School-based approaches to mitigate child health inequities in Canada: The Health Promoting Schools approach and equity, diversity, inclusion, and accessibility school practices

by

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Abstract

Childhood exposure to neighbourhood deprivation has been consistently associated with poor health behaviours, including unhealthy diets, sedentary behaviours, and poor mental health and wellbeing. These may result in health inequities that could present challenges to public health, especially in light of the COVID-19 pandemic, which has contributed to widening health inequities among children. Since children spend a substantial portion of their time in schools, these environments are ideal settings for health promotion. The Health Promoting Schools (HPS) approach has been recognized as the most effective and cost-effective school-based health intervention. However, implementing such interventions across Canada's vast landscape is a complex task due to the lack of comprehensive guidance for supporting an increasingly ethno-cultural and gender-diverse student population. In this context, the integration of equity, diversity, inclusion, and accessibility (EDIA) principles into school culture is essential for successfully implementing the HPS approach in Canadian settings.

This thesis aimed to develop standards and indicators for implementing and sustaining HPS in Canada and to examine the role of school practices that promote EDIA in mitigating child health inequities within deprived neighbourhoods of a province in Western Canada. The specific objectives of the thesis were to (1) perform a literature review to derive a comprehensive inventory of statements related to the implementation and sustainment of HPS, (2) conduct a consensus seeking process to establish a set of standards and indicators for HPS that are specific to Canada, and (3) determine whether the implementation of EDIA school practices modify the effects of school neighbourhood deprivation on students' healthy eating, physical activity, screen time, and mental health and wellbeing.

The first and second objectives were addressed by a study involving a comprehensive review of the literature and a consensus-seeking process. The literature review yielded 147 statements related to HPS implementation and sustainment, which were grouped into 42 standard components and 105 indicators. These were then evaluated by two expert panels comprising 53 education and policy experts from across Canada. Through three rounds of the Delphi survey, consensus was reached on 100% of standard components and 81% of indicators, which were then mapped into nine standards for HPS.

To address the third objective, I used cross-sectional data from 1,970 grade 4-6 students (aged 9-12 years) in 28 elementary schools participating in the APPLE Schools initiative in Alberta, Canada, during the Spring of 2023 and Spring of 2024. The study revealed that schools in more deprived neighbourhoods were more likely to have greater implementation of EDIA school practices. While these practices were not sufficient to mitigate the negative effects of neighbourhood deprivation, full implementation of EDIA appeared to be beneficial for students' diet quality.

This thesis provided some contributions for school health promotion in Canada. The developed set of HPS standards and indicators offers a guide for implementing and sustaining health promotion initiatives in Canadian schools, accounting for the country's unique educational, demographic, and ethno-cultural contexts. This work aligns with global efforts to advance school health promotion, supporting an international agenda that recognizes education's role in creating healthier, more equitable societies. The methodological approach used can serve as a model for other jurisdictions seeking to establish or update context-specific HPS guidelines. Additionally, this thesis contributes to understanding the relationship among school neighbourhood deprivation, EDIA practices, and child health behaviours in Canada. Future research should focus on

developing user-friendly tools to track HPS implementation, conducting longitudinal studies to evaluate the long-term impact of EDIA practices, and creating objective instruments for assessing EDIA implementation in schools. These efforts will help to inform policies and practices to mitigate health inequities among Canadian children, especially in deprived communities.

Preface

This thesis is an original work by Camila Honorato, structured in a paper-based format comprising four chapters.

Chapter 2 was written in collaboration with Drs. K. Maximova, P.J. Veugelers, and J. Dabravolskaj. Drs. K. Maximova and P. J. Veugelers conceptualized the idea and secured funding. All authors collectively decided on the methodological approach and executed the research. Dr. J. Dabravolskaj and I conducted the literature review, while Drs. P.J. Veugelers, J. Dabravolskaj, and I performed the content analysis. I was responsible for the statistical analysis. Dr. P.J. Veugelers and I drafted the first version of the manuscript. All authors contributed to the interpretation of findings and manuscript writing. This study received research ethics approval from the Health Research Ethics Board of the University of Alberta (Pro00121761) and was supported by operational funding from the Pan-Canadian Joint Consortium for School Health (JCSH). Part of Chapter 2 has been published as a report titled "Canadian Standards & Indicators for Health Promoting Schools" by the JCSH in September 2023.

For the manuscript in Chapter 3, Drs. K. Maximova and P.J. Veugelers served as supervisory authors and contributed to manuscript edits. N. Grubic provided dietary data management to support statistical analysis. Dr. J. Dabravolskaj provided advice for the analysis. The study in Chapter 3, which examined the role of EDIA school practices in mitigating child health inequities in deprived neighbourhoods, was based on observations in APPLE Schools (A Project Promoting healthy Living for Everyone in schools). This study received research ethics approval from the Health Research Ethics Board of the University of Alberta (Pro00119951), Unity

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This thesis represents not just my work, but the collective support and guidance of all of you. Thank you all.

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Chapter 1: Introduction

Childhood exposure to neighbourhood deprivation has detrimental effects on healthy development, with lasting consequences throughout life.[1–4] Children growing up in deprived neighbourhoods are more likely to have poor diets, sedentary behaviours, and worse mental health and wellbeing compared to those in less deprived neighbourhoods.[5–11] These negative effects persist into adulthood, with individuals who grew up in deprived neighbourhoods being at greater risk for engaging in unhealthy behaviours, such as smoking and alcoholism, experiencing disability, and facing premature mortality.[3,12] Although the negative effects of neighbourhood deprivation on health are well-established, the lack of a universal approach to measuring it complicates efforts to monitor its consequences for child health.[13–16]

Neighbourhood deprivation is a multidimensional problem that encompasses broader material and social characteristics of environments, including poverty, inadequate housing conditions, limited access to essential services, and poor sense of community.[17–19] Despite overall economic prosperity, children in high-income countries also experience various forms of deprivation. The Organisation for Economic Co-operation and Development (OECD) estimated that from 2019 to 2021, more than 69 million children were living in poverty in the world's 40 richest countries.[20] Similarly, in Canada, approximately 730,000 children were living in poverty in 2022, showing a 3.5% increase from the previous year and marking an upward trend post COVID-19 pandemic.[21] Economic deprivation disproportionately affected certain populations in the country. Visible minorities and Indigenous children were almost twice as likely to live in low-income families, compared to White Canadian children.[22] Considering that ethnic minority children might be more vulnerable to health inequities and face barriers to accessing healthcare,[23–26] these numbers highlight the need for special attention to these populations.

Given that children spend most of their time in schools, these environments are ideal settings for cultivating life-long health behaviours and mitigating the negative effects of neighbourhood deprivation on child health.[27,28] The OECD acknowledges the potential of schools not only to promote health but also to foster social mobility and establish strong foundations for equitable, inclusive, and sustainable democratic societies.[29] Recognizing this unique position of schools, the World Health Organization (WHO) created the Health Promoting Schools (HPS) approach, a holistic framework to promote learning, health and wellbeing of children across the globe.[27,28] In Canada, several school-based HPS interventions have successfully improved health behaviours of children living in deprived neighbourhoods.[30–34] However, implementing these interventions across Canada's decentralized education system is challenging due to the lack of comprehensive guidance for supporting an increasingly diverse student population.

Canada is undergoing its greatest demographic shift in 150 years, with immigrants comprising almost a fourth of the country's population in 2021.[35,36] Further contributing to this demographic diversity, an increasing number of young people have self-identified as sexually or gender diverse, with more than 10% of Canadian youth identifying as Two-Spirit, lesbian, gay, bisexual, transgender, queer, or other gender and sexual diversities (2SLGBTQ+) from 2019 to 2021.[37] Moreover, Canada is working towards reconciliation with its colonial history, striving to build stronger, respectful relationships with Indigenous Peoples and to create a more equitable society that honors Indigenous rights, cultures, and perspectives.[38] In this context, incorporating principles of equity, diversity, inclusion, and accessibility (EDIA) into Canadian school culture is fundamental for fostering healthy and positive school environments that support the needs of all students.

Although school-based interventions targeting inclusion have improved diet and physical activity levels of children in Canada,[30,32,39] there are no studies evaluating the specific role of EDIA principles in reducing health inequities among children in deprived school neighbourhoods. Therefore, the present literature review will discuss the relationship between school neighborhood deprivation and child health, the effectiveness of the HPS approach, and the role of EDIA in school settings in addressing child health inequities.

1.1 Neighbourhood deprivation and child health

The Ottawa Charter for Health Promotion defined health as something "created and lived by people within the settings of their everyday life; where they learn, work, play and love."[40(p3)] This definition expands on the holistic concept of health established by the WHO, which establishes health a state of complete physical, mental, and social wellbeing essential for an individual to properly function and contribute to their community.[41] According to these “settings” approaches to health, neighbourhoods are determinants of health and wellbeing, as they constitute the environments where people carry out their daily activities.

Neighbourhoods are geographical spaces that hold social and cultural significance for both residents and non-residents.[42] These are the environments where people spend a substantial portion of their time for many purposes, including working, learning, and accessing essential services. As such, neighbourhoods play an important role in fostering the health and wellbeing of communities.[4,19,42] Yet, neighbourhoods can also be a source of deprivation when resources and opportunities are scarce or unevenly distributed.

Townsend[17(p125)] defined deprivation as a “as a state of observable and demonstrable disadvantage relative to the local community or the wider society or nation to which an individual,

family or group belongs." In neighbourhoods, deprivation can manifest in various forms, such as limited access to quality education, nutritious food, adequate housing, green spaces, safe recreational areas, employment opportunities, and social support networks.[17,43] Exposure to these factors during key developmental years may negatively impact child health.[2,44,45] In a scoping review to evaluate the effects of neighbourhood deprivation on early child development, Minh et al.[2] observed that social inequalities related to children's residential neighbourhoods were associated with poor developmental health at school entry age. Similarly, a study using census data of kindergarten children in Canada found a higher prevalence of health disorders , such as physical, learning, emotional, behavioural, and speech and language difficulties, in children living in lower socioeconomic neighbourhoods.[46]

The impact of neighbourhood deprivation extends beyond early childhood, affecting older children and adolescents as well. A large cohort study in the United States involving 10,504 children aged 9 to 10 years old demonstrated that children exposed to socioeconomic deprivation exhibited worse mental health, lower cognitive performances, less physical activity and more sleep disorders compared to their peers from more affluent neighbourhoods.[11] Other studies have also established associations between neighbourhood deprivation and poor physical and mental health status,[47] increased risk of behavioural disorders[48] and early initiation of smoking and alcohol use in adolescents.[49]

Although existing research on the effects of neighbourhoods on child health has focused on residential areas, using home postal codes to assess neighbourhood characteristics, this approach may not capture the full complexity of children's exposures to deprivation.[2,44–46,49] Considering that children spend most of their waking hours in and around schools, the characteristics of school neighbourhoods may also play an important role in shaping child health

and wellbeing.[27,28,50] For example, the WHO recognizes the school's surroundings, including walking paths, neighbourhood dwellings, and shared community facilities, as determinants of child health, wellbeing, and learning.[28,51] Despite this importance, the specific effects of school neighbourhood deprivation on child health and mental health and wellbeing are understudied.[10,16] Understanding these effects is fundamental for developing strategies and public health policies that address the full spectrum of the neighbourhood influences on children's health and development.

1.1.1 Neighbourhood deprivation and child nutrition

Neighbourhood deprivation has been consistently associated with unhealthy dietary behaviours and poor nutrition in children. Studies have linked neighbourhood deprivation to high intake of sugar-sweetened beverages[6,52–54] and several indicators of poor nutritional status, including increased body mass index (BMI),[55] increased waist-to-height ratios,[7,53] and higher rates of overweight and obesity.[7,9,52,56] Additionally, a literature review examining the relationship between neighbourhood characteristics and child adiposity revealed that socioeconomic disadvantage in neighbourhoods was associated with high adiposity levels in children, although results were not consistent across studies.[57]

In Canada, Olstad et al.[54] conducted a longitudinal analysis using data from the Canadian Community Health Survey (CCHS), with a nationally representative sample of 18,670 children. Their findings revealed that despite overall improvements in diet quality from 2004 to 2015, dietary inequities increased for children living in more deprived neighbourhoods and this trend was more pronounced among children aged 6-11 years.[58] Moreover, high neighbourhood deprivation has been associated with poor cardiovascular health in children, including higher rates

of type 2 diabetes mellitus and hypertension, regardless of individual socioeconomic status.[58] These effects may be attributable to factors such as lack of walkable neighbourhoods.[5,58,59] For example, in a cross-sectional study with 5,741 grade 5 students in Nova Scotia, Canada, Veugelers et al.[59] found that children with more access to parks, playgrounds, and recreational facilities were less likely to be overweight and obese. Therefore, interventions targeting neighbourhood deprivation could be a promising strategy for reducing inequities in child nutrition.

1.1.2 Neighbourhood deprivation and child physical activity

Research examining the effects of neighbourhood deprivation on child physical activity has shown conflicting results.[60] Studies have reported both positive[9,61-63] and negative effects,[5-7] evidencing a complex relationship between neighbourhood deprivation and child physical activity. A school-based cross-sectional study in Bristol, United Kingdom, involving 1,307 children aged 10 to 11 years, found that children from schools in more deprived neighbourhoods were more likely to engage in school physical activity, regardless of their home socioeconomic status.[61] Similarly, the United Kingdom Millennium Cohort Study,[9] which included 7,262 11-year-old children, revealed that those in more deprived neighbourhoods were more likely to actively commute to and from school. Nevertheless, these same children were also more predisposed to unhealthy lifestyle behaviours, such as poor diet quality and higher screen time.[9]

In Canada, a cross-sectional study of 380 youth aged 12 to 16 years in Halifax, Nova Scotia, reported higher rates of physical activity among children attending schools in more socioeconomically deprived urban neighbourhoods, compared to their peers in deprived rural or suburban areas.[63] These findings suggest that walkability of neighbourhoods may play a role in these associations. However, other studies revealed constrating impacts of neighbourhood

deprivation on child physical activity. For instance, a cross-sectional study of 194 children aged 9 to 10 years in Liverpool, United Kingdom, found that children in highly deprived neighbourhoods with greater access to bedroom media were more likely to have lower physical activity levels.[7] Similarly, a study of 276 pre-schoolers in Dublin, Ireland, observed that children in highly deprived neighbourhoods were less likely to engage in structured physical activity, such as sports, compared to their peers in less deprived neighbourhoods.[6] Given these conflicting findings, further research is needed to better understand the relationship between neighbourhood deprivation and child physical activity, as well as to identify potential moderating factors that may account for these varied results.

1.1.3 Neighbourhood deprivation and child screen time

The literature examining the effects of neighbourhood deprivation on child screen time is limited, but existing studies indicate that children living in more deprived neighbourhoods are more likely to engage in excessive screen time activities.[7,9,59] In Canada, findings from the Health Behaviours School-aged Children Survey (HBSC), a cross-sectional study with a nationally representative sample of 15,917 youths aged 10 to 16 years, revealed that the combination of high social and physical neighbourhood deprivation was associated with a 40-60% increased risk of excessive screen time.[65] Furthermore, evidence suggests that this relationship may be influenced by gender.[66] A cohort study in Edmonton, Alberta, involving 1,633 preschool children found that girls living in more deprived neighbourhoods had, on average, higher weekly screen time, compared to those in less deprived areas.[66] Yet the study observed no such association for boys, implying that gender may play a role in these outcomes.

The relationship between neighbourhood deprivation and screen time could also be age-dependent. The QUebec Adipose and Lifestyle InvesTigation in Youth (QUALITY) study, a cohort study of 294 children in Montreal, Quebec, provided additional insights into this relationship.[67] The study reported that neighbourhood deprivation was associated with increased sedentary behaviour, defined as more than two hours of non-academic screen time, and low physical activity in children aged 8 to 10 years. In contrast, these effects were reversed in children aged 10 to 12 years, implying that as children become more independent, they may have increased access to explore their neighbourhoods, potentially influencing their screen time activities.[67] These diverging findings emphasize the need for more research to understand the age- and gender-specific effects of neighbourhood deprivation on child screen time.

1.1.4 Neighbourhood deprivation and child mental health and wellbeing

The impact of neighbourhood deprivation on mental health and wellbeing has been well established for adult populations.[67–72] Conversely, studies focusing on children and adolescents are limited.[8] A systematic review evaluating the effects of neighbourhood deprivation on child and youth mental health and wellbeing found negative associations between deprived neighbourhoods and both wellbeing and externalizing problem behaviours (e.g., aggressive behaviour), compared to internalizing problem behaviours (e.g., depressive symptoms).[8] The authors also cautioned that heterogeneity in the assessment of neighbourhood deprivation across studies limits the generalizability of these findings. This heterogeneity stems from the use of varied assessment approaches, including objective measures based on census data and subjective measures derived from parents' perceptions of their neighborhoods.[8]

Adding to the complexity of this relationship, findings from the Canadian Health Survey on Children and Youth (CHSCY), which included 47,871 children and adolescents aged 1 to 17 years, presented conflicting results.[73] While youth aged 12 to 17 years in more deprived neighbourhoods were more likely to report mental health problems and substance use (alcohol and cannabis), compared to their peers in less deprived areas, those in more materially deprived neighbourhoods (i.e., lacking access to goods and amenities) were less likely to experience these disorders. This inconsistency indicates that neighborhood-level measures of deprivation may introduce excessive variability and potential confounding factors when studying the relationship between deprivation and mental health in children and adolescents. The heterogeneity in neighbourhood-level assessments of deprivation further complicates comparability across studies.[8,13] Future research should consider focusing on individual-level measures of deprivation, such as socioeconomic status, to obtain objective assessments and understand their distinct impacts on the mental health and wellbeing of children.

1.2 The Health Promoting Schools (HPS) approach

Given the impact of neighbourhood deprivation on children's health and wellbeing,[5-11] it is important to develop effective strategies to mitigate these negative effects. In this context, schools are ideal settings for implementing health promotion interventions. Children spend most of their time in schools during key developmental years that will have lasting impacts on their adult health.[27,28] Schools are uniquely positioned to impart lifelong healthy habits in children,[27,74] potentially mitigating the adverse effects of neighbourhood deprivation in adulthood. Recognizing this opportunity, the WHO launched the Global School Health Initiative in 1995 to promote the

health and wellbeing of students, parents/guardians, teachers, and other members of the school community.[28,75]

This initiative paved the way for the development of the HPS approach, which recognizes schools as settings to promote healthy living, development, and learning for students and school communities.[28,75] Also known as "comprehensive school health," "coordinated school health," and "whole-school approach," the HPS approach encompasses four interconnected components of school health: social and physical environments, teaching and learning, policy, and partnerships and services.[28,76] Together, these components provide schools with tools to build capacity, strengthen connectedness among school community members, and support students in becoming healthy, active, and productive members of society.

1.2.1 The HPS approach globally

HPS interventions have consistently shown to yield long-lasting positive changes to school culture and improve students' learning, as well as their physical and mental health.[27,77,78] A Cochrane systematic review and meta-analysis of cluster randomized trials found that HPS-based interventions were effective in reducing the incidence of smoking and bullying and increasing physical activity and healthy eating in children and adolescents.[27] Other systematic reviews on the effectiveness of school-based interventions reported improvements following HPS-based approaches in diet quality,[78] knowledge of healthy eating,[78] step-counts per day,[77] and BMI. [77] Furthermore, HPS interventions were found to be the most cost-effective school-based health promotion interventions, offering the highest return on investment compared to other types of school-based initiatives.[79]

Considering the solid evidence supporting the HPS approach, the WHO advocates for its implementation in every school.[28] To advance this goal, several international organizations have developed standards and indicators to guide the implementation, scaling, evaluation, monitoring, and everyday practice of the HPS approach. These include guidance documents from the WHO itself,[28] the Schools for Health in Europe (SHE) Network Foundation,[80] the International Union for Health Promotion and Education (IUHPE),[81] and the Centers for Disease Control and Prevention (CDC) Healthy Schools department.[82] Despite the availability of these international resources, implementing the HPS approach across Canada's decentralized education system is challenging.[83] This is opposed to the mostly centralized systems found in European and other OECD countries,[84] where a unified approach to HPS implementation may be sufficient. However, the diversity of school jurisdictions across Canada requires a tailored approach that accounts for the country's unique educational, demographic, and ethno-cultural contexts.

1.2.2 The HPS approach in Canada

Several studies in Canada demonstrated the positive effects of HPS interventions on children's and youth's health and wellbeing.[30-34,79] The Alberta Project Promoting active Living and healthy Eating (APPLE) Schools initiative is an example of a successful HPS intervention which has been improving nutrition[31,33] and physical activity[32,34,85] of children living in Western Canada. These findings support the need for a tailored HPS approach for the country – one that can be adapted to its multiple school jurisdictions, each with distinct needs, priorities, cultures, and ethnically diverse communities. Although the Pan-Canadian Joint Consortium for School Health (JCSH) supports provincial and territorial ministries of health and of education in creating healthy school environments,[86] the lack of guidance on implementing and sustaining HPS

initiatives in the Canadian context limits the scale-up of this approach. This limitation ultimately results in a missed opportunity to improve Canadian children's health and wellbeing, highlighting the need to improve school health promotion practice in the country.

1.3 Equity, diversity, inclusion, and accessibility (EDIA) for Canadian children

EDIA principles have increasingly become central themes in education and health promotion.[87–90] According to the Canadian Commission for UNESCO,[91] *equity* ensures just and fair treatment for all individuals, irrespective of their differences; *diversity* acknowledges the wide spectrum of individual variations, including age, gender identity, sexual orientation, family situation, religion, ethnicity, disability, and socioeconomic status; *inclusion* upholds the fundamental right of every individual to be respected, valued, and appreciated equally in any environment; and *accessibility* guarantees equitable access to environments, activities, and services that accommodate the needs and preferences of individuals with disabilities. In Canada, the integration of these principles into school culture is essential to support the needs of a student population that is ethno-culturally and gender diverse.[36,37,88]

Canada's demographic landscape is rapidly evolving, with immigration playing an important role in shaping the nation's population composition.[36] In 2021, immigrants composed 23% of the Canadian population, the highest proportion in 150 years.[35] Projections suggest that by 2041, immigrants and their Canadian-born children could comprise more than half of the country's population (nearly 25 million people).[92] This demographic shift underlines the necessity of implementing EDIA principles in school culture. Although there is limited evidence, a scoping review found that immigrant children in Canada might be more vulnerable to health inequities and face additional barriers to access healthcare.[23] In contrast, the Canadian Health Measures Survey,

a longitudinal study with 7,460 children aged 6 to 17 years from 2007 to 2015, found no significant differences between mental health and wellbeing of immigrant, compared to non-immigrant children.[93] These contrasting findings expose the need for more research in this area.

The diversity of Canada's young population extends beyond immigration. In 2016, 27% of the youth population aged 15 to 24 years belonged to visible minority groups (i.e., non-white in colour).[94,95] Moreover, recent data from the Canadian Community Health Survey (2019 to 2021) showed that 10.5% of youth in this age group self-identified as Two-Spirit, lesbian, gay, bisexual, transgender, queer, or other gender and sexual diversities (2SLGBTQ+), a larger share than among any other age group.[37] Studies demonstrate that visible and sexual minorities youth are more likely to experience poor mental health, including psychological distress, suicidality, substance use, and risky sexual behaviour.[24,25,96,97] Given these findings, special attention should be directed towards these populations to address their health vulnerabilities.

The COVID-19 pandemic has exacerbated health inequities among children, partially due to school closures.[98,99] A study in northern Canada observed increased inequities in diet quality, physical activity, and screen time among students aged 9 to 12 years post-pandemic.[100] A systematic review found that pandemic lockdowns were associated with psychological distress, loneliness, anger, and fear in children and adolescents.[101] Other studies described social support as a protective factor against mental health disorders during this period.[101–103] These findings present an opportunity for implementing EDIA in school culture to foster positive social environments, address evolving needs of Canadian youth, and potentially mitigate post-pandemic health inequities.

Another dimension of EDIA in Canada pertains to Indigenous cultures, in response to the Truth and Reconciliation Commission's (TRC) 94 Calls to Action published in 2015.[38] The TRC

urges all governing systems to address the systemic effects of Canada's colonialism and ongoing prejudice against Indigenous Peoples. Schools play a key role in this reconciliation process, teaching students to honor their land, understand its historical roots, and value broader ways of knowing.[104,105] Education ministries across Canada, including Alberta's, are making efforts towards reconciliation by incorporating Indigenous perspectives into education curricula.[106,107] Yet, there is no guidance on how to incorporate Indigenous perspectives into school culture and health promotion initiatives.

Despite growing evidence of health inequities among ethno-culturally diverse, visible and sexual minority, and Indigenous youth populations,[23-26,96,97] there are no studies assessing the impact of EDIA principles for child health. Meanwhile, HPS interventions targeting social inclusion have shown promise in reducing health risk behaviours and health inequities among children and youth.[30,32,39] A cluster randomized trial to promote social inclusion among 2,545 students aged 13 to 14 years showed a 25% reduction in rates of substance use, antisocial behaviour, and early initiation of sexual activities four years after the start of an HPS-based intervention.[39] In Canada, Vander Ploeg et al.[30] observed that an HPS intervention is a viable approach for reducing inequities in child physical activity and obesity. Another Canadian study found that HPS initiatives implemented in low-income school neighbourhoods acted as an equalizer, increasing physical activity levels of children on weekend days to match those of children in middle-income-area control schools.[32] These findings underscore the potential of EDIA-informed HPS approaches to address health inequities. However, there is a need for research that examines how EDIA principles can be effectively incorporated into HPS-based initiatives to maximize their impact on reducing health disparities among diverse student populations.

In Canada, education ministries across the country support the implementation of EDIA in schools, and most provinces and territories already have school policies to achieve this goal.[88] The Alberta Ministry of Education, for example, has developed inclusion and diversity policies to support students in K-12 schools.[108] However, implementing EDIA in schools is a complex task, requiring a shift in school culture and communication practices to continuously assess students' needs.[109,110] Despite these efforts, there is little guidance on how to monitor and implement EDIA principles into school culture and health promotion initiatives.[87] Further research is needed to develop a guide for integrating EDIA principles into HPS-based initiatives, ensuring that all students, regardless of their ethnic background or identity, have equitable access to supportive school environments.

1.4 The role of EDIA in mitigating the effects of school neighbourhood deprivation on child health and mental health and wellbeing

While extensive literature exists on the impact of neighbourhood deprivation on child health and mental health and wellbeing,[5-11] to date, no studies assessed the role of EDIA principles in mitigating these effects. In contrast, school-based research across different countries has shown that the school social environment may impact child and youth mental health and wellbeing, providing insights into potential mitigating factors.[111-117]

In the Netherlands, a cross-sectional study with 6,422 adolescents aged 12 to 16 years observed that higher levels of school social disorder (e.g., higher number of fights, bullying behaviour) let to increased conduct and peer-to-peer relationship problems.[111] While a systematic review by Kidger et al.[112] revealed limited evidence to support a significant effect of the overall school environment on adolescent emotional health, it found that teacher support was positively

associated with school connectedness and better adolescent emotional health. This finding is further supported by a study from the Czech Republic,[113] where data from the national Health Behaviour in School-aged Children (HSBC) survey of 13,377 youth aged 11 to 15 years indicated that teacher support was a more important protective factor for adolescent psychological health than family support.

School-based interventions that foster positive relationships have demonstrated potential in promoting child and youth mental health. A systematic review by Garcia-Carrion et al.[114] found that interventions encouraging supportive relationships between school community members, including teachers and parents/guardians, decreased disruptive behaviours, increased wellbeing, and reduced anxiety and depression symptoms in children and adolescents. However, schools in more deprived neighbourhoods may face additional barriers in implementing such interventions. A cross-sectional study of 161 schools in Quebec, Canada,[115] found that schools located in more socially deprived neighbourhoods reported lower teacher commitment to student health and reduced parent/guardian and community engagement, emphasizing the need for securing school communities' buy-in for successful interventions.

Other studies have highlighted the importance of tailored school-based interventions that consider equity and inclusivity.[116-118,] A scoping review evaluating interventions to promote mental wellbeing and reduce inequities in child and youth health in high-income countries reported that, while most interventions were universal or targeted socially disadvantaged children and youth, none applied an equity lens to guide implementation or monitoring.[116] Mansfield et al.[117] further detailed that to increase buy-in for school-based interventions aimed at improving mental health and wellbeing of children and youth, approaches need to be tailored to different students' needs, thereby increasing inclusivity. Thornton et al.[118] also recognized the importance of addressing

broader social determinants of health, discussing the need of policy interventions targeting these determinants as a way to improve the long-term health of children and youth. This approach aligns with EDIA principles by addressing systemic problems that contribute to creating and widening health inequities among children and youth.

1.5 Measurement methods

1.5.1 Measuring neighbourhood deprivation

Although there is no consensus on a unique approach to measure neighbourhood deprivation, demographic and area-based and socioeconomic indicators (ABSIs) are frequently used for this purpose.[14,15,18] Researchers often rely on publicly available data, such as population census data, to construct these indicators, which offers the advantage of providing granular information.[14] According to Schuurman et al.[119], using smaller spatial units for mapping deprivation indices allows for a detailed characterization of neighbourhoods, capturing small areas of deprivation and affluence. This reliance on census data also imposes limitations, as researchers are constrained by the limited scope and time of data collection.[14]

ABSIs are usually combined into composite indices using statistical techniques such as principal component analysis (PCA), leading many countries to develop ABSIs based on their specific data.[14,15,120] A scoping review assessing different types of deprivation measurements identified 60 indices across 17 countries from North America, Europe, New Zealand, and Australia.[14] Most of these indices were developed at the national level and incorporated multidimensional constructs, including not only socioeconomic aspects of deprivation but also environmental (e.g., green space, dwellings, air quality) and health-related dimensions (e.g., mortality, substance use, disability).[14] While country-specific indices offer clear advantages for

health surveillance within their own population, this heterogeneity presents obstacles in terms of comparability across countries, potentially hindering global efforts to track and address deprivation on an international scale.[8,14] Another potential downside is the risk of ecological fallacy, where inferences about individuals are drawn from aggregate data.[14]

In Canada, researchers have developed national and regional indices to measure deprivation using Townsend's conceptualization.[43,120,121] To better understand the relationship between deprivation and health, Townsend distinguished two dimensions of deprivation: material and social. Material deprivation relates to limited access to goods and amenities, while social deprivation pertains to limited access to social activities and relationships.[10] Building on these concepts, Pampalon et al.[43] created a deprivation index for Quebec and Canada using six socioeconomic indicators related to material and social dimensions of deprivation. The material deprivation dimension includes the proportion of persons without a high school diploma, the employment population ratio, and average personal income. The social deprivation dimension comprises the proportion of persons living alone, the proportion of separated, divorced, or widowed individuals, and the proportion of single-parent families. This index has been widely used in Canadian research,[120] though few studies have applied it in school settings.[115,122]

Another measure of deprivation commonly used in Canadian research was initially developed by Matheson et al.[121] as the Canadian Marginalization Index (CAN-Marg).[120] In 2023, commissioned by Statistics Canada, this index was updated and renamed the Canadian Index of Multiple Deprivation (CIMD).[123] The CIMD comprises four dimensions: residential instability, economic dependency, ethno-cultural composition, and situational vulnerability. Residential instability captures how often people in a neighborhood move or change their living arrangements, including both housing and familial structures. Economic dependency examines how much people

rely on sources of income other than regular employment, including support from others or government assistance. Ethno-cultural composition pertains to the diversity of a community, focusing on immigrant populations and their characteristics. Finally, situational vulnerability assesses various social and demographic factors, such as housing conditions and education levels, while also considering other population features that might indicate disadvantage.

The recent update of the CIMD with 2021 Census of Population data further advances research and policy by offering an index with the most up-to-date demographic and socioeconomic information available.[123] In addition to the national index, the CIMD 2021 includes provincial indices for Quebec, Ontario, and British Columbia, as well as regional indices for the Atlantic and Prairie regions.[123] The Atlantic region CIMD index comprises indicators for the provinces of Newfoundland and Labrador, Prince Edward Island, Nova Scotia, and New Brunswick, while the Prairie region index includes indicators for Alberta, Manitoba, and Saskatchewan. These regional indices provide provinces and territories with tools to monitor deprivation within their jurisdictions, supporting policy development and informing resource allocation to address region-specific needs.

1.5.2 Defining standards and indicators for health promotion in schools

In the context of health promotion in schools, there is no consensus on the definition of standards and indicators. The WHO defines standards at a performance level, outlining how schools should operate to become health-promoting schools.[28] In contrast, the SHE Network Foundation views standards as specific goals that schools should strive to achieve, focusing on the quality (good or poor) of meeting these goals.[80] This distinction highlights the WHO's focus on

operational aspects, while the SHE Network Foundation considers standards as "ideals" to work towards.

The definitions of indicators also differ between these organizations. The WHO describes indicators as measurable variables to track the progress of health promotion activities, outcomes or objectives in schools.[28] Given the WHO's interest in monitoring HPS implementation across countries, they recommend using multiple data sources (e.g., global, national, regional, municipal) to populate indicators. However, this approach can be demanding due to the substantial financial and human resources involved in continuous data collection.[28] At the regional level, the SHE Network Foundation views indicators not only as tools to monitor HPS implementation in schools, but also as means to identify areas for improvement.[80] While both definitions emphasize monitoring and evaluation, the SHE Network's definition focuses on the role of stakeholders in using indicators for their specific school communities.

When developing standards for health promotion in schools, an important consideration is their achievability for school communities, considering the availability of resources and implementation barriers across school jurisdictions.[90] In this context, Sharma and Petosa[124] propose the concept of "consensus" standards, which are standards that stakeholders agree are meaningful and realistic for guiding the implementation of health promotion activities in their settings. This approach supports gathering stakeholder feedback to create standards tailored to the needs and capabilities of different school communities.

For indicators, Sharma and Petosa[124] discuss the need for theory-driven measures that can explain phenomena relevant to health education and promotion, such as behaviours or environmental conditions. The use of theory-driven indicators from behavioural or social sciences can improve health education and health promotion practices in several ways, including assessing

measurable program outcomes, identifying areas of improvement, specifying methods for behaviour change, and improving communication between stakeholders.[124] In addition to using theory-driven indicators, it's important to consider their acceptability and feasibility for securing buy-in and supporting HPS implementation activities in schools.[28,90,124] Acceptability means matching school community needs, while feasibility refers to schools' ability to implement indicators into practice.[90] To improve HPS implementation across diverse schools and communities, it is fundamental that stakeholders in both education and health sectors agree on these criteria.

1.5.3 Defining consensus among experts

Consensus can be defined as a shared understanding or agreement among a group of people, typically achieved through collaboration rather than compromise.[125] Approaches to reaching consensus involve bringing stakeholders together, usually with the assistance of a facilitator, to work towards a convergence of opinions.[125,126] Even when consensus is achieved at the group level, individual viewpoints may differ substantially.[125] These differences can affect outcomes when implementing actions based on the agreed-upon issues. Additionally, consensus does not represent the absolute truth, but rather an agreement reached by a specific group of people, reflecting its contextual nature.[125,126]

Among the research approaches for establishing consensus, the Delphi method has gained popularity in recent years.[125,127,128] This multi-stage survey aims to achieve agreement on a topic where none previously existed.[125] It involves administering an anonymous survey to experts in a particular field, seeking their opinion or judgment on a matter of interest. Responses are summarized and a second survey is developed based on initial feedback. The same group of experts

then answers this second survey, considering the first round's responses. [125,127,128] This iterative process can be repeated until consensus is achieved.[125] In this context, consensus is usually defined a priori, typically set as a percentage of agreement between 70-80%.[125,127–129] Several statistical methods are used to define expert agreement, including percentage of responses, Cohen's kappa, intraclass correlation coefficients, and Cronbach's alpha.[129]

The strengths of the Delphi method include no limitation on participant numbers, allowing for a wider range of opinions, and the use of anonymous surveys, which avoids the issue of dominant personalities commonly found in focus groups.[125,127,128] Limitations include the inability to introduce new ideas once the process has begun, potential attrition due to multiple survey iterations, and high costs associated with necessary human and financial resources.[125,127,128] Despite these limitations, the Delphi method has been widely used in school-based health research[130–135] and is regarded as an effective tool for gathering feedback and generating consensus from groups of experts.[125,127,128]

1.5.4 Measuring EDIA in schools

There is no universal definition of EDIA in education, with most countries and education systems developing their own definitions reflecting their history, priorities, and goals.[87,89] Therefore, measuring EDIA in school health represents a challenge, as there is no consensus for a reliable measurement approach. At the country level, measurement practices for EDIA in education are varied and incomplete.[87] In a 2022 report, the OECD revealed that education systems focus on collecting data about students socioeconomic, immigrant, and ethnic backgrounds, while neglecting to collect information about individual characteristics, such as sexual orientation.[87] For example, only Canada and Chile reported collecting data on sexuality of students, highlighting the

need for more comprehensive EDIA measurements. This limitation in data collection may be partially attributed to legal constraints in some countries, where legislative frameworks restrict the collection of certain personal characteristics due to privacy concerns.[87]

The literature on EDIA measurement instruments in education settings focuses on personal beliefs and attitudes of teachers, with most instruments relying on self-reporting methods.[136,137] Additionally, these instruments lack cultural responsiveness and fail to include input from stakeholders from diverse ethno-cultural backgrounds during their development.[136] A systematic review about equity, diversity, inclusion and antiracism training in educational settings found that content knowledge was the most common outcome assessed in studies, but there was no consistency across measurements, as most studies developed and applied their own survey instruments.[137] While there were efforts in developing instruments to assess EDIA in research environments,[138,139] there is still a need of a tool to assess the implementation of these principles in school settings.

1.5.5 Measuring child lifestyle behaviours in school settings

a. Measuring healthy eating in children

Assessing healthy eating in children is essential for understanding their nutritional status, identifying potential risks for developing chronic conditions (e.g., type 2 diabetes and obesity), and informing health promotion interventions.[140-142] Healthy eating refers to the consumption of a balanced and nutritious diet that meets the energetic and physiological needs of the human body.[142] This concept encompasses not only the quantity of food consumed but also the quality and diversity of the diet, including the intake of fruits, vegetables, whole grains, lean proteins, and other essential nutrients.[142,143] National dietary guidelines, such as Canada's Food Guide, usually

outline recommendations to guide healthy eating practices.[143] To measure healthy eating in children, assessment methods should capture both the quality and quantity of the diet.

Commo methods used to measure healthy eating in children include 24-hour multiple pass recalls (24-hour MPR) and food frequency questionnaires (FFQs).[140,141,144] The 24-hour MPR requires children to report all foods and beverages consumed in the previous 24 hours through interviews, paper surveys, or web-based questionnaires. While this method provides detailed information about dietary intake, it is subject to recall bias and may not capture day-to-day variations in diet.[140,141] In contrast, FFQs ask children to report their usual frequency of consumption from a list of foods over a specified period. While FFQs can capture daily dietary intake and are relatively easy to administer, they may not accurately measure portion sizes and specific food items.[140,144]

To address some of the limitations of the 24-hour MPR and FFQs, researchers have developed web-based questionnaires that combine aspects of both approaches, making healthy eating assessment more accessible and feasible for large-scale studies in school settings.[141] One such tool is the Food Behaviour Questionnaire (FBQ), which has been validated for use with school-aged children.[145] The FBQ utilizes a multiple-pass approach where students record their previous 24-hour intake of meals by choosing from a list of foods and beverages, while also including features of FFQs, such as portion size estimation.[145] Although these digital tools offer advantages such as standardized data collection and child-friendly interfaces, they rely on children's cognitive abilities to accurately recall and report their dietary intake, which can be difficult, especially for younger children.[141,144] Additionally, these questionnaires can be time-consuming, potentially leading to respondent fatigue and decreased data quality.

Despite their constraints, these questionnaires facilitate the evaluation of children's adherence to healthy eating guidelines.[141] In Canada, the Healthy Eating Food Index (HEFI-2019) has been developed to assess adherence to the Canadian Food Guide.[146] Dietary information collected through 24-hour MPR or FFQs can be used to calculate HEFI-2019 scores,[147] providing school health professionals with a standardized measure of children's healthy eating to identify areas for improvement and inform health promotion interventions in school settings.

b. Measuring child physical activity

In population-based research, including school settings, several methods are used to assess physical activity in children, such as pedometers, accelerometers, and self-report questionnaires.[148–150] Pedometers count steps, providing a cost-effective measure of physical activity, but cannot capture intensity or non-ambulatory movements.[148,150] Accelerometers, the most cited devices for measuring physical activity,[148–150] are technically advanced in measuring movement intensity and patterns. Yet, they are expensive and may not accurately capture certain activities like cycling or swimming.[148–150] Due to these limitations, self-report measures are preferred for large-scale studies in schools.[149]

Despite being susceptible to recall bias and overestimation of activity levels, self-report tools offer advantages including low cost, ease of administration to large groups, and the ability to capture contextual information about physical activity.[148–150] The Physical Activity Questionnaire for Older Children (PAQ-C) is an example of a self-report tool, which has been validated for use with Canadian elementary school children in grades 4-8.[151] This questionnaire assesses general physical activity levels over the past seven days, providing a look into children's school, home, and recreational activites.[151] As an inexpensive and easily administered tool, the PAQ-C offers

researchers and educators a resource for assessing children's physical activity in school settings, facilitating the development of interventions to promote active lifestyles among students.[152]

c. Measuring child screen time

Several methods are available to measure screen time in children, including direct observation, tracking devices, and self-reported questionnaires.[153,154] While direct observations and tracking devices offer detailed and accurate measurements, they can be time-consuming, intrusive, and expensive.[153,154] In contrast, self-reported questionnaires, though susceptible to recall bias and potential underreporting, are cost-effective and capable of capturing contextual information about screen use. As a result, these questionnaires are the most accessible and frequently used measure to assess children's screen time.[153,154] However, the lack of standardized questionnaires for assessing screen time in children presents a limitation for school health research.[155] This lack of standardization not only affects the comparability of studies but also limits the development of strategies to address excessive screen use among children.[155]

d. Measuring child mental health and wellbeing

The WHO defines mental health as a state of mental wellbeing that enables individuals to cope with life's difficulties, realize their potential, learn and work effectively, and contribute meaningfully to their communities.[156] As an abstract construct, measuring mental health and wellbeing is complex, especially in children.[150] Although no gold standard exists for assessment, self-reported questionnaires are the most common approach for evaluating mental health and wellbeing in children and young people.[158–160] Several validated instruments are available for use in clinical settings, including the Strengths and Difficulties Questionnaire (SDQ),[161]

KIDSCREEN,[162] and the WHO's Five Wellbeing Index (WHO-5).[163] While some of these have been used in school settings, there is a lack of appropriate, age-specific instruments that are both psychometrically sound and suitable for educational contexts.[160]

In Canada, APPLE Schools research has successfully used a child-centered tool to assess mental health and wellbeing in children.[100,122,164] The instrument was derived from a population-based survey and asks children to rate 12 statements related to their feelings, including both positively (e.g., "my future looks good to me," "I feel like I belong at school") and negatively worded items (e.g., "I worry a lot," "I am in trouble with my teacher[s]"). This design offers a brief yet multidimensional assessment that allows for emotional reflection while maintaining a child-friendly format, making it a practical for use in school settings.

1.6 Research questions and objectives

This thesis examines school-based approaches to address child health inequities in Canada. The thesis is structured around two research questions:

a) Which standards and indicators for HPS implementation and sustainment are achievable, acceptable, and feasible in Canadian settings, according to education and school policy experts?
b) Does the implementation of EDIA school practices modify the relationship between school neighbourhood deprivation and children's lifestyle behaviours and mental health and wellbeing?

To address these research questions, the specific objectives of this thesis are to:

a) Conduct a review of peer-reviewed and grey literature to create an inventory of statements relevant to the implementation and sustainment of the HPS approach in Canadian settings;

b) Apply the Delphi method to build consensus among education and school policy experts on which standards and indicators for HPS are achievable, acceptable, and feasible in Canadian settings;
c) Determine whether the implementation of EDIA school practices modifies the effects of school neighbourhood deprivation on students' diet quality, physical activity, screen time, and mental health and wellbeing.

1.7 Structure of the Thesis

This thesis follows a paper-based format and comprises four chapters. Chapter 1 provides a literature review, identifies research gaps, and introduces the research questions and objectives that guide this thesis. Chapter 2 comprises a study that combines a literature review, content analysis, and application of the Delphi method to develop standards and indicators for implementing and sustaining the HPS approach in Canadian settings. Chapter 3 includes a cross-sectional analysis using data collected from the APPLE Schools initiative during the Springs of 2023 and 2024 to examine whether the presence of EDIA school practices modifies the relationship between school neighbourhood deprivation and children's lifestyle behaviours and mental health and wellbeing. Finally, Chapter 4 summarizes the research findings, identifies strengths and limitations, discusses implications for policy and practice, and suggests directions for future research.

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Chapter 2: Developing Standards and Indicators to guide implementation and sustainment of Health Promoting Schools in Canada

2.1 Introduction

Health Promoting Schools (HPS) is a holistic approach, developed by the World Health Organization (WHO) to promote children's learning, as well as health and wellbeing of all members of the school community by making changes to the curriculum, school policies, and school environment.[1,2] The HPS approach has been shown to improve children's academic, physical, and mental health outcomes.[1,3,4] Given the existing and emerging public health challenges, such as substance use, vaping, bullying, and deteriorating lifestyle behaviours that put individuals at an increased risk of chronic diseases later in life, as well as increasing prevalence of mental illness fuelled by the COVID-19 pandemic and rising income and health inequities,[5–9] the HPS approach has re-entered the spotlight as an effective strategy to support the learning, health and wellbeing among school-aged children.[1,10]

To ensure the effective implementation and sustainment of HPS in school jurisdictions at the national level, we first need to agree on a set of standards and corresponding indicators to meet these standards.[10–14] Although the WHO and European sets of standards and indicators exist and serve as valuable resources,[10,15] the implementation and sustainment of the HPS approach are highly contextual. Canada's decentralized education system is unique as it is governed independently by 13 provinces/territories and is comprised of multiple school jurisdictions with distinct needs, priorities, cultures, and ethnically diverse communities.[16,17] Therefore, Canada needs its own set of standards and indicators to provide school administrators, teachers, students, families, local communities, policymakers, health service providers, health promotion professionals, and school health stakeholders with a roadmap to guide implementation, tailoring,

sustainment, monitoring, and evaluation of HPS in their school communities.[18] Herein we describe a process of developing national standards and indicators for HPS in Canada. The process is comprised of two steps: 1) a literature review to derive a comprehensive inventory of statements related to the implementation and sustainment of HPS; and 2) a consensus seeking process to establish a set of standards and indicators for HPS that are specific to Canada.

2.2 Methods

2.2.1 Step 1: Rapid Review of the Literature

To create an inventory of statements related to standards and indicators for HPS, we conducted a rapid review of peer-reviewed and grey literature. We searched Google Scholar, PubMed, Medline, and ERIC databases for peer-reviewed publications and Canadian public health websites for grey literature, and considered statements included in 8 key international reports.[10,19–25] The keywords used in literature searches were the following: ("health promoting school" OR "comprehensive school health" OR "coordinated school health") AND ("standards" OR "guidelines" OR "evaluation" OR "health promoting school assessment" OR "principles" OR "quality" OR "indicators" OR "planning" OR "maintenance" OR "adaptation" OR "scaling" OR "quality assurance" OR "implementation" OR "monitoring") AND "Canada." We screened the bibliographies of the identified publications for further relevant literature. Publications with titles and/or abstracts referring to HPS or its equivalents (i.e., Comprehensive School Health (CSH) and Whole-School Health) were deemed relevant. One reviewer (CH) screened the full text of these publications to assess whether they met each of the following criteria: 1) contained statements related to the implementation, adaptation, sustainment, scaling, and monitoring and evaluation of HPS or its equivalents; 2) was published in English; and 3) was published between 2012 and 2023.

A second reviewer (SS) verified the assessment by CH. Publications that met these criteria were rated on quality: publications were considered "high quality" if they were peer-reviewed or included statements related to standards and indicators derived from rigorous research with references to the peer-reviewed literature; "medium quality" if statements referenced grey literature only; "low quality" if statements originated from panel discussions or workshops without referencing the peer-reviewed or grey literature; and "very low quality" if the origin of statements was unclear. Initially, we limited the extraction of statements to the "high quality" publications only. Statements that were worded slightly differently but described the same underlying concept were considered duplicates, and those that addressed the same underlying concept(s) but provided additional context or details were merged. Informed by the *European Standards & Indicators for Health Promoting Schools*[19] and expert consultation, we compiled a list of 17 areas of interest for HPS in Canada (described further in the next section) and mapped the extracted statements to these areas of interest. Given the scarcity of statements in three of these areas (equity, diversity, inclusion and accessibility [EDIA] and school health, Indigenous Peoples and school health, and sustainment of the HPS approach), we also extracted the statements related to these areas of interest from the "medium quality" publications. We then classified the extracted statements either as standard components (which would drive the development of standards in further steps described below) or as indicators, using the following definitions: standards are the guiding principles and expectations of the implementation and sustainment of HPS; standard components are sub-components of these standards; and indicators are the monitoring tools or signs that indicate whether schools are meeting the standards for the implementation and sustainment of HPS.[18]

2.2.2 Step 2: Consensus Seeking Process

We conducted a three-round online Delphi survey to seek consensus on which standard components and indicators identified in Step 1 (see above) should be included in the set of national standards and indicators for HPS. The Delphi method is a structured process of soliciting experts' opinions through multiple survey rounds, whereby each consecutive survey round incorporates the results of the previous round,[26,27] and is widely used in school health research.[28–32] Using our professional networks (e.g., Pan-Canadian Joint Consortium for School Health), we recruited a convenience sample of experts in school health policy and education from 13 provinces/territories across Canada. In addition, we employed snowball sampling by asking these experts to suggest other experts and/or disseminate the information about this study through their professional networks. This yielded an initial roster of 87 experts, from which we selected 71 experts that rated their level of experience with HPS as 3 or greater on a 5-point scale, ranging from 1 "no experience" to 5 "extensive experience." We assigned these experts to a "policy expert panel" (EP1) or an "education expert panel" (EP2) based on their expertise. EP1 was comprised of government employees, health promotion professionals working for not-for-profit organizations, and academics working with HPS research at the policy level. EP2 included educators (school administrators, teachers, school health champions, and other school staff), health promotion practitioners working with schools, and academics working in HPS research at the school level.[18]

EP1 experts were asked to appraise standard components and indicators in the following eight areas of interest: 1) HPS approach; 2) School health policies; 3) Health and wellbeing of teachers and school staff; 4) Professional development; 5) School health services; 6) Resources; 7) Sustainment of the HPS approach; and 8) Monitoring and evaluation. EP2 experts were asked to appraise standard components and indicators in the following nine areas of interest: 1) School

physical environment; 2) School social environment; 3) Safety in the school environment; 4) Curriculum and health education; 5) Governance and leadership in the school community; 6) Communication; 7) Partnerships and collaborations; 8) EDIA in school heath; and 9) Indigenous Peoples and school health. In each round of the Delphi survey, experts were asked to appraise each standard component in terms of its achievability (i.e., is it realistic to achieve). Experts were also asked to appraise each indicator in terms of its acceptability (i.e., is it acceptable) and feasibility (i.e., is it doable). Experts were asked to indicate their agreement with each statement using a 5-point Likert scale (strongly disagree, disagree, neutral, agree, and strongly agree). Additionally, experts were asked to update, add details, split, merge, and reword or suggest new standards components and indicators.

Before the first survey round, experts were provided with an instructional video that explained the 17 areas of interest and the appraisal process. Before the second and third survey rounds, experts were provided with a summary report of the preceding round, including average ratings and changes to the standard components and indicators. Experts were given two weeks to respond to each survey round. Experts who did not complete their appraisal within two weeks were excluded from subsequent rounds, as per existing recommendations for the Delphi process.[26,27] Consensus was defined as ≥80% of experts responding strongly agree/agree or disagree/strongly disagree. Standard components and indicators that reached consensus in one of the survey rounds were excluded from further appraisal in subsequent survey rounds: specifically, those that reached consensus for strongly agree/agree were retained for the final set of standards and indicators, while those that reached consensus for strongly disagree/disagree were removed from further consideration. Standard components and indicators that did not reach consensus in the first or second survey rounds were included in the subsequent survey round.

Finally, the standards components for which consensus was reached were grouped into standards. This process was guided by: (1) established school health concepts (i.e., CSH, HPS)[10,33]; (2) asset-based approaches that recognize the strengths and resources within individuals, communities, and systems, fostering inclusivity, equity, and empowerment in education and health sectors[34]; (3) implementation science frameworks that focus on facilitating the uptake of evidence-based practices and distinguishing between the school community (inner setting) and external enablers (outer setting)[35]; (4) Canadian context and values that embrace the unique Canadian attributes (i.e., EDIA principles, Indigenous perspectives) and address systemic issues, including those highlighted by the Truth and Reconciliation Commission[36]; and (5) written feedback from education and policy experts across Canada, who expressed support for the asset-based approaches and highlighted the significance of the broader school community, diversity, Indigenous perspectives, effective leadership, and supportive governance systems in achieving HPS goals. Subsequently, we mapped the indicators to these standards. Experts provided informed consent prior to participating in the first round of the Delphi survey and were offered a $20 e-gift card for completing the first round, a $50 e-gift card for completing the first two rounds, and a $100 e-gift card for completing all rounds. This study was approved by the University of Alberta Research Ethics Board (Pro00121761).

2.3 Results

2.3.1 Step 1: Rapid Review of The Literature

The rapid review of the literature yielded 490 relevant peer-reviewed and grey literature publications (see Figure 2.1). Of these publications, 23 were rated as “high quality” and 4 as “medium quality”. We extracted 939 statements related to standards and indicators from the key

reports[10,19–25] and "high quality" publications,[11–13,37–56] and 66 statements related to the three under-represented areas of interest from "medium quality" publications.[57–60] De-duplication (i.e., sorting and merging similar statements together) resulted in 147 statements, which we grouped into 42 standard components and 105 indicators.

2.3.2 Step 2: Consensus Seeking Process

Of the 71 selected experts, we assigned 28 to EP1 and 43 to EP2. In EP1, 24 (86%) experts completed round 1, 22 (92%) completed round 2, and 21 (95%) completed round 3. In EP2, 29 (67%) completed round 1, 26 (90%) completed round 2, and 25 (96%) completed round 3. Table 2.1 shows descriptive characteristics of the experts who participated in the two panels. Most experts were women, 35-49 years of age, and described their level of experience with HPS as "extensive". They represented 11 of the 13 Canadian provinces and territories.

Figure 2.2 shows the flowchart of the consensus seeking process. In the first round, EP1 reached consensus on 9 of the 17 standard components and suggested three new standard components and changes to 8 standard components for which no consensus was reached. Additionally, four indicators became redundant and were removed. In the second round, EP1 reached consensus on all standard components. EP2 required 3 rounds to reach consensus on all standard components. The appraisal and consensus seeking process resulted in 45 standard components. In 3 rounds, EP1 and EP2 reached consensus on 87 of the 105 (81%) indicators.

Finally, these 45 standard components were grouped into nine standards, which were categorized into four descriptive domains (see Table 2.1). The grouping allowed some standard components to be merged, bringing the total number of standard components to 37. In the process of mapping indicators to the nine standards, indicators that were "indicative" of more than one

standard were listed under each of these standards. This brought the total number of indicators to 100. For most standard components and indicators, the wording changed throughout this step. For example, the standard component that was initially worded as "The implementation and maintenance of the HPS approach acknowledge the specific needs of all students and school communities" extracted from the literature, was revised to read "The implementation and sustainment of the HPS approach is tailored to the unique perspectives, priorities, and specific needs of students and school communities." The complete wording of the nine standards, 37 standard components, and 100 indicators is published online.[18]

2.4 Discussion

In this study, we employed a rigorous approach to identify and evaluate a comprehensive set of standards and indicators that can guide the implementation and sustainment of the HPS approach in Canada. First, building on the literature available to date, we conducted a rapid review to identify HPS-related statements, which were then categorized into standard components and indicators. Two expert panels then appraised the achievability of standard components, and the acceptability and feasibility of indicators. Throughout the three rounds of the consensus seeking process, experts were encouraged to fine-tune standard components and indicators to ensure they are appropriate and up to date. Finally, to ensure that standards and indicators are realistic and practical and thus can effectively guide the implementation and sustainment of the HPS approach, we designed the expert panels in such a way that each panel included experts with diverse expertise in school health policy and education (e.g., government employees, health promotion professionals, school administrators, teachers, and academics working with HPS research at the policy and school level).

Having a comprehensive set of well-defined standards and indicators is critical to the success and acceptability of the HPS approach, which comes with important short- and long-term benefits to students and the wider school community. A recent systematic review of school-based health promotion programs showed that HPS was the most effective and cost-effective approach and produced the most favourable return on investment.[3] Among the standard components we identified, many revolve around children's healthy lifestyle behaviours, including healthy eating and active living and mental health, and this is not surprising. Collectively, healthy lifestyle behaviours have the potential to prevent 80% of type 2 diabetes and cardiovascular disease, 40% of cancers, along with other chronic diseases.[61] In Canada, the public health burden of mental illness is considerable, affecting as many as 20% of adolescents and predisposing to negative psychosocial and health outcomes later in life.[62,63] The COVID-19 pandemic-related school closures, isolation, and rise in domestic stressors disrupted these safe and structured environments needed for children to flourish[64] and thus added to the public health burden of mental illness in Canada.[62,63] Moreover, we recently demonstrated that the pandemic exacerbated inequalities in lifestyle behaviours that will translate into further inequities in future health.[65] Elsewhere we highlighted the promise of the HPS approach in mitigating the negative impact of the pandemic on lifestyle behaviours and mental illness.[66,67] Given the spectrum of public health challenges affecting children, it is important now more than ever that Canada invests in the HPS approach. We hope that the formulation of the national HPS standards and indicators will guide this investment.

Finally, while the European and WHO reports emphasize student safety, health and wellbeing, the proposed set explicitly addresses the EDIA and Indigeneity principles that are integral to the Canadian culture. Therefore, the Canadian set includes standards, with multiple

standard components and indicators grouped under them, that can help address the unique needs of students with diverse ethno-cultural backgrounds and honour Indigenous Peoples and their heritage. Moreover, the Canadian set includes a number of standard components and indicators related to mental health and wellbeing and the sense of belonging, likely owing to the timing of this study that took place in post-pandemic. Finally, in consultations with our education and policy experts, we specified an actor or level of responsibility for each indicator to provide clarity and accountability in implementing the standards, making the indicators more attainable and actionable for stakeholders involved in HPS initiatives.

This study has several strengths. We employed a rigorous methodological approach to establish a comprehensive set of standards and indicators for HPS implementation and sustainment, which will serve as a valuable resource for other jurisdictions and countries seeking to develop their own HPS standards and indicators. We recruited 53 experts with diverse expertise in school health policy and education across geographic regions of Canada. We assigned experts to two panels based on their expertise and asked each panel to appraise statements within their area of expertise. Several limitations warrant to be considered. The Delphi method is a valuable tool to gather expert feedback on a pre-specified set of questions or practices, but may have limited utility for the introduction of new ideas. Nonetheless, participants had several years of experience with HPS. Moreover, we were limited by the scope and quality of existing literature on HPS implementation and sustainment, particularly in Canadian settings. We attempted to mitigate these limitations, at least partially, by offering participants an opportunity to leave comments and encouraged them to revise existing or suggest new standard components and indicators.

2.5 Conclusion

In this study, we provide the rationale and methodological underpinnings for establishing Canadian standards and indicators for HPS. Through a rigorous approach of engaging experts in multiple rounds to appraise, update, split, merge, reword, and reach consensus on a comprehensive inventory of existing HPS statements, we established a comprehensive set of up-to-date, realistic, and practical Canadian standards and indicators to support the implementation and sustainment of the HPS approach in Canadian settings. The methodological approach we took may be viable for application in other settings and jurisdictions that wish to establish or update standards and indicators for HPS.

Table 2.1. Demographic characteristics of experts participating the Delphi consensus seeking process for the establishment of national standards and indicators for Health Promoting Schools

	Policy expert panel (n=24)	Education expert panel (n=29)
Gender[a], %		
Woman	79.2	62.1
Man	20.8	37.9
Age, %		
<35 years old	8.3	10.3
35-49 years old	54.2	58.6
50-65 years old	37.5	27.6
>65 years old	-	3.4
Ethnic background, %		
Caucasian	95.8	89.7
Indigenous	-	6.9
Prefer not to answer	4.2	3.4
Province or Territory, %		
Newfoundland and Labrador	12.5	-
Prince Edward Island	12.5	-
Nova Scotia	8.3	3.4
New Brunswick	4.2	-
Ontario	16.7	6.9
Manitoba	8.3	27.6
Saskatchewan	8.3	24.1
Alberta	16.7	31.0
British Columbia	4.2	3.4
Yukon	4.2	-
Northwest Territories	4.2	3.4
Population centre[b], %		
Rural or remote community	4.2	10.3
Small community	16.7	37.9
Medium community	8.3	6.9
Large community	70.8	44.8
Level of experience with HPS[c], %		
Moderate experience	16.7	20.7
Considerable experience	33.3	37.9
Extensive experience	50	41.4
Years of experience in current role, %		
< 1 year	12.5	6.9
1 to 4 years	45.8	24.1
5 to 15 years	29.2	41.4
> 15 years	12.5	27.6

[a] Cisgender and Transgender.

[b] Rural or remote community: <1,000 people; Small community: 1,000 - 29,999 people; Medium community: 30,000 - 99,999 people; Large community: >100,000 people.[49]

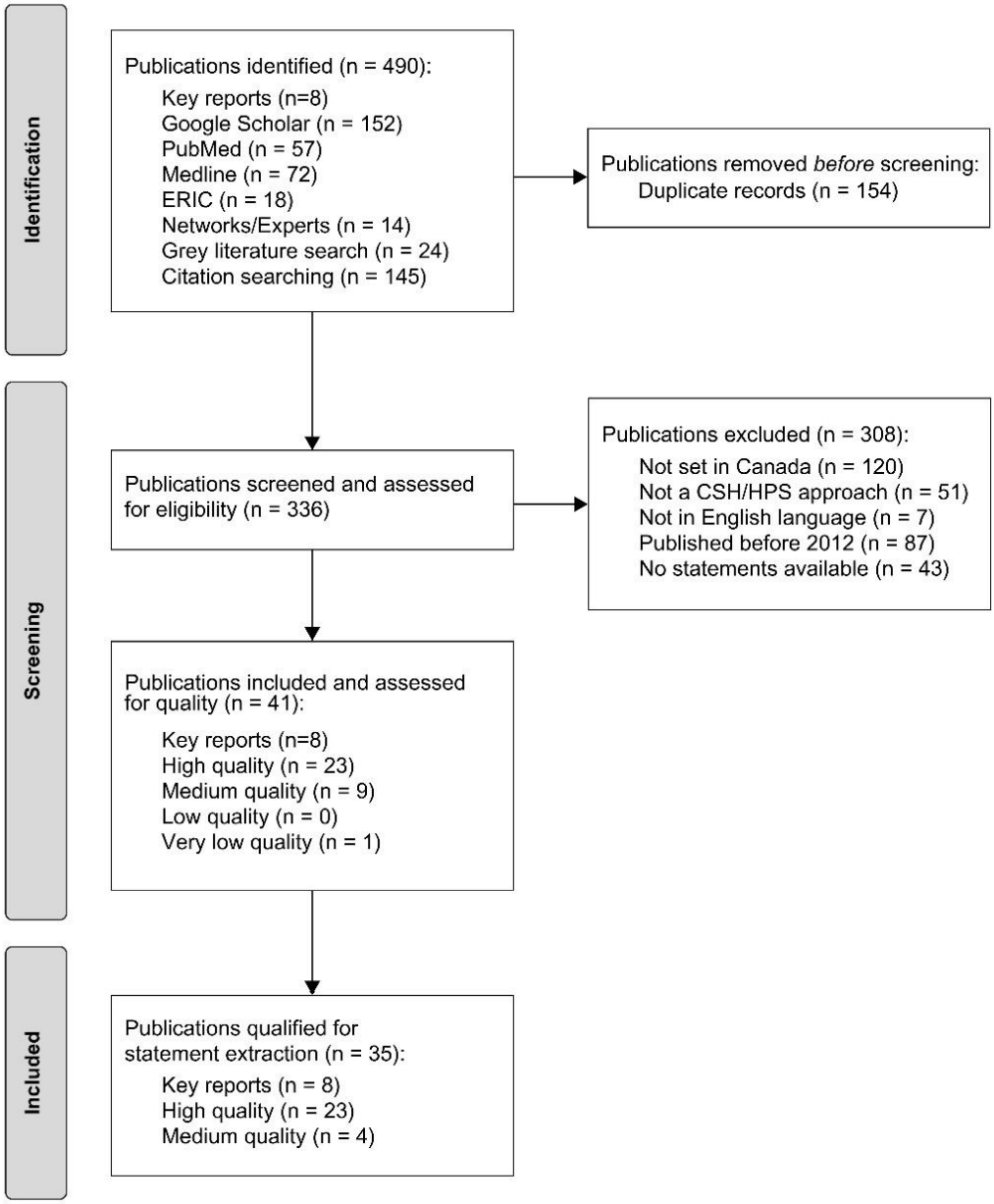
[c] Participants were asked to rate their level of experience with HPS on a scale of 1 (no experience) to 5 (extensive experience).

Table 2.2. Domains and Standards for Health Promoting Schools in Canada

Domains	Standards
The Health Promoting School	1. School engages the community for the implementation and sustainment of the HPS approach. 2. School leadership is dedicated to the HPS approach. 3. School policies support the HPS approach. 4. School environment is conducive to the safety and health and wellbeing of students and school staff. 5. School's curriculum and health education prepare students for healthy futures.
Enablers	6. Governing system prioritizes and supports the HPS approach. 7. School health services support the health and wellbeing of all students.
Canadian Values	8. School promotes equity, diversity, inclusion, accessibility, and Indigeneity.
Quality Improvement	9. Monitoring and evaluation inform the implementation and sustainment of the HPS approach.

HPS: Health Promoting School

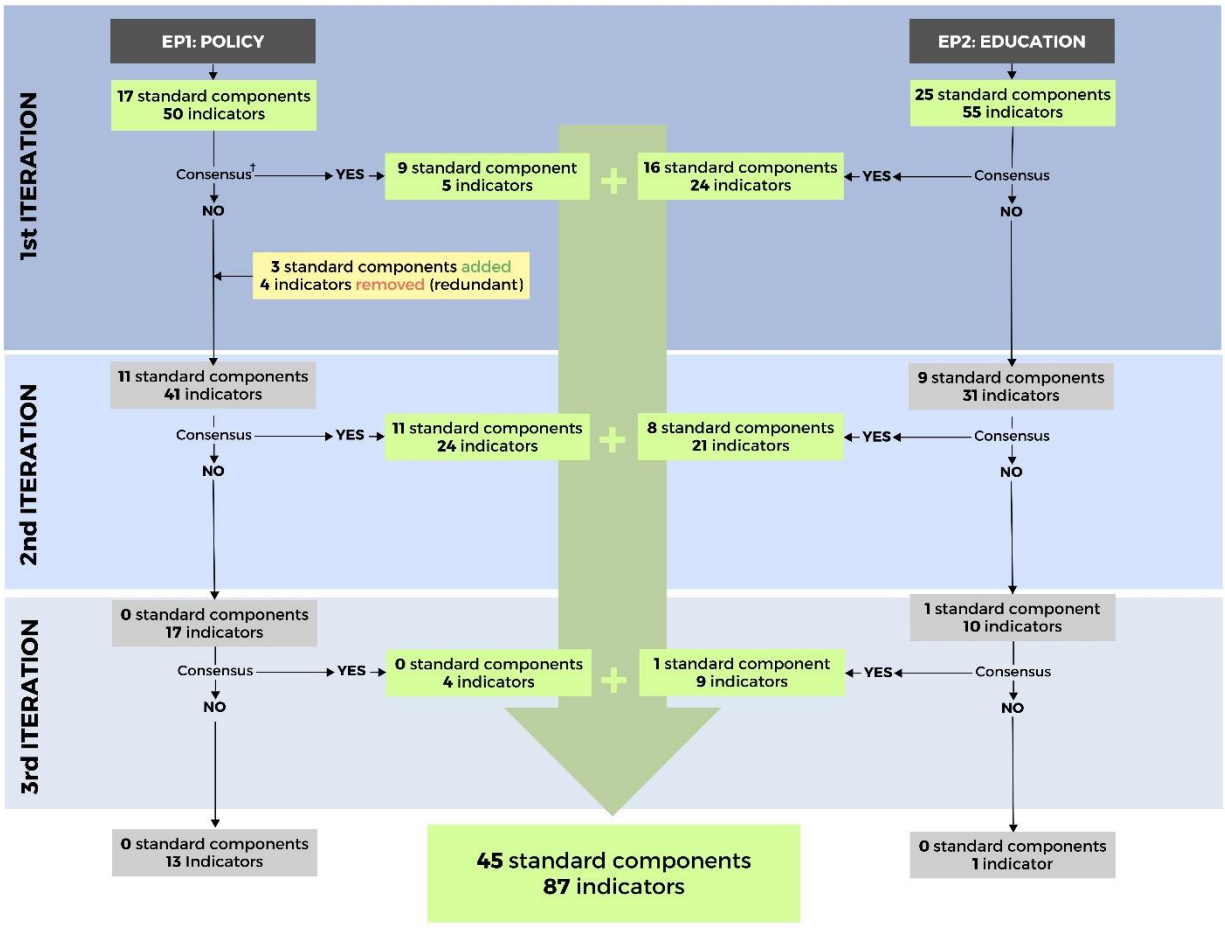
Figure 2.1. Summary of the selection of publications with statements related to standards and indicators for Health Promoting Schools



CSH: Comprehensive School Health; EDIA: Equity, diversity, inclusion, and accessibility; HPS: Health Promoting Schools; High quality: peer-reviewed or grey literature publications that included statements derived from a rigorous research process or cited references related to the formulation of the statements); Medium quality: peer-reviewed or grey literature publications in which statements originated from an expert panel or a workshop; Low quality: publications where

statements were the product of an expert panel or workshop; Very low quality: publications with statements but with no references (e.g., flyer).

Figure 2.2. Flow chart of the Delphi consensus seeking process for the establishment of national standards and indicators for Health Promoting Schools



EP: Expert panel

†Consensus was defined as ≥80% of participating experts responded strongly agree/agree or responded disagree/strongly disagree.

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Chapter 3: The role of equity, diversity, inclusion, and accessibility in mitigating child health inequities in deprived neighbourhoods of Alberta, Canada

3.1 Introduction

Exposure to neighbourhood deprivation during childhood can have long-lasting detrimental effects on health and development.[1–3] Townsend[4] defined deprivation as extending beyond economic poverty to encompass limited access to adequate education, nutrition, housing, and social networks. This multidimensional concept of deprivation has been recognized as a social determinant of child health.[1–3] Studies have demonstrated that children living in deprived neighbourhoods are more likely to have unhealthy diets, sedentary behaviours, and worse mental health and wellbeing, compared to those from more affluent neighbourhoods.[5–10] The impact of deprivation persists into adulthood, increasing the risks of unhealthy behaviours, such as smoking and alcoholism, disability, and premature mortality.[11,12] Addressing the effects of neighbourhood deprivation on child health early is essential to mitigate these long-term consequences.

While existing research on the effects of neighbourhoods on child health has focused on the places where children live, this approach may not fully capture their exposure to deprivation.[1–3,13,14] As children spend substantial time in and around schools, the characteristics of school neighbourhoods may also influence their health and wellbeing.[15–17] Schools are ideal settings for developing life-long health behaviours and potentially mitigating the adverse effects of neighbourhood deprivation.[16,17] To foster school environments that support both health and learning, ensuring equal opportunities for all children is fundamental.[18,19] This could be achieved by integrating principles of equity, diversity, inclusion, and accessibility (EDIA) into school culture. School-based interventions targeting inclusion have let to improvements in healthy eating

and physical activity levels among children,[20–22] reinforcing the potential of these approaches for health promotion.

In Canada, integrating EDIA principles into school culture is important to support an increasingly diverse student population. The country is undergoing its largest demographic shift in 150 years, with immigrants comprising 23% of the Canadian population in 2021.[23,24] Adding to this diversity, data from the 2019 to 2021 Canadian Community Health Survey revealed that 10.5% of youth aged 15 to 24 years self-identified as Two-Spirit, lesbian, gay, bisexual, transgender, queer, or other gender and sexual diversities (2SLGBTQ+).[25] Moreover, EDIA school culture is necessary to address the systemic effects of colonialism and ongoing prejudice against Indigenous Peoples, as noted by the Truth and Reconciliation Commission of Canada.[26] In response to these demographic shifts and historical inequities, implementing EDIA principles in schools has become an important strategy to ensure equitable education and support for all students.

Implementing EDIA in schools is a complex process that requires commitment from principals, teachers, parents/guardians, and the broader school community.[27,28] Implementation of complex processes usually occur in stages over time, ranging from partial implementation, where schools assess the fit and feasibility of new practices, to full implementation, where the practices are fully integrated and sustained into school culture.[29] EDIA school practices involve a broad range of activities, including curriculum adaptation, culturally sensitive teaching methods, inclusive language use, and resource allocation according to local priorities.[19] These practices ensure that all students, regardless of their ethnic background, culture, sexual orientation, gender identity, or Indigenous heritage, have equitable access to supportive school environments.[19,30] The importance of such practices has been amplified by the COVID-19 pandemic, which has contributed to widening health inequities among children.[31,32] By promoting social justice and

fostering positive learning environments,[19,28] EDIA practices could mitigate the effects of school neighbourhood deprivation on children's health and wellbeing. However, to the best of our knowledge, no studies have evaluated how EDIA practices might modify the relationship between school neighbourhood deprivation and child health. Understanding this relationship is crucial for developing effective strategies to address health inequities in diverse school settings. Therefore, the present study aimed to examine whether the implementation of EDIA school practices modifies the relationship between school neighbourhood deprivation and children's lifestyle behaviours and mental health and wellbeing. By investigating this relationship, we seek to provide insights that can inform policy decisions and guide the development of targeted interventions to promote health equity among school-aged children in Canada.

3.2 Methods

3.2.1 Study design and participants

This was a cross-sectional study conducted in 28 elementary schools participating in the APPLE Schools (A Project Promoting healthy Living for Everyone in schools) initiative in Alberta, Canada. APPLE Schools is an innovative comprehensive school health (CSH) initiative that has been improving healthy eating, physical activity, and mental health habits of students living in socioeconomically disadvantaged communities in Western Canada.[22,31,33–35] Data were collected through school-based surveys from grade 4-6 students (mostly aged 9 to 12 years) during the Springs of 2023 and 2024.

Students completed a one-hour survey during regular class time and reported their gender, grade, family affluence, 24-hour diet intake, physical activity, screen time, and mental health and wellbeing. Prior to survey administration, parents/guardians provided active-informed passive

consent for their child to participate in the study and students provided assent. Out of the 3,319 students invited, 1,970 completed the survey, with a response rate of 59.35%. In addition, 28 school principals completed an online survey about their schools' practices and policies. All study procedures were approved by the Health Research Ethics Board of the University of Alberta (Pro00119951), Unity Health Toronto Research Ethics Board (REB# 22-118) and participating school boards.

3.2.2 Outcomes of interest: student lifestyle behaviours and mental health and wellbeing

Dietary intake: Students completed a validated web-based food behaviour questionnaire.[36] This tool used a multiple-pass approach, in which students recorded their previous 24-hour intake of meals, snacks and beverages, including serving sizes for each food item (0.5, 1, 1.5, 2, 2.5, or 3 servings). Dietary data was used to estimate students' daily intake of sodium, free sugars and saturated fat in grams, total daily energy intake in kilocalories, and to calculate the Healthy Eating Food Index 2019 (HEFI-2019). The HEFI-2019 evaluates how food choices align with the 2019 Canada's Food Guide (CFG) recommendations and ranges from 0 to 80 points, with higher scores indicating better alignment with the 2019 CFG.[37]

Using Canada's Dietary Guidelines,[38] sodium, free sugars and saturated fat intake were categorized as adequate or excessive based on the following cut-off values: excessive sodium intake was defined as equal or greater than 2,300 mg per day, while excessive free sugars and saturated fat intake were defined as equal or greater than 10% of total daily energy in kilocalories. The HEFI-2019 score was dichotomized at the centre of the scale, with scores equal or greater than 40 points considered as "higher HEFI-2019 scores" and less than 40 as "lower HEFI-2019 scores".

Physical activity: Students completed the Physical Activity Questionnaire for Older Children (PAQ-C).[39] The PAQ-C scores range from 1 to 5, with higher scores indicating higher physical activity. Physical activity levels were dichotomized at the centre of the PAQ-C scale, with scores equal or greater than 2.5 points considered as "higher physical activity" and less than 2.5 points as "lower physical activity".

Screen time: Students reported how many hours per day they spend (a) watching videos, (b) playing video games, and (c) chatting using any type of electronic device (e.g., cellphones, iPads, computers, game consoles, TVs) on weekdays and weekends. Response options were on a scale from 0 hours to more than 8 hours a day. The average screen time for each activity was calculated using the formula [(weekday screen time * 5 + weekend screen time * 2) divided by 7 days]. The screen times for all three activities were summed and then averaged to obtain the total daily screen time. Based on the Canadian 24-Hour Movement Guidelines for Children and Youth,[40] total daily screen time was categorized as adequate (equal to or less than 2 hours per day) or excessive (greater than 2 hours per day).

Mental health and wellbeing: Using an instrument derived from a population-based survey,[41] students were asked to rate 12 statements related to their feelings, including 7 positively worded items ("my future looks good to me," "I like the way I look," "I like myself," "I feel like I belong at school," "I do well in my school work," "I feel like I have many friends," and "If I have problems, there is someone I trust to go to for advice") and 5 negatively worded ones ("I feel unhappy or sad," "I worry a lot," "I am in trouble with my teacher[s]," "I have trouble paying attention," and "I have trouble enjoying myself"). A 3-point scale ("never or almost never," "sometimes," "often or almost always") was used in the survey. Each response option was assigned a score of 1, 2 and 3 for "never or almost never", "sometimes", and "often or almost always",

respectively for positively worded items and reverse coded for negatively worded ones. Points were summed to create a cumulative score for mental health and wellbeing, ranging from 12 to 36, with higher scores indicating better mental health and wellbeing. Mental health and wellbeing scores were dichotomized at the centre of the scale, with scores equal or greater than 24 considered as "good mental health and wellbeing" and less than 24 points as "poor mental health and wellbeing."

3.2.3 Exposure of interest: school neighbourhood deprivation

School neighbourhood deprivation was assessed using the 2021 Canadian Index of Multiple Deprivation (CIMD).[42] Informed by the Canadian Marginalization Index (CAN-Marg),[43] the CIMD is a composite index that quantifies multiple dimensions of deprivation at the smallest census geographic unit, the dissemination area (DA), which is usually comprised of 400 to 700 people living in one or more adjacent dissemination blocks.[42,44] The CIMD was calculated with unsuppressed and unrounded data derived directly from the 2021 Census of Population.[42] Using principal component analysis, information from 55,827 DAs and 32 census indicator variables, selected by established literature and in consultation with experts, were condensed into four dimensions of deprivation, namely: (1) residential instability, which represents the fluctuation of the neighbourhood population in a given area; (2) economic dependency, which reflects a neighbourhood's reliance on sources of income other than employment income; (3) ethno-cultural composition, which captures the ethnic diversity of a neighbourhood population; and (4) situational vulnerability, which measures the sociodemographic conditions related to education and housing in a neighbourhood.[42]

In this study, we developed a provincial index specific to Alberta, isolating 6,010 Das from the Prairie Region CIMD (see Table 3.S1).[42] We mapped school postal codes to their respective DAs using the 2021 Census of Population information and subsequently matched these to our provincial CIMD index, working as a proxy for the level of school neighborhood deprivation experienced by the student population. To facilitate interpretation, we categorized each dimension scores into tertiles of deprivation, with tertile 1 representing "lower deprivation" (or lower diversity for ethno-cultural composition) and tertile 3 representing "higher deprivation" (or higher diversity for ethno-cultural composition) for each dimension of deprivation.

3.2.4 Potential moderator: implementation of EDIA school practices

School principals completed an online survey about their schools' practices and policies. To assess the level of implementation of EDIA school practices in their schools, school principals were asked to answer "yes," "no" or "unsure" to the following questions: (1) "does your school or school district have policies or guidelines related to offering EDIA-relevant curriculum and programs?", (2) "does your school support professional development of teachers related to offering EDIA-relevant curriculum and programs? (e.g., Circle of Courage)," (3) "does your school communicate with staff regarding EDIA-relevant curriculum and programs? (e.g., agenda items at staff meetings)," (4) "does your school communicate with families regarding EDIA-relevant curriculum and programs? (e.g., newsletters, announcements, parent information nights)," and (5) "does your school have a specific committee to address EDIA-relevant curriculum and programs?". Each response option was assigned a score of 1 for "yes" and 0 for "no" or "unsure". A composite score for implementation of EDIA school practices was calculated by summing the scores for all responses, resulting in a score range of 0 to 5, with higher scores indicating more

implementation of EDIA school practices. To facilitate analysis, we dichotomized this composite score into "partial implementation of EDIA school practices" for scores smaller or equal to 4 points and "full implementation of EDIA school practices" for scores equal to 5 points.

3.2.5 Student and school characteristics

Students reported their gender (girl, boy, other, prefer not to answer), grade (4, 5, 6) and completed the Family Affluence Scale III (FAS-III). FAS-III is a validated questionnaire to assess child and adolescent perceived socioeconomic status,[45] consisting of 6 questions: (1) "do you have your own bedroom for yourself? (no=0, yes=1)," (2) "how many computers does your family own (including laptops and tablets, not including game consoles and cellphones)? (no=0, one=1, two=2, more than two=3)," (3) "how many bathrooms (room with a bath/shower or both) are in your home? (no=0, one=1, two=2, more than two=3)," (4) "does your family have a dishwasher at home? (no=0, yes=1)," (5) "does your family own a car, van or truck? (no=0, yes, one=1, yes, two or more=2)," and (6) "how many times did you and your family travel to another province or country for a holiday/vacation in 2022? (not at all=0, once=1, twice=2, more than twice=3)." Responses were summed to create the FAS-III index, which ranges from 0 to 13, with higher scores indicating higher family affluence. Finally, we matched school postal codes to 2021 Census of Population to obtain the corresponding population centre for each school. According to Statistics Canda,[46] small population centres were defined as populations ranging from 1,000 to 29,999 inhabitants; medium population centres as populations ranging from 30,000 to 99,999 inhabitants; and large urban population centres as populations exceeding 100,000 inhabitants.

3.2.6 Statistical analysis

Descriptive statistics were used to summarize school and student characteristics. To ensure data quality, observations with unrealistic behaviours were removed (i.e., diet intake < 500 or above 5,000 kilocalories).[36] Descriptive statistics were also applied to generate stacked bar charts illustrating the distribution of EDIA school practices across dimensions of deprivation and to examine the distribution of students' lifestyle behaviours and mental health and wellbeing across these dimensions, comparing partial and full implementation of EDIA school practices. Pearson Chi-squared tests were conducted to assess the statistical significance of differences between these distributions.

Multivariable logistic regression was used to estimate odds ratios (OR) and 95% confidence intervals of the associations between school neighbourhood deprivation and student lifestyle behaviours and mental health and wellbeing. To acknowledge the nested nature of the data, mixed effect models were fitted, and a series of likelihood ratio (LR) tests and intraclass correlation (ICC) of null models were conducted to evaluate the proportion of total variance in the outcomes attributable to the differences between schools.[47] Since there was evidence of minimal clustering effects (ICC < 0.02), standard logistic regression models were deemed appropriate and used in the analysis. A purposeful selection approach was used for model building and adjusting for potential confounders incrementally, starting from Model 1 (adjusted for gender alone) to Model 3 (adjusted for gender, grade, and Family Affluence Scale). As there were no substantial differences in the associations across the models, results from the fully adjusted model (Model 3) were presented to account for all potential confounders.

To investigate the role of implementation of EDIA school practices (full and partial) on the association between school neighbourhood deprivation and student lifestyle behaviours and mental health and wellbeing, interaction terms were included in the logistic regression models. First,

results were stratified by partial and full implementation of EDIA school practices. Next, results were further detailed in a matrix of six combinations of odds ratios for lower, middle, and higher deprivation, using the group with lowest exposure/moderator levels (i.e., lower deprivation combined with partial implementation of EDIA school practices) as a reference category. Sensitivity analysis was conducted for dietary intake due to the presence of substantial missing data (>28%). To assess the robustness of findings, missing data was simulated as worse dietary intake (i.e., excessive sodium, free sugars, and saturated fat intake and lower HEFI-2019 scores). Statistical significance was determined as $p<0.05$. All statistical analyses were conducted using Stata/BE 18 Statistical Software.[48]

3.3 Results

3.3.1 Study population and characteristics

Table 3.1 presents descriptive characteristics of participating students and schools. The sample consisted of 1,970 students from grades 4, 5 and 6, with a median Family Affluence Scale score of 10 (IQR: 8-11). Most students reported excessive sodium (58.7%), adequate free sugars (54.9%) and excessive saturated fat (65.3%) intake and had low HEFI-2019 scores (61.0%). The majority of students reported lower levels of physical activity (74.3%) but adequate screen time (54.8%). Only 12.1% of students reported poor mental health and wellbeing.

Of the 28 participating schools, most were located in large population centres (75.0%), had fully implemented EDIA school practices (53.6%), and were in more deprived neighbourhoods for residential instability (50.0%), ethno-cultural composition (57.1%), and situational vulnerability (see Table 3.1). For economic dependency, schools were mostly in the middle-deprived neighbourhoods (46.4%).

Figure 3.1 depicts the distributions of the extent of implementation of EDIA school practices across the four dimensions of school neighbourhood deprivation. Schools with full implementation of EDIA school practices (presence of 5 practices) were located in more deprived school neighbourhoods across all four dimensions of deprivation. Yet, these findings were not statistically significant ($p>0.05$).

Table 3.2 shows the distributions of lifestyle behaviours and mental health and wellbeing of students across the four dimensions of deprivation and implementation of EDIA school practices. Students in more deprived neighbourhoods reported worse diet quality, less physical activity, more screen time, and worse mental health and wellbeing compared to students in less deprived neighbourhoods, regardless of the level of implementation of EDIA practices in their schools. However, most of these differences were not statistically significant ($p>0.05$).

2.3.2 The role of implementation of EDIA school practices on the relationship between school neighbourhood deprivation and student lifestyle behaviours and mental health and wellbeing

In schools with partial implementation of EDIA practices, students in neighborhoods with higher residential instability, ethno-cultural diversity, and situational vulnerability were more likely to report excessive free sugars intake, low HEFI-2019 scores, less physical activity, and more screen time, compared to their peers in schools located in less deprived neighborhoods (see Table 3.3). Students in schools from neighborhoods with higher economic dependency were less likely to exhibit worse lifestyle behaviours and mental health and wellbeing, though these differences were not statistically significant.

In schools with full implementation of EDIA practices, students in more deprived neighborhoods across all dimensions were more likely to report excessive sodium and free sugars

intake, less physical activity, more screen time, and worse mental health and wellbeing, compared to their peers in schools located in less deprived neighborhoods (see Table 3.3). Yet, students in schools located in neighborhoods with higher ethno-cultural diversity and situational vulnerability were less likely to report excessive saturated fat intake (OR: 0.63, 95% CI: 0.44, 0.91 and OR: 0.74, 95% CI: 0.56, 0.97, respectively). Furthermore, students in schools in more economically dependent neighborhoods were less likely to have low HEFI-2019 (OR: 0.67, 95% CI: 0.46, 0.97) scores, compared to their peers in less deprived neighbourhoods.

Table 3.4 compares the effects of school neighbourhood deprivation on student lifestyle behaviours and mental health and wellbeing between schools with full and partial implementation of EDIA school practices. Students in more deprived neighborhoods, across all dimensions of deprivation, were more likely to report excessive sodium intake, less physical activity, more screen time, and worse mental health and wellbeing in schools with full implementation of EDIA practices, compared to their peers in less deprived neighbourhoods with partial EDIA implementation (see Table 3.4). However, students in more economically dependent neighborhoods were less likely to have low HEFI-2019 scores (OR: 0.67, 95% CI: 0.47, 0.97) in schools with full EDIA implementation, compared to those in less deprived neighbourhoods with partial EDIA. In sensitivity analyses, this effect on HEFI-2019 scores became non-significant (see Supplementary Table 3.S2).

3.4 Discussion

This study assessed the role of implementation of EDIA school practices on the association between school neighbourhood deprivation and lifestyle behaviours and mental health and wellbeing of students. Schools with fully implemented EDIA practices were more frequently

located in more deprived neighbourhoods for residential instability, economic dependency, ethno-cultural composition, and situational vulnerability. Students in more deprived neighbourhoods were more likely to report worse diet quality, less physical activity, more screen time, and worse mental health and wellbeing, compared to students in less deprived neighbourhoods. In schools with full EDIA implementation, students in more deprived neighbourhoods were more likely to have worse lifestyle behaviours and mental health and wellbeing, compared to their peers in less deprived neighbourhoods with partial EDIA implementation. However, full implementation of EDIA appeared to be protective for diet quality, as students in more economically dependent neighbourhoods were less likely to report low HEFI-2019 scores. These findings suggest that while EDIA school practices may not completely mitigate the effects of school neighbourhood deprivation, full implementation might offer benefits for some student lifestyle behaviours.

Several studies have demonstrated a relationship between neighbourhood deprivation and high intake of sugar-sweetened beverages,[5,7,49,50] sodium,[49] and indicators of poor nutritional status, including increased body mass index (BMI),[51] increased waist-to-height ratios,[7,8] and higher rates of overweight and obesity.[5,8,52,53] Our findings revealed a protective effect of fully implemented EDIA school practices on students' diet quality in more deprived neighbourhoods, showing the potential of such practices to serve as a health promotion strategy to address diet-related health inequities among children.

While EDIA practices showed promise in improving diet quality, their impact on physical activity levels presented a more complex picture. The relationship between neighbourhood deprivation and physical activity is complex, with studies reporting both positive[52,54-56] and negative[8,9,50] effects. Our findings showed that children in more deprived neighbourhoods with full implementation of EDIA reported lower levels of physical activity, compared to their peers in less

deprived neighbourhoods with partial EDIA implementation. This could be a result of lack of access to safe environments and infrastructure that enable physical activity, such as well-maintained playgrounds, accessible, parks, walkable streets, and recreational facilities.[9,56-58] Thus, EDIA school practices may need to be complemented by broader community-level interventions that target environmental barriers to physical activity in deprived neighbourhoods. This finding highlights the complex interplay between EDIA practices, neighbourhood deprivation, and physical activity, indicating that while EDIA implementation alone may not fully mitigate the effects of deprivation on physical activity, it remains an important approach to addressing health inequities.

Regarding sedentary behaviours, our results are consistent with previous studies indicating that children living in more deprived neighbourhoods are more likely to engage in excessive screen time activities.[8,10,52,58-60] The persistence of these effects even in schools with full implementation of EDIA school practices highlights the challenge of addressing excessive screen time solely through school-based interventions. Studies have shown that limiting access to bedroom media and increasing parental social interactions can be effective strategies to reduce screen time among children.[8,61] Recognizing the role of home environments in shaping children's sedentary behaviours, actively engaging families in the implementation of EDIA school practices could reinforce positive habits learned at school and enable families to make informed decisions about screen time in their homes.

In schools with full EDIA implementation, students in neighborhoods with all levels of ethno-cultural composition were more likely to report worse mental health and wellbeing, compared to those in less diverse neighborhoods with partial EDIA implementation. This finding raises questions about the efficacy of current EDIA school practices in mitigating the effects of

deprivation on child mental health and wellbeing. The implications of these results are also relevant due to Canada's rapidly evolving ethno-cultural landscape.[24] Statistics Canada projects that by 2041, immigrants and their Canadian-born children could comprise more than half of the country's population.[66] Given that immigrant children in Canada may be more vulnerable to health inequities,[67] this demographic shift emphasizes the importance of implementing EDIA principles in school culture. Moreover, the COVID-19 pandemic has widened existing health inequities among children, disproportionately affecting disadvantaged communities.[30,31] As governments navigate the complexities of post-pandemic recovery, the implementation of EDIA practices in schools present a unique opportunity to address these health inequities and foster more inclusive school environments.

In Canada, education ministries have shown support for implementing EDIA in schools, with most provinces and territories already establishing school policies to achieve this goal.[68] In Alberta, the Ministry of Education has developed inclusion and diversity policies to support students in K-12 schools.[69] While these initiatives show promise in advancing EDIA implementation across Canadian schools, our findings highlight the complexity of this task. We found that most schools in deprived neighbourhoods have fully implemented EDIA practices, demonstrating that these initiatives have been put into action. However, these practices appeared to be protective for only some student lifestyle behaviours, suggesting that implementation alone may not be sufficient to address the effects of school neighbourhood deprivation on students' health.

It is important to recognise that implementation of complex processes, such as EDIA practices, is a staged process over time.[29] These stages encompass initial exploration, installation, partial implementation, full implementation, and sustainability of the new practices. Our study

likely captured schools at different stages in this process and could explain why variability in the effects of EDIA school practices, as schools at different implementation stages may have different capacities to influence student behaviours. Furthermore, implementing EDIA in schools demands significant shifts in school culture and communication practices to continuously assess and meet students' needs.[19,28] For schools in more deprived neighbourhoods, resource limitations may hinder stakeholder buy-in, adding another layer of complexity to this task. A cross-sectional study of 161 schools in Quebec, Canada, revealed that schools in more socially deprived areas reported lower teacher commitment to student health and reduced parent/community engagement.[27] Thus, teacher and school community buy-in should be considered to sustain meaningful change through EDIA practices in deprived neighbourhoods.

To improve buy-in from school communities, Veugelers et al.[30] proposed adapting EDIA principles to each school's individual needs, priorities, culture, resources, and social contexts. This approach is supported by studies demonstrating the effectiveness of school-based interventions targeting social inclusion in reducing health inequities among children.[20,22] For example, Vander Ploeg et al.[20] observed that such interventions were viable approaches for reducing health inequities while improving physical activity and preventing childhood obesity. Similarly, another Canadian study found that school-based initiatives promoting inclusion in low-income neighbourhoods acted as equalizers, increasing physical activity levels of children to match those of their peers in middle-income-neighbourhood control schools.[22] These tailored approaches ensure that all students, regardless of their ethnic background or identity, have equitable access to supportive school environments, which in turn contributes to reducing inequities in child health.

This study has several strengths. To our knowledge, this was the first study to examine the role of EDIA in mitigating the effects of school neighbourhood deprivation on child lifestyle

behaviours, mental health and wellbeing. The large student sample size and the use of validated self-report instruments improve the reliability of our findings. Moreover, employing area-based deprivation measures specific to one province improves the contextual relevance of our findings. However, there are some limitations to be considered. The cross-sectional nature of the study provides a snapshot of EDIA implementation and student lifestyle behaviours at a single point in time, preventing us from establishing causal relationships or temporal sequences. Schools that have fully implemented EDIA practices may have done so recently or long ago, and our study design cannot distinguish between these scenarios. This timing could have influenced our findings. Additionally, schools in more deprived neighbourhoods may face greater challenges with student lifestyle behaviours and mental health and wellbeing. As a result, these schools might be more likely to fully implement EDIA school practices, which could lead to confounding by indication. This situation could mask the beneficial effects of these practices, as the factors leading to full implementation might also be associated with worse student behaviours. The reliance on self-reported measures may introduce recall and social desirability bias. The substantial missing dietary data (>28%) and the dichotomization of continuous variables may also bias and limit the precision of our estimates. Finally, the relatively small number of schools (n=28) included in the study may have restricted our ability to fully capture the scope of implementation of EDIA practices across different school settings and their impacts on student health. These limitations highlight the need for longitudinal studies to better understand how EDIA implementation unfolds over time and impacts student health.

3.5 Conclusion

This study found that schools in more deprived neighbourhoods were more likely to have full implementation of EDIA practices. While full implementation of these practices offered some protection for students' diet quality, it did not consistently mitigate the effects of neighbourhood deprivation on other lifestyle behaviours and mental health and wellbeing. These findings suggest that EDIA school practices, while promising, may benefit from being tailored to each school community's unique needs and designed to increase buy-in from teachers and families, especially in deprived neighbourhoods.

Table 3.1. Characteristics of 1,970 grade 4-6 students from 28 elementary schools participating in the APPLE Schools Spring 2023-24 data collection in Alberta, Canada*

Student-level	n=1,970	School-level	n=28
Gender, %		**Population centre,[c] %**	
Girls	48.5	Rural or remote	7.1
Boys	47.3	Small	7.1
Other[a]	4.3	Medium	10.7
Grade, %		Large	75.0
4	34.9	**EDIA school practices**	
5	33.8	1-3 practices	25.0
6	31.3	4 practices	21.4
FAS-III[b], median (IQR)	10 (8 - 11)	5 practices	53.6
Lifestyle behaviours			
Sodium intake‡		**Canadian Index of Multiple Deprivation**	
Adequate (< 2300 mg), %	41.3	***Residential instability, %***	
Excessive (≥ 2300 mg), %	58.7	Low	14.3
Free sugars intake‡		Middle	35.7
Adequate (<10%E), %	54.9	High	50.0
Excessive (≥ 10%E), %	45.1	***Economic dependency, %***	
Saturated fat intake‡		Low	14.3
Adequate (<10%E), %	34.7	Middle	46.4
Excessive (≥ 10%E), %	65.3	High	39.3
HEFI-2019 scores‡		***Ethno-cultural composition, %***	
Higher (HEFI-2019 ≥ 40), %	39.0	Low	21.4
Lower (HEFI-2019 < 40), %	61.0	Middle	21.4
Physical activity		High	57.1
Higher (PAQ-C ≥ 2.5), %	25.7	***Situational vulnerability, %***	
Lower (PAQ-C < 2.5), %	74.3	Low	32.1
Screen time		Middle	21.4
Adequate (≤ 2 hours/day), %	54.8	High	46.4
Excessive (> 2 hours/day), %	42.6		
Mental health and wellbeing			
Good (MHW score ≥ 24), %	83.5		
Poor (MHW score < 24), %	12.1		

E: total energy intake in kilocalories, FAS-III: Family Affluence Scale III, HEFI-2019: Healthy Eating Food Index 2019, IQR: Interquartile range, MHW: Mental health and wellbeing, PAQ-C: Physical Activity Questionnaire for Children

[a]Students identified as 'other' or 'prefer not to answer.'

[b]FAS-III was used as a self-reported measure of socioeconomic status. The FAS III is a composite scale comprised of 6 items related to family household and resources, with scores ranging from 0 (lowest affluence) to 13 (highest affluence).[44]

[c]Rural or remote community: <1,000 people; Small community: 1,000 - 29,999 people; Medium community: 30,000 - 99,999 people; Large community: >100,000 people.[45]

*Percentages may not total 100% due to missing data.

‡Percentages for dietary behaviours are based on the available data (n=1,510).

Table 3.2. Distribution of students' lifestyle behaviours and mental health and wellbeing by school neighbourhood deprivation and level of implementation of equity, diversity, inclusion, and accessibility (EDIA) school practices.

	Sodium[a]				**Free sugars[a]**				**Saturated fat[a]**			
	Partial EDIA		**Full EDIA**		**Partial EDIA**		**Full EDIA**		**Partial EDIA**		**Full EDIA**	
	Adequate	**Excessive**	**Adequate**	**Excessive**	**Adequate**	**Excessive**	**Adequate**	**Excessive**	**Adequate**	**Excessive**	**Adequate**	**Excessive**
Residential instability												
Lower	28.2	28.5	**25.0**	**17.4**	29.4	27.5	23.6	18.0	31.2	27.2	22.0	20.6
Middle	29.4	30.5	**34.4**	**41.6**	33.4	27.5	35.5	42.0	27.0	32.7	36.2	39.6
Higher	42.5	41.1	**40.6**	**41.0**	37.1	45.0	40.9	39.9	41.8	40.2	41.8	39.8
Economic dependency												
Lower	30.2	32.0	*	*	30.8	32.8	*	*	26.5	34.4	*	*
Middle	39.3	40.8	43.8	45.1	40.1	36.7	46.1	44.7	41.3	37.1	42.4	47.1
Higher	30.6	27.3	56.2	54.9	29.1	30.7	53.9	55.3	32.3	28.5	57.6	52.9
Ethno-cultural composition												
Lower	19.1	16.4	**11.0**	**10.4**	**19.4**	**14.3**	11.2	9.1	16.4	17.5	**6.9**	**12.1**
Middle	45.6	48.7	**7.3**	**12.6**	**51.2**	**44.6**	9.1	11.8	48.7	47.9	**7.9**	**11.6**
Higher	35.3	34.9	**81.7**	**77.1**	**29.4**	**41.0**	79.8	79.1	34.9	34.6	**85.2**	**76.4**
Situational vulnerability												
Lower	57.5	58.9	16.4	18.1	62.9	55.0	20.0	15.9	58.2	59.8	**13.8**	**20.6**
Middle	23.8	22.6	17.7	16.5	21.7	23.9	17.4	15.4	23.8	22.2	**12.5**	**18.7**
Higher	18.7	18.5	65.9	65.4	15.4	21.1	62.6	68.7	18.0	18.0	**73.7**	**60.8**

Table 3.2. Cont.

	HEFI-2019 scores[b]				Physical activity[c]				Screen time[d]			
	Partial EDIA		Full EDIA		Partial EDIA		Full EDIA		Partial EDIA		Full EDIA	
	Higher	Lower	Higher	Lower	Higher	Lower	Higher	Lower	Adequate	Excessive	Adequate	Excessive
Residential instability												
Low	**30.6**	**26.7**	23.6	18.3	**31.6**	**29.4**	**12.7**	**18.7**	**33.3**	**25.2**	**21.1**	**12.8**
Middle	**34.7**	**27.3**	36.2	40.3	**34.4**	**35.0**	**30.1**	**39.7**	**35.8**	**33.7**	**37.5**	**38.3**
High	**34.7**	**46.0**	40.2	41.4	**34.0**	**35.6**	**57.2**	**41.7**	**30.9**	**41.2**	**41.5**	**49.0**
Economic dependency												
Low	27.3	33.7	*	*	21.9	28.0	*	*	25.8	26.5	*	*
Middle	39.8	40.1	43.4	45.3	47.0	34.3	**34.9**	**38.9**	36.2	39.5	37.0	39.6
High	32.9	26.2	56.6	54.7	31.2	37.7	**65.1**	**61.1**	38.0	34.0	63.0	60.4
Ethno-cultural composition												
Low	**19.0**	**16.6**	10.7	10.5	**25.6**	**24.3**	12.0	12.3	22.7	26.5	13.2	11.3
Middle	**52.3**	**44.4**	8.6	11.7	**47.4**	**35.6**	7.5	14.6	41.7	35.6	13.7	11.6
High	**28.7**	**39.0**	80.7	77.8	**27.0**	**40.1**	80.5	73.1	35.5	37.9	73.1	77.1
Situational vulnerability												
Low	**65.3**	**54.0**	17.4	17.0	**66.1**	**64.4**	**12.0**	**14.6**	**69.1**	**58.8**	15.5	12.8
Middle	**19.0**	**25.7**	16.6	17.0	**18.1**	**19.9**	**26.4**	**18.2**	**16.3**	**23.5**	20.1	19.3
High	**15.7**	**20.3**	66.0	66.0	**15.8**	**15.7**	**61.6**	**67.2**	**14.6**	**17.7**	64.4	67.9

Table 3.2. Cont.

	Mental health and wellbeing[e]			
	Partial EDIA		Full EDIA	
	Good	Poor	Good	Poor
Residential instability				
Low	30.1	30.6	17.2	16.7
Middle	35.1	27.8	37.5	37.7
High	34.8	41.7	45.3	45.7
Economic dependency				
Low	25.5	31.9	*	*
Middle	38.5	30.6	39.2	34.0
High	36.0	37.5	60.8	66.1
Ethno-cultural composition				
Low	**25.4**	**13.9**	12.2	13.0
Middle	**39.7**	**36.1**	12.6	14.2
High	**35.0**	**50.0**	75.2	72.8
Situational vulnerability				
Low	**65.2**	**58.3**	14.5	14.2
Middle	**20.4**	**12.5**	19.8	21.0
High	**14.5**	**29.2**	65.8	64.8

HEFI-2019: Healthy Eating Food Index 2019, Partial EDIA: implementation of 1 to 4 school practices, Full EDIA: implementation of 5 school practices.

[a]Using Canada's Dietary Guidelines[37] recommended limits, sodium, free sugars and saturated fat intake was categorized as adequate or excessive using the following cut-off values: excessive sodium intake was defined as equal or greater than 2,300 mg per day, excessive free sugars and saturated fat intake were defined as equal or greater than 10% of total daily energy in kilocalories.

[b]Lower HEFI-2019 scores were defined as scores lower than 40 points.

[c]Lower physical activity was defined as less than 2.5 points in the Physical Activity Questionnaire for Children (PAQ-C).[38]

[d]Using the Canadian 24-Hour Movement Guidelines for Children and Youth,[43] screen time was dichotomized as adequate (equal to or less than 2 hours per day) or excessive (greater than 2 hours per day).

[e]Poor mental health and wellbeing was defined as less than 24 points in the mental health and wellbeing scale.[40]

*There were no observations of student lifestyle behaviours and mental health and wellbeing in lower-deprivation neighbourhoods with full implementation of EDIA school practices.

Results in bold indicate statistically significant differences ($p < 0.05$) based on Pearson Chi-square tests.

Table 3.3. Effects of school neighbourhood deprivation and students' lifestyle behaviours and mental health and wellbeing according to levels of implementation of equity, diversity, inclusion, and accessibility (EDIA) school practices.

	Excessive sodium[a]				**Excessive free sugars[b]**				**Excessive saturated fat[b]**			
	Partial EDIA		**Full EDIA**		**Partial EDIA**		**Full EDIA**		**Partial EDIA**		**Full EDIA**	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Residential instability												
Lower	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Middle	1.15	0.79, 1.68	**1.56**	**1.15, 2.12**	1.04	0.71, 1.52	1.36	1.00, 1.86	1.24	0.83, 1.87	1.23	0.89, 1.69
Higher	1.21	0.87, 1.69	1.33	0.98, 1.79	**1.50**	**1.06, 2.12**	1.12	0.83, 1.53	1.19	0.83, 1.71	1.12	0.81, 1.54
Economic dependency												
Lower	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Middle	1.04	0.80, 1.55	1.09	0.76, 1.57	0.81	0.54, 1.23	0.83	0.57, 1.19	0.79	0.51, 1.24	0.89	0.60, 1.32
Higher	0.84	0.54, 1.30	1.05	0.74, 1.49	0.95	0.61, 1.47	0.88	0.61, 1.25	0.71	0.44, 1.14	0.77	0.52, 1.13
Ethno-cultural composition												
Lower	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Middle	1.08	0.74, 1.57	**1.86**	**1.09, 3.17**	1.17	0.79, 1.74	1.61	0.96, 2.73	**0.63**	**0.41, 0.96**	0.90	0.50, 1.60
Higher	1.07	0.72, 1.59	1.12	0.81, 1.55	**1.80**	**1.19, 2.73**	1.25	0.89, 1.76	0.75	0.48, 1.17	**0.63**	**0.44, 0.91**
Situational vulnerability												
Lower	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Middle	0.96	0.65, 1.42	0.96	0.66, 1.39	1.40	0.93, 2.09	1.00	0.68, 1.47	0.89	0.58, 1.36	1.39	0.91, 2.13
Higher	1.05	0.68, 1.62	1.10	0.85, 1.41	**1.69**	**1.08, 2.64**	**1.31**	**1.01, 1.70**	1.00	0.63, 1.62	**0.74**	**0.56, 0.97**

Table 3.3. Cont.

	Poor HEFI-2019 scores[c]				Lower physical activity[d]				Excessive screen time[e]			
	Partial EDIA		Full EDIA		Partial EDIA		Full EDIA		Partial EDIA		Full EDIA	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Residential instability												
Low	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Middle	1.11	0.76, 1.62	1.25	0.91, 1.69	0.78	0.54, 1.11	**1.41**	**1.01, 1.96**	1.33	0.96, 1.86	**1.65**	**1.24, 2.18**
High	**1.76**	**1.24, 2.49**	1.20	0.89, 1.63	1.02	0.71, 1.46	0.82	0.61, 1.11	**1.65**	**1.20, 2.28**	**1.83**	**1.40, 2.40**
Economic dependency												
Low	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Middle	0.82	0.54, 1.24	0.71	0.48, 1.03	0.68	0.44, 1.03	1.19	0.79, 1.79	1.02	0.70, 1.49	1.23	0.87, 1.74
High	0.76	0.48, 1.19	**0.67**	**0.46, 0.97**	0.97	0.62, 1.51	1.01	0.69, 1.48	0.81	0.55, 1.19	1.06	0.76, 1.47
Ethno-cultural composition												
Low	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Middle	0.95	0.65, 1.39	1.18	0.70, 2.00	**0.61**	**0.43, 0.87**	**2.08**	**1.22, 3.55**	0.83	0.59, 1.15	1.01	0.68, 1.51
High	**1.56**	**1.02, 2.36**	0.86	0.62, 1.20	1.46	0.99, 2.15	1.10	0.82, 1.48	0.93	0.67, 1.29	1.16	0.89, 1.51
Situational vulnerability												
Low	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Middle	**1.57**	**1.04, 2.38**	1.10	0.75, 1.60	1.19	0.78, 1.81	0.87	0.62, 1.21	**1.49**	**1.03, 2.16**	1.22	0.89, 1.67
High	1.43	0.90, 2.26	0.94	0.73, 1.21	1.22	0.77, 1.92	**1.42**	**1.10, 1.84**	1.24	0.82, 1.86	**1.41**	**1.13, 1.76**

Table 3.3. Cont.

	Poor mental health and wellbeing[f]			
	Partial EDIA		Full EDIA	
	OR	95% CI	OR	95% CI
Residential instability				
Low	Ref.	-	Ref.	-
Middle	0.71	0.41, 1.24	1.12	0.74, 1.71
High	0.80	0.48, 1.31	1.04	0.70, 1.56
Economic dependency				
Low	Ref.	-	Ref.	-
Middle	0.56	0.30, 1.05	0.93	0.54, 1.59
High	0.78	0.42, 1.43	1.17	0.71, 1.92
Ethno-cultural composition				
Low	Ref.	-	Ref.	-
Middle	1.06	0.61, 1.86	**2.02**	**1.11, 3.66**
High	1.28	0.76, 2.17	1.38	0.90, 2.12
Situational vulnerability				
Low	Ref.	-	Ref.	-
Middle	0.52	0.25, 1.08	1.36	0.86, 2.16
High	1.54	0.88, 2.71	1.33	0.93, 1.88

Logistic regressions were adjusted for gender, grade, and Family Affluence Scale III (FAS-III).
CI: confidence interval, HEFI-2019: Healthy Eating Food Index 2019, OR: odds ratio, Partial EDIA: implementation of 1 to 4 school practices, Full EDIA: implementation of 5 school practices.
[a]Using Canada's Dietary Guidelines[37] recommended limits, excessive sodium intake was defined as equal or greater than 2,300 mg per day.
[b]Using Canada's Dietary Guidelines[37] recommended limits, excessive free sugars and saturated fat intake were defined as equal or greater than 10% of total daily energy in kilocalories.
[c]Lower HEFI-2019 scores were defined as scores lower than 40 points.
[d]Lower physical activity as defined as less than 2.5 points in the Physical Activity Questionnaire for Children (PAQ-C).[38]
[e]Using the Canadian 24-Hour Movement Guidelines for Children and Youth,[43] excessive screen was defined as more than 2 hours per day.
[f]Poor mental health and wellbeing was defined as less than 24 points in the mental health and wellbeing scale.[40]
Bolded results are statistically significant ($p<0.05$).

Table 3.4. Comparative effects of school neighbourhood deprivation on students' lifestyle behaviours and mental health and wellbeing between schools with partial and full implementation of equity, diversity, inclusion, and accessibility (EDIA) school practices.

	Sodium[a]				Free sugars[b]				Saturated fat[b]			
	Partial EDIA		Full EDIA		Partial EDIA		Full EDIA		Partial EDIA		Full EDIA	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Residential instability												
Lower	Ref.	-	0.78	0.51, 1.20	Ref.	-	0.84	0.54, 1.32	Ref.	-	1.04	0.66, 1.63
Middle	1.02	0.66, 1.57	1.37	0.93, 2.01	0.95	0.61, 1.49	1.24	0.84, 1.84	1.27	0.79, 2.03	1.25	0.83, 1.88
Higher	1.06	0.71, 1.59	1.16	0.80, 1.70	1.37	0.90, 2.09	1.03	0.70, 1.51	1.22	0.79, 1.88	1.14	0.77, 1.70
Economic dependency												
Lower	Ref.	-	*	*	Ref.	-	*	*	Ref.		*	*
Middle	1.04	0.70, 1.55	1.09	0.76, 1.57	0.81	0.54, 1.23	0.83	0.57, 1.19	0.79	0.51, 1.24	0.89	0.60, 1.32
Higher	0.84	0.55, 1.30	1.05	0.74, 1.50	0.95	0.61, 1.47	0.88	0.61, 1.26	0.71	0.44, 1.14	0.77	0.52, 1.13
Ethno-cultural composition												
Lower	Ref.	-	1.07	0.61, 1.89	Ref.	-	1.00	0.55, 1.83	Ref.	-	1.47	0.76, 2.87
Middle	1.12	0.70, 1.78	**1.92**	**1.06, 3.50**	1.17	0.72, 1.92	1.62	0.89, 2.95	0.76	0.45, 1.27	1.07	0.56, 2.05
Higher	1.11	0.69, 1.80	1.16	0.76, 1.77	**1.80**	**1.08, 3.00**	1.25	0.80, 1.96	0.89	0.52, 1.52	0.75	0.47, 1.21
Situational vulnerability												
Lower	Ref.	-	1.18	0.80, 1.74	Ref.	-	0.84	0.57, 1.25	Ref.	-	1.44	0.94, 2.21
Middle	1.01	0.67, 1.53	1.01	0.68, 1.49	1.32	0.86, 2.01	0.95	0.63, 1.42	1.00	0.64, 1.56	**1.57**	**1.00, 2.44**
Higher	1.11	0.71, 1.75	1.16	0.87, 1.54	1.59	1.00, 2.54	1.24	0.93, 1.65	1.14	0.69, 1.86	0.83	0.62, 1.13

Table 3.4. Cont.

	Poor HEFI-2019 scores[c]				Lower physical activity[d]				Excessive screen time[e]			
	Partial EDIA		Full EDIA		Partial EDIA		Full EDIA		Partial EDIA		Full EDIA	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Residential instability												
Low	Ref.	-	0.65	0.42, 1.94	Ref.	-	**1.94**	**1.21, 3.11**	Ref.	-	1.01	0.67, 1.52
Middle	0.89	0.57, 1.39	0.99	1.46, 1.88	1.03	0.69, 1.54	**1.88**	**1.28, 2.77**	1.34	0.92, 1.96	**1.66**	**1.18, 2.34**
High	1.40	0.92, 2.14	0.96	0.66, 1.10	1.36	0.90, 2.05	1.10	0.77, 1.57	**1.66**	**1.14, 2.42**	**1.84**	**1.32, 2.56**
Economic dependency												
Low	Ref.	-	*	*	Ref.	-	*	*	Ref.	-	*	*
Middle	0.82	0.54, 1.25	0.71	0.48, 1.03	0.68	0.45, 1.04	1.19	0.79, 1.79	1.02	0.70, 1.49	1.23	0.87, 1.74
High	0.76	0.49, 1.19	**0.67**	**0.47, 0.97**	0.97	0.62, 1.52	1.01	0.69, 1.48	0.81	0.55, 1.19	1.06	0.76, 1.47
Ethno-cultural composition												
Low	Ref.	-	1.06	0.60, 1.89	Ref.	-	1.21	0.72, 2.02	Ref.	-	0.84	0.53, 1.32
Middle	0.98	0.61, 1.57	1.22	0.68, 2.21	0.66	0.44, 1.00	**2.25**	**1.27, 3.99**	0.76	0.52, 1.12	0.94	0.60, 1.46
High	1.60	0.97, 2.65	0.89	0.58, 1.37	**1.58**	**1.01, 2.45**	1.19	0.83, 1.71	0.86	0.58, 1.26	1.08	0.77, 1.49
Situational vulnerability												
Low	Ref.	-	0.93	0.63, 1.38	Ref.	-	**1.61**	**1.05, 2.49**	Ref.	-	1.14	0.79, 1.65
Middle	1.54	1.00, 2.38	1.08	0.72, 1.60	1.34	0.87, 2.06	0.98	0.69, 1.39	**1.55**	**1.06, 2.27**	1.27	0.91, 1.76
High	1.40	0.87, 2.25	0.92	0.69, 1.23	1.38	0.86, 2.20	**1.60**	**1.21, 2.12**	1.29	0.84, 1.96	**1.46**	**1.14, 1.87**

Table 3.4. Cont.

	Mental health and wellbeing[f]			
	Partial EDIA		Full EDIA	
	OR	95% CI	OR	95% CI
Residential instability				
Low	Ref.	-	1.66	0.89, 3.10
Middle	0.91	0.48, 1.74	1.45	0.85, 2.50
High	1.03	0.56, 1.89	1.35	0.80, 2.29
Economic dependency				
Low	Ref.	-	*	*
Middle	0.56	0.30, 1.05	0.93	0.55, 1.60
High	0.78	0.42, 1.43	1.17	0.71, 1.92
Ethno-cultural composition				
Low	Ref.	-	**2.95**	**1.32, 6.59**
Middle	1.93	0.90, 4.15	**3.63**	**1.64, 8.01**
High	**2.32**	**1.11, 4.87**	**2.48**	**1.26, 4.88**
Situational vulnerability				
Low	Ref.	-	1.50	0.86, 2.65
Middle	0.59	0.27, 1.25	1.55	0.94, 2.55
High	1.76	0.97, 3.20	**1.51**	**1.01, 2.25**

Logistic regressions were adjusted for gender, grade, and Family Affluence Scale III (FAS-III).
CI: confidence interval, HEFI-2019: Healthy Eating Food Index 2019, OR: odds ratio, Partial EDIA: implementation of 1 to 4 school practices, Full EDIA: implementation of 5 school practices.
[a]Using Canada's Dietary Guidelines[37] recommended limits, excessive sodium intake was defined as equal or greater than 2,300 mg per day.
[b]Using Canada's Dietary Guidelines[37] recommended limits, excessive free sugars and saturated fat intake were defined as equal or greater than 10% of total daily energy in kilocalories.
[c]Lower HEFI-2019 scores were defined as scores lower than 40 points.
[d]Lower physical activity as defined as less than 2.5 points in the Physical Activity Questionnaire for Children (PAQ-C).[38]
[e]Using the Canadian 24-Hour Movement Guidelines for Children and Youth,[43] excessive screen was defined as more than 2 hours per day.
[f]Poor mental health and wellbeing was defined as less than 24 points in the mental health and wellbeing scale.[40]
Bolded results are statistically significant ($p<0.05$).

Table 3.S1. The Canadian Index of Multiple Deprivation (CIMD): Prairie Region[41]

Area of deprivation	Indicator
Residential instability	Proportion of persons living alone
	Average number of persons per dwelling
	Proportion of dwellings that are apartment buildings
	Proportion of movers within the past 5 years
Economic dependency	Proportion of population participating in the labour force (aged 15 and older)
	Ratio of employment to population
	Dependency ratio (population aged 0-14 and population aged 65 and older divided by population aged 15-64)
Ethno-cultural composition	Proportion of the population that is foreign-born
	Proportion of the population self-identified as visible minority
	Proportion of the population with no knowledge of either official language (linguistic isolation)
	Proportion of the population which are recent immigrants
	Proportion of the population with no religious affiliation
Situational vulnerability	Proportion of the population identified as Indigenous
	Median income
	Proportion of single parent families
	Proportion of the population aged 25-64 without a high-school diploma
	Proportion of homes needing major repairs
	Proportion of the population that is low-income
	Median dollar value of dwelling
	Proportion of children younger than age 6

Table 3.S2. Comparative effects of school neighbourhood deprivation on students' healthy eating between schools with partial and full implementation of equity, diversity, inclusion, and accessibility (EDIA) practices: sensitivity analysis simulating missing data as worse dietary intakes.

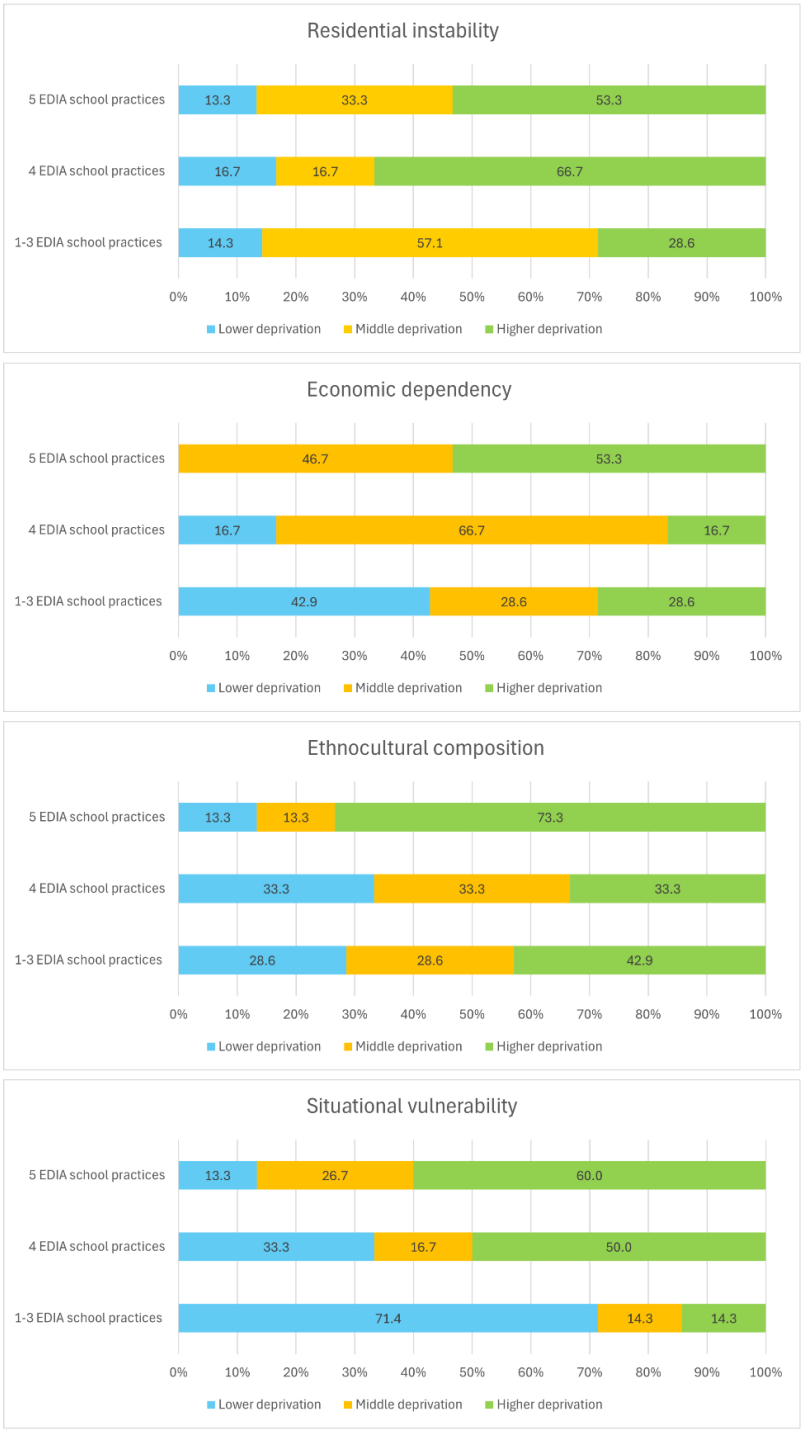
	Sodium[a]				**Free sugars[b]**				**Saturated fat[b]**			
	Partial EDIA		**Full EDIA**		**Partial EDIA**		**Full EDIA**		**Partial EDIA**		**Full EDIA**	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Residential instability												
Lower	Ref.	**-**	**0.54**	**0.36, 0.80**	Ref.	-	**0.49**	**0.33, 0.72**	Ref.	-	0.68	0.45, 1.05
Middle	1.17	0.79, 1.73	1.13	0.80, 1.62	1.10	0.76, 1.59	0.95	0.68, 1.33	1.39	0.90, 2.13	1.06	0.73, 1.55
Higher	0.74	0.51, 1.09	1.21	0.86, 1.70	0.92	0.64, 1.33	1.08	0.78, 1.49	0.92	0.62, 1.39	1.20	0.83, 1.73
Economic dependency												
Lower	Ref.	-	*	*	Ref.	-	*	*	Ref.		*	*
Middle	1.23	0.84, 1.80	1.09	0.77, 1.54	1.14	0.79, 1.64	0.79	0.56, 1.11	0.99	0.65, 1.50	0.86	0.58, 1.26
Higher	**1.57**	**1.06, 2.33**	**1.59**	**1.14, 2.21**	**1.79**	**1.22, 2.63**	**1.45**	**1.05, 2.00**	1.21	0.78, 1.86	1.15	0.80, 1.67
Ethno-cultural composition												
Lower	Ref.	-	0.80	0.49, 1.31	Ref.	-	0.73	0.46, 1.17	Ref.	-	1.12	0.61, 2.07
Middle	**0.50**	**0.33, 0.76**	1.49	0.87, 2.54	**0.42**	**0.28, 0.61**	1.04	0.65, 1.66	**0.38**	**0.24, 0.61**	0.94	0.52, 1.70
Higher	0.72	0.47, 1.09	**0.65**	**0.45, 0.93**	0.94	0.63, 1.41	**0.54**	**0.39, 0.77**	0.63	0.39, 1.02	**0.46**	**0.30, 0.70**
Situational vulnerability												
Lower	Ref.	-	0.69	0.48, 1.01	Ref.	-	**0.41**	**0.28, 0.58**	Ref.	-	0.85	0.56, 1.28
Middle	**0.67**	**0.45, 0.98**	1.11	0.78, 1.58	0.82	0.56, 1.19	1.11	0.80, 1.55	0.74	0.49, 1.12	**1.65**	**1.09, 2.49**
Higher	0.71	0.47, 1.09	0.95	0.74, 1.23	0.99	0.65, 1.50	0.94	0.73, 1.19	0.83	0.52, 1.31	**0.74**	**0.56, 0.98**

Table 3.S2. Cont.

	Poor HEFI-2019 scores[c]			
	Partial EDIA		Full EDIA	
	OR	95% CI	OR	95% CI
Residential instability				
Low	Ref.	-	**0.45**	**0.30, 0.68**
Middle	1.02	0.68, 1.51	0.84	0.58, 1.20
High	0.97	0.65, 1.45	1.00	0.71, 1.42
Economic dependency				
Low	Ref.	-	*	*
Middle	0.98	0.65, 1.46	0.72	0.50, 1.03
High	1.35	0.86, 2.04	1.03	0.73, 1.47
Ethno-cultural composition				
Low	Ref.	-	0.81	0.49, 1.35
Middle	**0.47**	**0.31, 0.71**	0.98	0.58, 1.65
High	1.02	0.65, 1.61	**0.52**	**0.36, 0.76**
Situational vulnerability				
Low	Ref.	-	**0.57**	**0.40, 0.83**
Middle	1.00	0.66, 1.52	1.14	0.80, 1.63
High	0.91	0.58, 1.44	0.78	0.60, 1.01

Logistic regressions were adjusted for gender, grade, and Family Affluence Scale III (FAS-III).
CI: confidence interval, HEFI-2019: Healthy Eating Food Index 2019, OR: odds ratio, Partial EDIA: implementation of 1 to 4 school practices, Full EDIA: implementation of 5 school practices.
[a]Using Canada's Dietary Guidelines[37] recommended limits, excessive sodium intake was defined as equal or greater than 2,300 mg per day.
[b]Using Canada's Dietary Guidelines[37] recommended limits, excessive free sugars and saturated fat intake were defined as equal or greater than 10% of total daily energy in kilocalories.
[c]Lower HEFI-2019 scores were defined as scores lower than 40 points.
Bolded results are statistically significant ($p<0.05$).

Figure 3.1. Implementation of equity, diversity, inclusion, and accessibility (EDIA) school practices across the four dimensions of school neighbourhood deprivation in 28 elementary schools participating in the APPLE Schools Spring 2023-24 data collection in Alberta, Canada.



P-values for Chi-square tests of independence are as follows: Residential Instability: $p = 0.631$, Economic Dependency: $p = 0.063$, Ethno-cultural Composition: $p = 0.466$, and Situational Vulnerability: $p = 0.107$

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Chapter 4: Overview and future directions

This thesis examined two school-based approaches to mitigate child health inequities in Canada. First, it reviewed the literature and conducted a consensus-seeking process to develop standards and indicators for implementing and sustaining HPS in Canada. Next, it assessed the role of EDIA school practices in mitigating child health inequities in deprived neighbourhoods of Alberta. The present chapter provides an overview of the key findings, identifies the strengths and limitations of this research, discusses the implications for public health practice, and proposes future directions for research.

4.1 Summary of findings

Chapter 1 reviewed the literature on the effects of neighbourhood deprivation on child health and the importance of EDIA for school health promotion in Canada. This review established neighbourhood deprivation as multidimensional construct, extending beyond economic poverty to encompass limited access to adequate education, nutrition, housing, clothing, working conditions, physical environments, and social interactions.[1] Childhood exposure to neighbourhood deprivation has been consistently associated with unhealthy eating, less physical activity, more screen time, and worse mental health and wellbeing of children.[2–7] Studies on the effects of neighbourhood deprivation on child health has focused on residential areas, where children live.[10–14] However, this approach may not capture the full scope of children's exposure of deprivation. Considering that children spend most of their time in and around schools,[15,16] school neighbourhood deprivation may also be a determinant of child health.

According to the Ottawa Charter for Health Promotion's "settings" approach to health,[17] which states that health is created and lived by people within the settings of their everyday life,

schools are ideal environments to promote learning, health, and wellbeing of children. Building on this concept, the WHO developed the HPS approach, recognized as the most effective and cost-effective school-based intervention, to create healthy school environments worldwide.[15,18,19] This approach not only provides opportunities to establish lifelong health behaviours in children[15,16] but also offers a promising strategy for reducing the negative impacts of neighborhood deprivation on child health. In the Canadian context, HPS initiatives should be culturally sensitive and incorporate EDIA principles to support the country's growing ethno-culturally and gender-diverse student population.[20-22] Despite this need, implementing these initiatives across Canada's multiple school jurisdictions poses challenges due to the lack of clear guidance on how to adapt the HPS approach to the country's educational needs.

Chapter 2 was a study aimed at developing standards and indicators for HPS implementation and sustainment in Canadian settings. The study combined a literature review with a consensus-seeking process involving education and policy experts from several regions across Canada. This approach yielded a set of standards and indicators tailored the country's diverse educational, demographic, and ethno-cultural contexts. The resulting standards will support Canadian schools in creating environments that foster student learning, health, and wellbeing across the country.

Finally, Chapter 3 assessed the role of EDIA school practices on the association between school neighbourhood deprivation, measured using the 2021 CIMD, and students' lifestyle behaviours and mental health and wellbeing. This was a cross-sectional study using data from 1,970 grade 4-6 students (mostly aged 9-12 years) in 28 elementary schools participating in the APPLE Schools initiative in Alberta, Canada, during the Springs of 2023 and 2024. The results revealed that schools in more deprived neighbourhoods were more likely to have full

implementation of EDIA practices. While these practices were not sufficient to mitigate the negative effects of neighbourhood deprivation, full implementation of EDIA in schools appeared to be protective for students' diet quality. These findings suggest that schools in more deprived neighbourhoods could benefit from EDIA practices suited to their unique needs.

4.2 Strengths and limitations

This thesis had several strengths. In Chapter 2, the development of HPS standards and indicators benefited from a rigorous methodological approach, including a literature review and a consensus-seeking process involving a nationally representative sample of education and policy experts. This approach ensured that the resulting standards and indicators are evidence-based, achievable, acceptable, and feasible in the Canadian context. Chapter 3 utilized a large sample of students, applied validated self-report instruments for assessing student lifestyle behaviours and mental health and wellbeing, and employed an area-based deprivation index specific to Alberta.

However, several limitations should also be noted. In Chapter 2, the Delphi method may have restricted the introduction of new ideas, and the study was constrained by the scope and quality of existing literature on HPS implementation and sustainment in Canadian settings. In Chapter 3, the cross-sectional design of the study on school neighbourhood deprivation and EDIA practices prevents causal inferences. This design cannot establish the timeline of EDIA implementation or its long-term effects. Additionally, confounding by indication may occur, as schools facing greater challenges might be more likely to fully implement EDIA practices. The reliance on self-reported measures may have introduce recall and social desirability bias. The substantial missing dietary data (>28%) and the dichotomization of continuous variables could affect the reliability of the findings. Finally, the relatively small number of schools might not have

captured the full scope of implementation of EDIA school practices, potentially limiting the generalizability of the results.

4.3 Implications for practice

For provincial and territorial education and health ministries, the development of national standards and indicators for HPS provides guidance for policy development and implementation. This set of standards and indicators can inform the design of contextually relevant policies and support resource allocation to adapt, implement, monitor, and sustain school health promotion initiatives aligned with each region's unique needs. Given Canada's evolving ethno-cultural landscape,[20–22] cross-sectoral collaboration between education and health ministries is crucial to incorporate EDIA principles into school health policies, especially for reaching students in deprived neighbourhoods. These actions align with global efforts to advance school health promotion,[16,23,24] contributing to the global agenda of utilizing education systems to build equitable societies.

For school districts and principals, the HPS standards and indicators serve as a roadmap for creating healthy school environments. The standards provide overarching goals, while indicators function as tools to measure progress in implementing HPS practices. The finding that full implementation of EDIA practices was more common in deprived neighbourhoods suggests that school leaders are responding to their communities' needs. However, the limited protective effect of these practices on student lifestyle behaviours and mental health and wellbeing indicates a need for improvement. School leaders should prioritize professional development opportunities for staff to improve their understanding and implementation of EDIA practices, ensuring these are integrated into school culture.

For teachers and health promotion practitioners, the HPS standards and indicators offer guidance for integrating health promotion into curriculum and school activities. Teachers, as the primary connection with students, play an important role in the success of school-based health interventions.[25,26] The standards and indicators can also act as a bridge between schools and their broader communities, facilitating collaboration with parents/guardians, families, cultural leaders, and other stakeholders in creating supportive, EDIA-grounded school environments.

For school health researchers, the methodology used to develop the HPS standards and indicators provide a model for other countries or education systems to update or create context-specific health promotion guidelines. By incorporating feedback from diverse stakeholders involved in school health promotion, this approach ensures that standards and indicators are culturally appropriate, acceptable, realistic, and practical for use in educational settings.

Lastly, when considering the relationship between EDIA school practices, school neighbourhood deprivation, and student health, it is important to position these factors within the framework of proximal and distal risk factors. School neighbourhood deprivation can be viewed as a more distal risk factor, influencing student health outcomes through various pathways such as limited access to resources, exposure to environmental stressors, and reduced opportunities for healthy behaviours. In contrast, EDIA school practices represent a more proximal risk factor, directly shaping the immediate school environment and potentially moderating the effects of neighbourhood deprivation on student health. This positioning helps us to inform intervention strategies: addressing school neighbourhood deprivation would constitute an upstream intervention, targeting broader socioeconomic and environmental factors that influence health, while implementing and improving EDIA school practices represents a more downstream intervention, focusing on the immediate school context. Both approaches are necessary for school

health promotion, with upstream interventions addressing root causes of health inequities and downstream interventions providing more immediate support and resources to students. School health promotion initiatives should consider this dual approach, combining efforts to improve neighbourhood conditions with targeted EDIA practices tailored to each school's unique context and needs.

4.4 Future research

Future research should aim to develop user-friendly tools for tracking HPS implementation at the provincial/territorial, school district, and school levels. These tools should emphasize the collaborative nature of the HPS approach, enabling all members of the school community to participate in the monitoring and evaluation process. While this thesis has provided insights into the role of EDIA practices in mitigating the effects of school neighbourhood deprivation, longitudinal studies are necessary to evaluate their long-term impact on child health. Such studies should assess the moderating effects of EDIA practices on neighbourhood deprivation over time and identify the key characteristics that contribute to their effectiveness. Finally, research should prioritize the development of objective tools for assessing EDIA implementation in schools, facilitating self-reflection, needs assessment, and the identification of areas for improvement.

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