage and noise reduction, there may be an opportunity to consider a strong evaluation of porous asphalt as a means to encourage active transport.

Table 42: Beyer et al.³⁷

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	Y	Y	Y	High
Key Finding(s)	Within the review, three studies considered new street light in comparison to unlit control roads and a summary effect indicated a 55% reduction in total crashes and a 22% reduction in injury crashes. Even when new street lighting was implemented during the day, a 17% reduction in total crashes was identified (pooled RR=0.83, 95% CI: 0.57-1.21) compared to unlit daytime roads ³⁷ . Improved street lighted in comparison to pre-existing light levels also indicated a 28% reduction in crashes (pooled RR=0.72, 95% CI: 0.50-1.02).				

Legend: Y= Yes, F= With Flaws

Table 43: Elvik et al.³⁸

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	Y	Y	Y	High
Key Finding(s)	Summary estimates that accounted for road surface conditions were statistically insignificant, demonstrating no relationship between road crashes and porous asphalt. A total summary estimate, across road surface conditions, showed a slight trend towards crash reduction, but was statistically insignificant (p=0.05). The findings were inconclusive.				

Legend: Y= Yes, F= With Flaws

Take Home Message: Driving Environment

Street lighting is effective at reducing road traffic crashes, injury crashes and fatality crashes.



5.4.2 Elder Driving

The driving environment can create unique challenges for the elderly population. Indeed, elderly drivers are at an increased risk for traffic collisions⁹³). Heightened risk has been attributed to age-related shifts in vision, cognition, mobility and medical health status as well as the driving environment³⁹. One highly ranked systematic review considered modifications to the driving environment that could improve road safety among older drivers^{39, 94}. Although the systematic review ranked high for scientific rigour, the author’s findings reflected the recommendations proposed in the *Highway Design Handbook for Older Drivers and*

Pedestrians^{39, 95}; a report, published in 2001, that was not retrieved from their search strategy nor was it evidence based. To avoid being biased away from the evidence-driven results, findings or conclusions based solely on the *Highway Design Handbook for Older Drivers and Pedestrians* report were disregarded. Six of eight included studies identified that larger text sizes, bright background colour, and potentially Clearview fonts increase sign visibility for older drivers³⁹. One study identified that larger lane divisions increase their detection in some weather conditions³⁹.

Table 44: Bohr³⁹

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	Y	F	Y	High
Key Finding(s)	Eight articles were included; however, one did not examine elderly driving. Six articles considered interventions to increase the visibility of signs for older adults. Larger text on road signage increased older drivers’ ability to detect and decipher messages. The use of <i>Clearview</i> fonts for road signage required further research in realistic road conditions; however, there is some early evidence to suggest that the <i>Clearview</i> font does increase visibility of posted signs. The seventh study identified that larger (six inch in comparison to four inch) and well-maintained lane divisions improved detection. In some weather and road conditions, poorly maintained lane divisions were less easily detected. Levels of statistical significance were not reported.				

Legend: Y= Yes, F= With Flaws

Take Home Message: Elder Driving

To increase the visibility of signs to older drivers, font, text colour and background colour are important considerations.

5.4.3 Crash Prevention Interventions

Traffic speed is an important factor in the frequency and severity of traffic collisions and associated morbidity and mortality^{96, 40}. Indeed, vehicular speed is predictive of crash incidence and severity⁹⁶. Given this, several interventions, including red light cameras and area-wide traffic calming measures, have been suggested to

reduce traffic speed and increase adherence to traffic regulations. Measures to reduce traffic speed and reduce collision rates at intersections are considered essential in reducing morbidity and mortality association with traffic crashes^{41, 44, 45}. One systematic review was identified that determined crash rates increase with speed,

especially on minor roads. With limited reporting on methodology, the systematic review ranked low for scientific rigour; however, the findings correspond with existing literature that emphasizes the importance of traffic speed^{40, 43, 44, 96}.

Red-light cameras and speed cameras are widely used as measures to reduce traffic collisions^{41, 44}. Three systematic reviews

addressed the use of speed cameras^{44, 45} or red-light cameras⁴¹ to reduce traffic collisions and associated injuries or fatalities. All three reviews ranked high in their scientific rigour and found significant reductions in collisions in the area of the camera^{41, 44, 45}, though the magnitude of this effect was variable. Overall, these studies provide evidence that the use of a speed or red-light camera will reduce crash rates and associated injuries.

Table 45: Aarts, L. & van Schagen, I.⁴⁰

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
					Low
Key Finding(s)	Eight studies were identified that developed mathematical formulas to describe the relationship between individual vehicle speed or average road speed and accident rates. These formulas suggest that crash rates increased with accelerated speed. This effect was more pronounced on minor roads compared to major roads.				

Legend: Y= Yes, F= With Flaws

Table 46: Wilson, C. et al.⁴⁵

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	Y	Y	Y	High
Key Finding(s)	14 observational studies were identified that considered the impact of speed cameras on vehicle collisions, injuries and deaths. Reductions in collisions (range: 5-69% reduction), road traffic injuries (range: 12-65% reduction) and deaths (range: 17-71% reduction) were identified at sites with speed cameras.				

Legend: Y= Yes, F= With Flaws

Table 47: Pilkinton, P. & Kinra, S.⁴⁴

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	Y	Y	Y	High
Key Finding(s)	A reduction in adverse outcomes in the area surrounding the speed camera was found in all studies. A 5-69% reduction in collisions, a 12-65% reduction in injuries and a 7-71% reduction in deaths was reported.				

Legend: Y= Yes, F= With Flaws

Table 48: Aeron-Thomas, A. & Hess, S.⁴¹

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
					Low
Key Finding(s)	Red light cameras were effective in reducing the incidence of total casualty crashes. Four studies investigated the impact of speed cameras on total casualty crashes (pooled rate ratio=0.87; 95% CI= 0.77-0.98). Data was less conclusive on the reduction of total crashes, specific casualty collision types and traffic violations.				

Legend: Y= Yes, F= With Flaws



Although traffic cameras are effective at reducing collisions, they may not be appropriate for all settings. Indeed, while cameras may be beneficial in high risk, localized intersections, when traffic collisions are scattered through a larger, often residential area, traffic cameras may not be an optimal strategy⁴³. Area-wide traffic calming measures are designed to discourage the use of residential streets for through traffic to increase the safety of residential roads⁴³. Measures include speed bumps, raised crosswalks, blocking of roads and reduced speed requirements⁴³. One highly ranked systematic review determined area-wide traffic calming measures to be effective at

reducing crashes and associated injuries and deaths⁴³. Traffic calming could be an effective strategy to protect Albertans in residential neighbourhoods.

One review considered policing programs, in addition to the use of cameras, to reduce traffic collisions causing injury⁴². Although this review was ranked low for scientific rigour due to insufficient information regarding the methodology used, it highlights the need for ongoing enforcement of traffic regulations in collaboration with environmental changes⁴². Indeed, man-powered police programs including photo-radar and check points were identified to increase road safety⁴².

Table 49: Bunn, F. et al.⁴³

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	Y	F	Y	High
Key Finding(s)	Traffic calming measures were found to be protective against deaths (pooled RR=0.79), crashes (pooled RR=0.89) and injuries (pooled RR=0.85). Further, traffic calming measures were protective against motor-pedestrian collisions (pooled RR=1.01). Authors noted that heterogeneity was significant within included studies, limiting their ability to accurately determine the magnitude of effect.				

Legend: Y= Yes, F= With Flaws

Table 50: Blais, E. & Dupont, B.⁴²

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	F		F		Low
Key Finding(s)	Police programs, including breath testing, checkpoints, cameras and photo-radar, tend to reduce crashes causing injuries. The magnitude of effect ranged between a 23-31% reduction in crashes causing injuries.				

Legend: Y= Yes, F= With Flaws

Take Home Message: Crash Prevention Interventions

Red-light cameras, speed cameras and area-wide traffic calming measures are all effective at reducing traffic collisions and associated injuries.

5.4.4 Proximity to Traffic

Accurately determining the effects of traffic exposure is challenging given the wide array of potential confounders, including social, physical, and environmental contributors to health, such as socioeconomic status (SES). Therefore, it is important to ensure that studies have statistically accounted and stratified for these factors that may bias findings. Of note, none of the systematic reviews identified appraised the quality or validity of the studies included in their review, which limited the ability to determine if confounding factors were adequately controlled.

One moderately ranked review identified that of 29 peer reviewed studies, 25 reported statistically significant associations between health outcomes and proximity to traffic⁴⁶. Traffic exposure was associated with poor respiratory symptoms, childhood cancers,

preterm birth, low birth weight and poor heart health⁴⁶. However, authors did not report on potential confounders, including SES, limiting the usability of findings.

Both air pollution as well as noise associated with traffic may influence the effects of traffic exposure on health^{47, 48}. Two reviews considered the health effects associated with air pollution⁴⁸ or traffic noise⁴⁷. While these studies establish an association, mediating factors including SES, temporality or ethnicity were inconsistently considered. Given that both reviews also ranked low for scientific rigour, the findings are to be interpreted with caution. Additional research that more specifically defines and measures confounding factors is needed. To this end, one review did consider approaches to measurement of traffic exposure more precisely⁴⁸.

Table 51: Boothe, V.L. & Shendell, D.G.⁴⁶

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	F	Y	F		Moderate
Key Finding(s)	<p>Respiratory Symptoms and Proximity to Traffic Seven of ten studies reported statistically significant associations in self-reported respiratory symptoms. Mixed findings in respiratory related doctor visits or hospitalizations were reported in five studies. Four of six studies reported statistically significant associations in asthma prevalence.</p> <p>Childhood Cancers and Proximity to Traffic Three of four studies reported statistically significant associations with acute non-lymphocytic leukemia or acute lymphocytic leukemia.</p> <p>Adverse Birth Outcomes and Proximity to Traffic Three included studies reported statistically significant associations with preterm birth or low birth weight. Mortality Risks and Proximity to Traffic Associations were reported between proximity to traffic and cardiopulmonary, stroke, and cardiovascular mortality in the Netherlands, the United Kingdom, and Canada.</p> <p><i>*Of note, causality cannot be implied based on the findings presented.</i></p>				

Legend: Y= Yes, F= With Flaws

**Table 52:** Lipfert, F.W. & Wyzga, R.E. ⁴⁸

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	F				Low
Key Finding(s)	Authors identified variation in defining traffic density and 'proximity' to traffic, ranging from 0.1 meters to 100 meters or greater. Only one measure of risk was provided and cited an increased risk of 1.41 for all cause mortality and 1.95 for cardiopulmonary mortality for those living near a major roadway, approximately 5% of their study sample (p-value, 95% CI, and sample size not reported). The number of identified studies, their original data or results, levels of significance and consistency of findings between studies was not reported.				

Legend: Y= Yes, F= With Flaws

Table 53: Clark, C. & Stansfeld, S.A. ⁴⁷

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y				Low
Key Finding(s)	Based on a narrative review approach, the authors identified some evidence to suggest an association between vehicular and air traffic noise and hypertension, cardiovascular disease or catecholamine secretion. There was evidence to suggest an association with psychological symptoms, but not psychiatric disorders. Annoyance and sleep disturbance as a result of noise were suggested as mechanisms by which noise may affect health. The number of identified studies, original study results, levels of significance and consistency of findings between studies was not reported.				

Legend: Y= Yes, F= With Flaws

While all three reviews identify significant associations, it is challenging to conclusively attribute these associations to traffic exposure. Inconsistency in the control of confounding factors, the determination of causality or the exploration of directionality limits the usability of findings. Indeed, while there is potential that traffic exposure influences health or mediates risk factors for chronic disease, the existing evidence is insufficient to allow for action oriented conclusions or recommendations.

Despite a lack of empirical evidence, communities have articulated that they experience adverse health outcomes as a result of exposure to traffic ⁴⁹. Indeed, one promising practice retrospectively assessed community perception of an interstate that was developed

in their neighbourhood, increasing the amount of heavy and industrial traffic exposure. Use of a participatory research approach in this study enabled the community to advocate for the use of electric hybrid buses to reduce pollution and address some of their health concerns based on the study findings ⁴⁹. A lack of information regarding the methodological approach resulted in the study being ranked low scientific rigour. However, strong community involvement and program characteristics along with positive process outcomes resulted in this study being ranked as promising. Indeed, the study suggests that it is possible to act upon community concerns about traffic and their health impacts, using participatory research as a tool.

Some communities may be concerned about adverse health effects of their proximity to heavy or industrial traffic. Participatory action research may support communities in advocating for changes that address or reduce their concerns. Existing evidence is unclear and

confounded, limiting the applicability of current findings associating adverse health impacts with residential proximity to traffic. Further research, controlling for confounding, is needed to better articulate the relationship between traffic and health.

Table 54: Wier, M. et al. ⁴⁹

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Low	High	Promising
Description	Interstate 280 (I-280) through southeast San Francisco was constructed in the 1960's and divided the Excelsior neighbourhood. This neighbourhood consists of predominantly low-income or immigrant communities.		
Key Findings	Community members perceived poor health outcomes associated with exposure to increased and industrial traffic. Objective measurement identified that 10% of local traffic was attributed to buses/ trucks and that traffic contributed to environmental hazards (increased noise and poor air quality).		

Take Home Message: Proximity to Traffic

Scientifically rigorous synthesis of existing evidence is needed to better understand the relationship between proximity to traffic and health or predictors of health.

5.4.5 Active School Transport

Adequate physical activity supports healthy development in children, reduces chronic disease, and may reduce obesity trends ^{97, 98, 50}. Active school transport (AST) may be one mechanism to increase physical activity among children as this is a habitual form of exercise. Two systematic reviews ^{53, 54} considered correlates of active school transport. The first was highly ranked and identified physical, economic and socio-cultural environmental predictors of AST ⁵⁴. Of particular relevance were the predictors pertaining to the physical environment. Predictors of active school transport included the distance to school and the presence of community recreational spaces, including parks, sporting venues or recreational facilities ⁵⁴.

The second review, also examined environmental and infrastructural correlates of AST ⁵³. Safety and short commute distances were predictors of AST ⁵³. A lack of detailed information of the review methods resulted in this review scoring low for scientific rigour.

Another two systematic reviews ^{51, 52} examined correlations between physical activity (PA) or body weight and AST. Although neither systematic review concluded AST and physical activity were positively correlated due to mixed study results; a majority of studies within each systematic review did identify positive associations between increased PA and AST ^{51, 52}. Both studies identified mixed findings in



terms of an association between AST and body weight.

Table 55: Pont, K. et al. ⁵⁴

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	Y	Y	Y	High
Key Finding(s)	12 assessments examining a relationship between distance to school and active transport were conducted in 8 studies. Of these 12 assessments, 9 identified statistically significant inverse relationships between distance and AST. 7 studies examined community recreational environments and AST; of these, 2 found positive associations between the presence of parks, sporting venues or recreational facilities and active transport and an additional 3 found mixed results. Magnitude of effects and levels of significance were not reported. The reviewed studies did not allow for meta-analytic techniques to determine the magnitude of association between predictors of active transport across studies.				

Legend: Y= Yes, F= With Flaws

Table 56: Lee, C. & Zhu Z. ⁵³

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	F				Low
Key Finding(s)	8 studies identified an inverse relationship between travel distance and AST. 9 studies identified that the built environment design (i.e. sidewalks, street patterns, and mixed land use) and related characteristics (i.e. safety, lighting, traffic volume and aesthetics) were associated with physical activity. Magnitude of effects and their levels of significance were not reported.				

Legend: Y= Yes, F= With Flaws

Table 57: Faulkner, G.E.J. et al. ⁵¹

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	Y	F		Moderate
Key Finding(s)	This study aimed to identify associations between active school transport (AST) and physical activity (PA) as well as AST and body weight. 13 studies considered AST and physical activity; of these, nine identified a positive correlation. An additional two studies identified that children actively commuting to school expended significantly more kilocalories daily. Ten studies considered AST and body weight; of these, only one reported that AST was associated with lower body weights. Levels of significance for the included studies' results were not consistently reported.				

Legend: Y= Yes, F= With Flaws

Table 58: Lee, M.C. et al. ⁵²

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
		F	F		Low
Key Finding(s)	Of the 32 studies included studies, 25 assessed the relationship between active school transport (AST) and physical activity (PA). Of these, 24 considered total physical activity levels; 12 identified positive correlations, four identified significant gender interactions and nine were statistically insignificant. Of the 18 studies considering AST and body weight, 9 found no statistically significant association while one found AST to be associated with higher body mass index (BMI). Five studies found significant associations for some sub-groups and three found consistent positive correlations between body weight and AST. Levels of significance for the included studies' results were not consistently reported.				

Legend: Y= Yes, F= With Flaws

Another systematic review examined potential influences on increased rates of obesity⁵⁰. Although this review lacked sufficient detail describing their approach to collecting information, the authors identified that a combination of factors relating to energy input and output likely contributed to the increased prevalence of obesity being observed in children⁵⁰. A reduced rate of active school transport was also considered a mediator of this relationship⁵⁰.

Building on the presented evidence describing predictors and potential benefits of AST, there have also been programs and initiatives that encourage children's active transport. The Walk to School (WTS) program in the United States demonstrated high community uptake⁵⁶. Indeed, the program was initially two states in 1997, but had participation across all 50 states by 2002⁵⁶. The Walk to School (WTS) program was recently evaluated by surveying program coordinators that had registered schools or districts to participate in the 2002 Walk to School Day event⁵⁶. Program coordinators provided information about their use of WTS services, participation in the 2002 event, and perceptions of AST in their district or school. Although the evaluation approach had potential for selection and information bias, there was

clear community leadership and the potential for population impact was high. Program coordinators reported that participation in the program, including the 2002 event, resulted in increased AST⁵⁶. Additional detailed evaluation, with direct measurement of active transport, would strengthen the evaluation and evidence related to WTS programming.

Interviews with representatives from nine schools with AST initiatives identified that policies, funding and surrounding environment influence the success of walk to school programs⁵⁵. This evaluation of AST programming collectively was identified as most promising and suggests that with consideration of protective factors for active transport, programming can be successful. Of note, both program evaluations used perceived or process outcomes to ascertain program effectiveness; future research should include direct outcome measurement^{55,56}.

The body of evidence suggests that AST is a viable mechanism to increase habitual physical activity in children, and where already in place, these programs have strong uptake. The body of evidence also highlights the need to consider environment, demographic, infrastructural and financial factors that influence the success of AST initiatives.

Table 59: Anderson, P.M. et al.⁵⁰

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
					Low
Key Finding(s)	This review considered factors that may have resulted in increased rates of obesity among children. No single factor was found to be wholly attributable for increased obesity, but rather many complimentary changes in terms of energy intake and expenditure in our current lifestyles are considered. Factors included diet, exercise and physical activity. The number of included studies, original results, magnitude of effects, levels of significance and consistency between study findings was not reported.				

Legend: Y= Yes, F= With Flaws

**Table 60:** Vaughn, A.E. et al. ⁵⁶

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Low	High	Promising
Description	The Walk to School program provides encouragement and support for AST, including national (USA) events, such as the Walk to School Day. Their goals include increased physical activity and improved pedestrian safety.		
Key Findings	34.9% of program coordinators perceived an increase in active commuting. Program coordinators reporting increased levels of AST also reported a greater number of groups involved (5.3 compared to 4.6; $p=0.018$) in the program and an increased number of activities offered (3.5 compared to 2.8; $p=0.0003$). A final regression model indicated schools with policy change ($OR=3.74$, $p<0.0001$), environmental changes ($OR=1.56$; $p=0.055$) and number of activities offered ($OR=1.19$, $p=0.006$) predicted AST.		

Table 61: Eyler et al. ⁵⁵

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	High	High	Most Promising
Description	The study included school representatives that had meaningful active school transport (AST) initiatives in place. While a variety of AST programming was accepted, AST involvement extended beyond a <i>Walk to School Day</i> event.		
Key Findings	Eight risk or protective factors for AST were identified: clean, connected sidewalks; use of cross guards and crosswalks surrounding schools to increase safety; school participation in <i>Walk to School Days</i> ; availability of taxpayer funding for AST programs; external advocacy involvement; parking lot functionality; conducive natural environments (e.g. weather, terrain); and perceptions of local safety. In addition, six policy actions that were perceived to have directly impacted program success were identified: reducing traffic speed surrounding schools; mediating the drop-off of students using different travel modes (bus, car, active transport); limiting bus service to students living outside walkable areas; considering active transport when determining a school's location; modifying school start/end times to facilitate AST; and considering factors that influence students/parents selection of a school to attend.		

Take Home Messages: AST

1. Some evidence to suggest a positive correlation between AST and PA.
2. Close presence of community recreation spaces, proximity to schools, supportive infrastructure and safety were the strongest predictors of AST.
3. Programming to facilitate AST has strong community uptake. The success of active AST programming may be influenced by the infrastructure, policies and environment surrounding schools. These factors should be considered and addressed in the development of AST programming.

5.4.6 Adult Active Transport

Active transport (AT, active travel) is one mechanism to increase routine physical activity, which has cardiovascular⁹⁹ and mental health benefits¹⁰⁰. Further, physical activity protects against osteoporosis^{101, 100}, obesity¹⁰², and associated illnesses. For this reason, interventions to increase active transport are of interest from a population health perspective. One systematic review examined factors that may increase active transport⁵⁹. Although this systematic review ranked low for scientific rigour, it identified that interventions may increase walking by up to 60 minutes weekly, however, no associated health improvements were identified⁵⁹.

A moderately ranked systematic review identified that infrastructural and environmental factors were correlated with increased active transport⁵⁸, suggesting that adults are more likely to commute actively if there is a supportive infrastructure, including walkable and connected streets to nearby destinations.

Organizational travel plans (OTPs) are typically institutionally initiated sets of interventions designed to encourage active travel⁵⁷. OTPs may include policies facilitating active travel,

provision or coordination of active transport options, as well as engineering, educational, enforcement, or promotional measures⁵⁷. Of particular interest was the engineering component of OTPs, including pedestrian crossings, cyclist lanes, or improved footpaths⁵⁷.

There was limited evidence to suggest that OTPs influence individuals' mode of transportation, unless adults were already preparing for or considering active transport⁵⁷. School travel plans provided some evidence of parent reported increases in active transport on the trip home from school, but results were mixed and inconclusive overall⁵⁷. Given that the review was ranked high for scientific rigour, there is currently insufficient evidence to suggest that OTPs increase active transport.

Increases in active transport may be coupled with increases in cyclist or pedestrian injury. One study considered environmental factors that may precipitate certain locations to be hotspots for pedestrian injury⁶⁰. Traffic calming measures and passive pedestrian countermeasures, such as signaled crosswalks, may protect against injuries in injury hotspots⁶⁰.

Table 62: Shephard, R.J.⁵⁹

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y				Low
Key Finding(s)	The number of included articles, original results, magnitude of effects and levels of significance were not reported. Further, authors' conclusions appear to be drawn from single articles (both intervention and review literature). One review article identified that interventions to encourage walking resulted in a 30-60 minute increase per week. A second cited review however did not find any health benefits associated with this level of increase.				

Legend: Y= Yes, F= With Flaws

**Table 63:** Panter, J.R. & Jones, A ⁵⁸

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	Y	F		Moderate
Key Finding(s)	Authors aimed to identify both psychological (14 studies) and environmental factors (36 studies) that determine active travel (seven studies considered both). Walkability (6 of 6 studies identified positive associations), street connectivity (4 of 5 studies identified positive associations), facility provision (15 of 16 studies identified positive associations), residential density (3 of 4 studies identified positive associations) and land use mix (2 of 2 studies identified positive associations) were correlated with increased active travel. The magnitude and statistical significance of associations was not provided.				

Legend: Y= Yes, F= With Flaws

Table 64: Hosking, J. et al. ⁵⁷

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	F	Y	Y	High
Key Finding(s)	Of the 17 included studies, 10 reported a shift towards less car use, five reported no significant effect, and two reported mixed results. One study of individuals preparing for or considering active transport measured self-reported health and identified improvements in mental health, vitality and general health. Two randomized cluster trials considered AST, with one showing no effect and the other identifying a 9.8 %, parent reported increase in walking for the trip home from school compared to control counterparts (95% CI for difference= 14.1-20.1). Included studies contained methodological weaknesses, necessitating more rigorous evidence to determine the impact of OTPs.				

Legend: Y= Yes, F= With Flaws

Table 65: Schuurman, N. et al. ⁶⁰

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Low	Low	Least Promising
Description	Pedestrian injury hotspots were mapped using insurance, GIS and surveillance data. Characteristics of geographic hotspots were considered to identify predictors of injury.		
Key Findings	The presence of demonstrated environmental risk factors at injury hotspots, lack of traffic calming measures and a lack of passive pedestrian safety countermeasures characterized injury hot spots. Hot spots were also more likely to be in the proximity of licensed bars.		

Take Home Messages: Adult Active Transport

Supportive infrastructures are correlated with increased active transport.

5.4.7 Cycling

Bicycling positively influences rates of physical activity, obesity, cardiovascular health and morbidity^{59, 91, 103-107}. For this reason, several studies have considered how to increase the proportion of individuals who cycle and how to ensure cyclist safety⁶¹⁻⁶³. One systematic review assessed opportunities to increase rates of cycling⁶¹. Infrastructural change, including bike lanes and end of trip facilities, increased cycling⁶¹.

Although increased cycling can have positive health impacts, there is also a potential for increased injury and associated morbidity and mortality. Indeed, cyclists are at particular risk when they use the same infrastructure as other travel modalities (i.e., pedestrians or motorists)⁶². For this reason, it is important to consider how the infrastructure can support safe cycling. One moderately ranked systematic review

identified that cyclist facilities reduced the risk of injury⁶².

In addition to bike lanes, some areas use blue cycle crossings in high risk intersections. Blue cycle crossings allow roadways to be marked in blue to heighten the attention of motorists while cyclists and pedestrians have designated lanes through the junction⁶³. One article estimated the safety effects of blue cycle crossings with mixed results depending on the number of blue cycle crossings. Single and double blue cycle crossings did not significantly improve safety⁶³. When intersections contained four crossings, accident and injury rates increased⁶³. Given these adverse outcomes and limited scientific rigour, the study was ranked less promising. Additional research is needed to ensure that blue cycle crossings are safe.

Table 66: Pucher, J. et al.⁶¹

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	F	F	F	Moderate
Key Finding(s)	Among studies considering on-road bike lanes (total included unknown), 5 found positive correlations between bike lanes and cycling, 7 found increased cycling after lanes were built and 17 identified individual preference for lanes. Bike parking at train stations (8 articles) was found to increase use of public transit and cycling, while bike racks on buses (3 articles) were identified as having high uptake by transit users.				

Legend: Y= Yes, F= With Flaws

Table 67: Reynolds, C.C.O. et al.⁶²

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	Y	Y	F		Moderate
Key Finding(s)	Five studies of roundabouts produced 9 measures of crash risk: 4 identified increased risks for crashes under select circumstances (i.e. 2-lane roundabouts), 1 identified a reduced risk and 4 found no effect. Two studies investigating the impact of coloured or raised cycle crossing identified mixed results. 6 of 9 studies investigating bike lanes identified reductions in crashes with on-road bike lanes. Crash rates were higher for major vs. minor road ways. Levels of significance were inconsistently reported.				

Legend: Y= Yes, F= With Flaws

**Table 68:** Jensen, S.U. ⁶³

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Low	Mid	Less Promising
Description	Roadways in areas of conflict between vehicles and cyclists are marked in blue to draw attention of motorists and are called blue cycle crossings. Cyclists also have a lane marking through the junction area.		
Key Findings	At junctions with single or double blue lane crossings, accidents and injuries were not significantly reduced. In junctions with four blue cycle crossings, accidents increased by 60% and injuries by 139%.		

Take Home Messages: Cycling

Bicycle facilities, including cyclist specific lanes and end of trip facilities, increased rates of cycling and also reduced risk for injury.

5.5 Building Design & Design Features

Only one article describing a practice or intervention was identified that related to building design or design features ⁶⁴. This article related to modifications to the design of elevator and stair functionality as an intervention to increase physical activity in the workplace.

5.5.1 Elevator or Stair Design

In an effort to increase physical activity and shift attitudes towards stair use, one intervention provided a “skip-stop” elevator

intended for able bodied individuals. This elevator stopped only at every third floor and was accompanied by an adjacent, open stairwell to connect the skipped floors. A second, typically operating elevator was available with a special pass to individuals unable to use stairs. In addition, an enclosed stairwell was provided to meet fire regulations. An online survey was used to evaluate stair use, building satisfaction and attitudes towards stair use and identified that most building users reported daily stair use ⁶⁴.

Table 69: Nicoll, G. & Zimring, C ⁶⁴

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	Mid	Promising
Description	The intervention used a “push” strategy over a 24 week period to encourage physical activity by programming elevators to stop only every third floor. An open staircase adjacent to the skip-stop elevator connected individuals to the skipped floors. A second, standard operation elevator was available with a pass to individuals unable to use the stairs along with an enclosed stairwell to meet fire regulation codes.		
Key Findings	72% of survey respondents reported daily stair use. However, 41.4 % also reported that stair use was necessary due to elevator locations or that work responsibilities made stair use a necessity, suggesting that it was perceived as a requirement rather than a desirable behaviour.		

Take Home Messages: Elevator or Stair Design

Building design may be used to promote stair use with skip-stop elevators. Additional research is needed to determine if building designs can alter attitudes towards stair use as a positive, health promoting behaviour.

5.6 Other Themes

Six systematic reviews^{65, 67-70} and three additional intervention articles^{71, 72, 74} were identified that addressed the affect of the built environment on obesity. One intervention article⁷⁵ was identified that addressed the built environment as a whole rather than a specific component of the built environment.

5.6.1 Obesity Prevention

Obesity is a salient public and population health concern in all age, gender, race, ethnicity, regional and socioeconomic groups^{108, 109}. Further, obesity is risk factor for type 2 diabetes, cardiovascular disease, high blood pressure, osteoarthritis, some cancers and gallbladder disease¹¹⁰⁻¹¹². In one systematic review, 84% of identified research articles described significant associations between measures of obesity and the built environment⁶⁸. Concern regarding the methodologic rigour of many included studies, suggests a need for more rigorous research to conclusively establish a link between the built environment and obesity⁶⁸.

Further detailing the relationship between obesity and the built environment, another literature review found increased walkability and availability of recreational facilities were positively associated with physical activity⁶⁹. Further, individuals living in more walkable areas with increased access to recreational facilities were less likely to be overweight or obese⁶⁹.

In a literature review with nine included articles, neighbourhood deprivation, walkability and land use mix were all significantly associated with measures of overweight or obesity⁶⁵.

Table 70: Papas et al.⁶⁸

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	F	F	F		Moderate
Key Finding(s)	In 17 of 20 identified studies, statistically significant positive associations between aspects of the built environment and body mass index were identified. Indeed, studies identified associations between body mass index (BMI) and walkability, residential proximity to traffic, urban sprawl, mixed land use, greenery and commute time. Further, the availability of fitness facilities, supermarkets and fast food outlets were all associated with BMI.				

Legend: Y= Yes, F= With Flaws

**Table 71:** Sallis, J.F. & Glanz, K.⁶⁹

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	F				Low
Key Finding(s)	As cited in this article, 9 of 10 identified literature reviews recognized that proximity to recreational facilities was valuable in increasing physical activity. Of 4 identified reviews assessing physical activity and walkability, all 4 cited positive associations (as cited in Sallis). Citing the Papas review (discussed earlier), the authors note that environments supporting physical activity may reduce obesity and/or overweight. Of note, authors do not report the number of identified studies, the magnitude of effects, levels of significance or agreement between studies. Results appear to be drawn from a limited selection of previously completed literature reviews.				

Legend: Y= Yes, F= With Flaws

Table 72: Booth et al.⁶⁵

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
				F	Low
Key Finding(s)	Of nine identified studies, six described positive correlations with components of the built environment and either overweight or obesity prevalence. Of these, 4 studies identified inverse relationships between neighbourhood deprivation and obesity/overweight. The remaining five studies considered walkability in terms of distance to resources or land use mix. Inverse relationships between walkability and obesity/overweight were identified in 4 of 5 articles.				

Legend: Y= Yes, F= With Flaws

Table 73: Khan et al.⁶⁷

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	F	Y	F		Moderate
Key Finding(s)	Of 24 recommended strategies to prevent obesity, eight related to the built environment: increased access to outdoor recreational facilities, enhanced infrastructure for cyclists, enhanced infrastructure for pedestrians, placement of schools within residential proximity, improved access to public transit, increased zoning for mixed land use, enhanced safety in locations where individuals could be physically active and increased traffic safety.				

Legend: Y= Yes, F= With Flaws

One systematic review identified community based strategies to create safe, physical activity promoting neighbourhoods. A literature review, coupled with an expert panel process, identified 24 recommended strategies for obesity prevention⁶⁷. Of these, eight pertained to the built environment. They include modifications to the built environment that would promote

active transport by developing infrastructure for cycling and walking, locating schools close to residential areas, improving access to public transit, increasing safety in public areas where individuals could engage in physical activity and increasing traffic safety⁶⁷. Increased access to outdoor recreational facilities and mixed land use were also recommended⁶⁷.

One literature review considered urban design, geography and public health nutrition in urban environments. The review implemented a narrative approach to extracting information from included studies and synthesizing their findings. A relationship between physical activity and the environment exists, though mediators and moderators of this relationship require further assessment; a relationship between the built environment and diet was not established ⁷⁰.

A final systematic review considered a population of particular interest in the United States as they have been disproportionately represented in obesity statistics: African Americans ⁶⁶. Positive associations with physical activity were identified with light traffic, safety, and the presence of sidewalks; however, the findings were inconsistent between studies ⁶⁶.

There is some evidence to suggest that physical activity may be influenced by physical environment, additional research is needed to clarify this relationship among African Americans. The presence of supermarkets and specialty stores was positively associated with meeting fruit and vegetable consumption guidelines ⁶⁶.

Corresponding with the systematic reviews, a photovoice project as part of Kaiser Permanente's Community Health Initiative (CHI) identified a need to ensure that infrastructure is conducive to being physically active ⁷¹. The CHI was a community driven program to prevent obesity by increasing healthy eating and physical activity ⁷¹. The findings highlighted community members' concern about the maintenance and safety of neighbourhoods, parks and sidewalks ⁷¹.

Table 74: Townshend, T. & Lake, A.A ⁷⁰

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
	F	F	F		Moderate-Low
Key Finding(s)	The findings of this review were inconclusive. A broad relationship between the built environment and physical activity was established, with additional inquiry required to determine mediators and moderators of the association. A relationship between diet and physical activity was not established.				

Legend: Y= Yes, F= With Flaws

Table 75: Casagrande et al. ⁶⁶

	Research Question	Search Strategy	Article Selection	Validity Assessment	Overall Ranking
					Low
Key Finding(s)	Of ten included studies, five identified statistically significant relationships between either diet or physical activity and aspects of the built environment. Among the two studies examining the impacts of supermarkets, both identified statistically significant positive associations between fruit and vegetable consumption and availability of supermarkets.				

Legend: Y= Yes, F= With Flaws

**Table 76: Kramer et al.** ⁷¹

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	Mid	Promising
Description	As part of the Kaiser Permanente (KP) Community Health Initiative (CHI), an obesity prevention program to promote healthy eating and physical activity was initiated in three neighbourhoods in Colorado, US. A photovoice project was completed as part of an evaluation and the findings of this study relate the photovoice project.		
Key Findings	Four themes were identified from the photovoice pictures and captions: the need for more safe and walkable sidewalks; access to healthy foods in schools and neighbourhoods; increased attention to gang activity; and the safety and cleanliness of parks and recreation areas.		

Table 77: Kim et al. ⁷²

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Mid	High	Very Promising
Description	A Community Health Living Index (CHLI) was developed that identified the level of community support for active living and healthy eating in terms of programming, infrastructure and policy.		
Key Findings	Over 80% of question items in the CHLI tool were accurately understood without confusion. Among subgroups of participants, inter-rater reliability was 85% or greater.		

In an effort to support the development of healthy communities and community based initiatives, the *Community Healthy Living Index* (CHLI) was developed and pilot tested ⁷². After pilot testing in six communities, the tool was identified to have strong face validity and high inter-rater reliability on individual items ⁷². As a result, the tool is now being tested nationally in the United States and may show promise as a facilitator for community improvement and development.

To support obesity and chronic disease prevention at a community level, the Ingham County Health Department (ICHHD) in Michigan developed a health impact assessment (HIA) tool ⁷³. Using a participatory research approach the HIA tool was pilot tested in Meridian Township of Michigan. During the pilot testing, developers were asked to use the new HIA tool as a replacement for a previously used environmental checklist that did not consider health impacts ⁷³. Authors' suggest that the dialogue about the tool and its potential benefits were meaningful and ultimately the

development was adjusted to be more walkable ⁷³. Limited information about the methodology used to pilot test the tool and develop findings resulted in the project being ranked as less promising. A stronger, more detailed evaluation is needed to validate preliminary positive process findings.

Another program was developed to provide government funding to six disadvantaged communities in Victoria, Australia in an effort to increase healthy eating and physical activity ⁷⁴. While many program components focused on individual behaviour change, the six communities also highlighted an interest in increased recreational opportunities, access to fruits and vegetables, as well as increased active transport, which may involve modifications to the built environment ⁷⁴. At the time of publication, an evaluation was planned but had yet to be implemented and as a result neither process nor indicator outcomes were available. This program was ranked as less promising due to the limited information available about the evaluation.

Table 78: Roof, K. & Glandon, R. ⁷³

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Low	Mid	Less Promising
Description	In response to increased rates of obesity and chronic disease, the Ingham County Health Department (ICHHD) was interested in developing a strategy to better understand and address health impacts resulting from land use decisions.		
Key Findings	Results from data analysis were not presented, however, authors note that their experience with using the HIA tool resulted in changes to the proposed development plan and that these changes increased walkability.		

Table 79: de Silva-Sanigorski et al. ⁷⁴

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Low	Mid	Less Promising
Description	Six disadvantaged communities in Victoria Australia were given government funding for three years to promote healthy eating and physical activity. Communities were located in both urban and rural locations.		
Key Findings	At the time of publication, an evaluation had been planned but was yet to be implemented. For this reason, findings were unavailable.		

Take Home Message: Obesity Prevention

1. *There is evidence to suggest a relationship between components of the built environment, including land use mix and walkability, and obesity.*
2. *The Community Health Living Index shows promise as a tool to encourage community-based obesity prevention programming.*

5.6.2 Overarching Approaches

One promising practice considered Canadian case studies within each province where collaboration in a built environment project has led to improvements in health outcomes ⁷⁵. Although each case study addressed different components of the built environment, qualitative interviews with key informants identified three common lessons learned between projects. Informants highlighted the need to cultivate effective partnerships with all

major stakeholders early in the project and the benefit of then using these relationships to advance health promotion agendas ⁷⁵. In order to increase the sustainability of the project, informants indicated a need for projects to be community owned and driven ⁷⁵. Finally, a focus on the end results throughout implementation was thought to build enthusiasm, excitement and engagement ⁷⁵.

**Table 80:** Lees, E. & Redman, H ⁷⁵

	Certainty of Effectiveness	Potential for Population Impact	Level of Promise
	Low	High	Promising
Description	A pan-Canadian overview of case studies from each province where collaborative projects to modify the built environment and improve health are profiled.		
Key Findings	Qualitative interviews with key informants from each case study identified three themes: <ol style="list-style-type: none"> 1. Early and effective stakeholder engagement. 2. Strong commitment through community owned and driven projects. 3. Focus on the end results throughout implementation to generate momentum. 		

Take Home Message: Overarching Approaches

Stakeholder involvement, community ownership and self-determination, and a goal-oriented approach may increase the successful implementation and uptake of health promotion interventions related to the built environment.

6.0 Discussion

The results of this review highlight the multifaceted effects of the built environment on health and risk factors for morbidity or mortality in Canada. Several important concepts informed the development of recommendations and conclusions.

Cross-Sectoral Engagement

Given that the built environment includes a multitude of broad and diverse components, a single sector is unable to make sustained, population level advancement in health promotion through the built environment. Indeed, the interventions identified cross several sectors. For example, the development of a trail to promote active transport would include the health sector, the transportation sector, the recreation sector, city planners and communities. For this reason, it is necessary to work across sectors to ensure that all necessary stakeholders participate in programming.

Scientifically Rigorous Evidence

While this review identified that there is an abundance of existing research, both in terms of association and intervention studies as well as systematic reviews, the usability of this evidence was limited due to the generally low

scientific rigour. Given that built environment interventions are costly and have the potential to have high population impact, they need to be grounded in strong evidence to minimize population risk.

Despite concerns about scientific rigour, there were several areas with sufficient evidence to warrant action, including the following: increasing availability of and access to well maintained and strategically developed park and recreation spaces, the use of street lighting, red light cameras and speed cameras to reduce crash and injury risk, and provision of infrastructure to support active transport.

Consideration and Management of Risks

Advancement in aspects of the built environment may inadvertently increase risk in another area. For example, while active transport may increase physical activity and protect against chronic disease, it may also increase the risk of serious injury due to increased proximity with heavy traffic flow. As such, it is important to consider how to further protect individuals against unintended and adverse consequences when implementing built environment interventions.

Limitations

The approach used to generate evidence for this review included several limitations. Variability in the search approach used to identify intervention articles between risk factors limits the comprehensiveness of identified practices, interventions, or programs and thus some important studies or evaluations may have been missed in the areas of environmental hazards, injury prevention, and ultraviolet radiation. Further, for nutrition and physical activity, given the vast amount of retrieved literature, the search was limited to very recently published intervention studies and

thus some classic or relevant interventions that were reported earlier than 2005 may have been missed.

The broad definition of the built environment resulted in a project that was meaningful to stakeholders but had a large scope. The results, therefore, from both reviews (the appraisal of systematic reviews and the promising practices review) are diverse and unfocused. Indeed, the content of included articles is expansive and it is possible that some impactful or relevant topic areas were missed.

7.0 Conclusions

Increasing Opportunities for Physical Activity in the Community and at School

1. The availability of recreation facilities, including parks and trails, increases physical activity. Parks with multiple components, maintained condition, increased social environments and positive aesthetics as well as those that were safe, accessible, or renovated were more likely to be visited.
2. Opportunities to increase use of school grounds include school ground greening, renovation and provision of shaded areas.
3. Among adults living in rural settings, physical activity was associated with the presence of trails and parks as well as pleasant aesthetics.

Facilitating Healthy Eating

1. Gardening programs are a promising strategy to increase fruit and vegetable consumption in adults and children.
2. There may be inequitable access to healthy food options, including reduced access to supermarkets and increased density of fast food outlets. Additional research is needed to investigate whether access to healthy food options is predictive of fruit and vegetable consumption, diet related disease, or weight status.

Safe Housing

1. Additional formative research and field evaluation is needed to determine the

effectiveness of housing interventions, however, early evidence exists to suggest that housing improvements may increase respiratory health.

2. Preliminary projects indicate that comprehensive implementation of SafeGrowth principles in communities may improve perceptions of crime. Additional research is needed to assess incidence of crime.

Mental Health Promotion

1. There is strong evidence to suggest a relationship between urbanicity and depressive symptoms.

Prevention of Traffic Crashes and Associated Injuries

1. To increase the visibility of signs to older drivers, font, text colour and background colour are important considerations.
2. Red-light cameras, speed cameras, street lighting, and area-wide traffic calming measures are effective at reducing traffic collisions and associated injuries.

Proximity to Traffic

1. Scientifically rigorous synthesis of existing evidence is needed to better understand the relationship between proximity to traffic and health or predictors of health.

Active Transport among Children and Adults

1. Among children, active school transport may increase physical activity. Close presence of community recreation spaces, proximity to schools, supportive infrastructure and safety are the strongest predictors of active school transport.
2. Programming to facilitate active school transport has strong community uptake. The success of active school transport programming may be influenced by the infrastructure, policies and environment surrounding schools. These factors should be considered and addressed in the development of AST programming.
3. Supportive infrastructures are correlated with increased active transport. Among cyclists, bicycle facilities, including cyclist specific lanes and end of trip facilities, increased rates of cycling and also reduced risk for injury.

Obesity Prevention

1. There is evidence to suggest a relationship between components of the built environment, including land use mix and walkability, and obesity.
2. The Community Health Living Index shows promise as a tool to encourage community-based obesity prevention programming.
3. Building design may be used to promote stair use with skip-stop elevators. Additional research is needed to determine if building designs can alter attitudes towards stair use as a positive, health promoting behaviour.

Increasing the Success of Interventions related to the Built Environment

1. Stakeholder involvement, community ownership and self-determination and a goal-oriented approach may increase the successful implementation and uptake of health promotion interventions related to the built environment.



Appendices

Appendix A: Steering & Working Committee Membership

Table 81: Working Group Members

Name	Title	AHS/HPDIP Area
Julia Arndt	Research/Project Coordinator	Mental Health Screening & Early Detection, HPDIP
Lori Bough-Littlejohns	Research Project Coordinator	Healthy Public Policy Unit, HPDIP
Marie Carlson	Population Health Consultant	Healthy Public Policy Unit, HPDIP
Kerry Coupland	Program Coordinator, Population & Public Health, Steering Committee Liaison, Working Group Chair	Public Health Innovation & Decision Support, Population & Public Health
Patrick Curley	Program Coordinator, Environmental Carcinogens	Environmental & Occupational Carcinogens Unit, Environmental Public Health
Ken Dong	Environmental Health Officer	Environmental Public Health, Population & Public Health
Sherry Elnitsky	Research Project Coordinator	Injury Prevention, HPDIP
Tanya Ewashko	Population Health Consultant	Healthy Public Policy Unit, HPDIP
Steve Friesen	Research Associate	Health System & Workforce Research Unit
Steve Gaspar	Program Coordinator, Environmental Carcinogens	Environmental & Occupational Carcinogens Unit, Environmental Public Health
Steve Quantz	Program Coordinator, Ultra Violet Radiation	Environmental & Occupational Carcinogens Unit, Environmental Public Health
Folake Arinde	Project Coordinator, Environmental Hazards	Environmental & Occupational Carcinogens Unit, Environmental Public Health
Annette Li	Program Coordinator, Nutrition	Provincial Nutrition Services, Population & Public Health
Janice Patterson	Active Living Specialist	Chronic Disease Prevention, HPDIP
Erin Walton	Coordinator, Mental Health Promotion	Mental Health Promotion, HPDIP

**Table 82: Steering Committee Members**

Name	Title	AHS/HPDIP Area
Farah Bandali	Director	Provincial Nutrition Services, Population & Public Health
Beth Evans	Manager	Mental Health Promotion, HPDIP
Debbie Gray	Manager	Mental Health Screening & Early Detection, HPDIP
Brent Friesen	Medical Officer of Health	North Zone
William Hohn	Director	Environmental Public Health, Population & Public Health
Deborah McNeil	Director	Public Health Innovation & Decision Support, Population & Public Health
Laura McLeod	Medical Officer of Health	Population & Public Health
Corinne Parker	Manager	Environmental & Occupational Carcinogens Unit, , Environmental Public Health
Clare Hildebrandt	Manager	Public Health Innovation & Decision Support, Population & Public Health
Patti Restoule	Director	Public Policy, Injury Prevention, Reducing Disparities, HPDIP
Kelly Lynn Spafford	Manager	Primary Prevention, HPDIP
Carla Spinola	Manager	Healthy Public Policy, HPDIP
Nancy Staniland	Manger	Injury Prevention, HPDIP

Appendix B: Promising Practices Review: Appraisal of Scientific Rigour and Community Participation

Table 83: Detailed quantitative appraisal criteria with considerations for reviewers.

Selection Bias	
Sample was population based	<ul style="list-style-type: none"> Was the sample and sampling strategy appropriate to obtain a representative sample given the target population? Was the sample selected from the whole target population?
Eligibility criteria were specified	<ul style="list-style-type: none"> Listed inclusion, exclusion, or eligibility criteria
Random Selection	<ul style="list-style-type: none"> Participants were selected for inclusion in the study randomly Selection of participants was not targeted or was appropriately targeted Not a convenience sample
Dropout rates/reasons reported	<ul style="list-style-type: none"> Attrition was identified and considered Where available, reasons for drop out were requested and identified
Reasons for loss same in each group	<ul style="list-style-type: none"> Did the attrition differ between experimental and control groups? If so, were the reasons for drop out different?
Subjects were randomly allocated	<ul style="list-style-type: none"> Each participant had an equal likelihood of being in the experimental or control groups If yes, this is an RCT
Follow up > 80%	<ul style="list-style-type: none"> At least 80% of the sample were included in follow-up data
Intent to treat if RCT	<ul style="list-style-type: none"> In many studies, participants will not have followed the protocol, either deliberately or accidentally or may not comply. Further, sometimes individuals who were not eligible to participate are accidentally included in the study. To address these situations, all participants must be kept in the study. The policy that analysis will be based upon all participants in each group as randomized is known
Information Bias	
All groups assessed in the same manner	<ul style="list-style-type: none"> Were the same tools and approaches used to assess all participants?
Blinding for outcome/exposure measurement	<ul style="list-style-type: none"> Were the investigators responsible for collecting data on outcomes or exposures blind to the participants' allocation?
Blinding for caregivers	<ul style="list-style-type: none"> Were individuals involved in the care or intervention of participants blind?
Blinding for participants/subjects	<ul style="list-style-type: none"> Was the patient blind to their exposure or treatment group?
Concealed allocation for RCT	<ul style="list-style-type: none"> Did the investigators blind themselves to who was in which group?
Baseline assessments valid/reliable	<ul style="list-style-type: none"> Were the assessment measures or tools used to assess exposure or prognostic factors reliable or valid? Were existing tools used?
Outcome assessments valid/reliable	<ul style="list-style-type: none"> Were the assessment measures or tools used to assess outcome



	<ul style="list-style-type: none"> measures valid and reliable? Were existing tools used?
Confounding	
Differences in prognostic factors described	<ul style="list-style-type: none"> Are prognostic factors in each group described (e.g., Age, gender, etc.) Often in Table 1 of the manuscript
Groups comparable on prognostic factors	<ul style="list-style-type: none"> Were the differences between groups tested? T-tests/Chi2? Were these listed? Also see Table 1 or 2
Confounding factors taken into consideration during analysis	<ul style="list-style-type: none"> Was analysis stratified based on differences? Was regression used to control or adjust for covariates? Did the analysis account for confounding factors?

Table 84: Detailed qualitative appraisal criteria with considerations for reviewers.

Reflexivity	
Investigator background or perspective described	<ul style="list-style-type: none"> In a qualitative study, the research contributes and influences the construction of meanings throughout the research process. Given this, the investigators background or perspective may influence how they see meaning in the data. We are looking for a description of their background or perspective.
Influence on study clearly stated	<ul style="list-style-type: none"> Given that as stated above, there will be an element of subjectivity, the investigators influence on the study and its meanings is described or stated.
Credibility	
Theoretical Framework	
Adequate given the aims of the study?	<ul style="list-style-type: none"> Does the method fit the research question?
Role in interpretation of data is clear	<ul style="list-style-type: none"> Does the method influence the way the data will be considered?
Sampling	
Approach is clearly stated and appropriate with the aim	<ul style="list-style-type: none"> How the sample was recruited is described and fits with the research question. A targeted selection may be appropriate and reasonable given the aim and theoretical framework of a study.
Biases in selection are articulated	<ul style="list-style-type: none"> Do the authors discuss potential bias that occurs during selection? Including bias based on individuals willing/unwilling to participate.
Is theoretically justified	<ul style="list-style-type: none"> Does the sampling strategy fit with the theoretical framework?

Data Collection

Activities clearly described	▪ Are the activities or approaches stated?
Limitations discussed	▪ Do the authors acknowledge limitations? Are any listed?

Analysis Approach

Systematic	▪ Is the approach to understanding the data systematic?
Transparent	▪ Is the approach described? Do they tell you enough that you could understand what they did and potentially replicate it?
Consistent with qualitative tradition and aims?	▪ Does the approach align with the tradition selected for the study design? E.g. If phenomenology is the tradition used, then phenomenological analysis should be used, not grounded theory.
Trustworthiness of the data is checked? Interpretation emerges from the data?	▪ Do the authors check that the findings are reflective of the participants experiences and meanings? This means taking the findings back to the participants for verification. ▪ Does the data determine the findings or did the perspective of the researcher have potential to overshadow the data?

Transferability

The context of the study is understandable given the description of sample characteristics and site	▪ Is there enough information about the sample characteristics to gauge whether their sample is comparable to your population of interest? This is not about whether the target populations are similar, but rather is about the amount of information provided
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Detailed Information Regarding Assessment of Community Participation

The scale appraised a community's knowledge, participation, and/or leadership of the initiative based on the available information within each publication. Where there was no indication that the community involved had knowledge of the initiative or where the community only had knowledge (but no participation) the article was scored zero, low community involvement. Where there was indication that the community was able to participate in the initiative, the

article was scored one, mid community involvement. Finally, where there was indication that the community was able to lead, guide, or provide direction to the initiative, the article was scored two, high community involvement. Articles that did not provide an indication of the community's involvement were assumed low community involvement (community participation score of zero).



C: Critical Appraisal of Systematic Reviews- Appraisal Criteria

Table 85: Detailed appraisal criteria for the assessment of systematic reviews.

	Considerations
Research Question	<ul style="list-style-type: none"> ▪ defined population ▪ defined intervention ▪ defined outcome(s) ▪ considered study design
Search Strategy	<ul style="list-style-type: none"> ▪ clearly stated databases searched ▪ clearly stated search terms used ▪ stated years reviewed ▪ methods comprehensive ▪ methods replicable ▪ included non-published (grey) literature
Selection Strategy	<ul style="list-style-type: none"> ▪ defined inclusion and exclusion criteria ▪ multiple (2+) judges for selection ▪ replicable
Validity Assessment	<ul style="list-style-type: none"> ▪ criteria reported ▪ assessed bias
Data Extraction	<ul style="list-style-type: none"> ▪ multiple (2+) extractors ▪ attempts made to retrieve missing data from included articles ▪ agreement between extractors reported
Combining of Findings	<ul style="list-style-type: none"> ▪ methods reported ▪ methods appropriate given outcomes, homogeneity, etc.

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