Narrowing the knowledge to action gap:

A mixed methods exploration of the implementation of knowledge exchange strategies

by

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Examining Committee Membership

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Author's Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Statement of Contributions

This thesis consists in part of three manuscripts that have been submitted for publication. Exceptions to sole authorship:

Chapter 3: Brown, K.M., Elliott, S.J., & Leatherdale, S.T. (Submitted, March 2017). Researchers supporting schools to improve health: influential factors & outcomes of knowledge brokering in the COMPASS Study. Revised manuscript under review in *Journal of School Health.*

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As lead author of these three chapters, I was responsible for conceptualizing study design, carrying out data collection and analysis, and drafting and submitting manuscripts. My co-authors provided guidance during each step of the research and provided feedback on draft manuscripts. Dr. Susan Elliot provided significant direction throughout.

Under Dr. Susan Elliott's supervision, I also prepared the remaining chapters in this thesis, which were not written for publication.

Abstract

Adolescence represents a time in which many health behaviours related to chronic disease risk are formed and carried into adult life. Schools are considered key settings for adolescent health interventions; however, despite extensive research in this area, schools face challenges implementing interventions at the local level. Knowledge exchange, in which researchers and knowledge users collaborate to discuss and apply research findings, is one strategy to reduce the "knowledge to action gap" between school health research and practice. While knowledge exchange strategies are emerging in school health research, the need for evaluation has been emphasized.

This dissertation explored knowledge exchange strategies within the first phase of COMPASS (2012-2016), a longitudinal study of Ontario and Alberta secondary schools and students. Schools received annual summaries of their students' health behaviours and a COMPASS researcher (i.e., knowledge broker) supported them in taking action to improve student health. Mixed methods were used to examine influential factors and outcomes of the COMPASS knowledge exchange strategies.

A quantitative analysis of school- and student-level data from the first three years of COMPASS found that school characteristics (e.g., school size, existing health initiatives and relationships with public health units at baseline) and study-related factors (e.g., knowledge broker assigned to the school, knowledge brokering engagement level in previous year[s]) influenced schools' participation in knowledge brokering. Knowledge brokering engagement was significantly associated with school-level changes related to healthy eating, physical activity, and tobacco programming, but changes were not evident at the aggregate student level.

Qualitative interviews with researchers (n=13), school staff (n=13), and public health staff (n=4) expanded on influential factors and outcomes regarding use of COMPASS findings and knowledge brokering engagement. Knowledge users focused on factors that influenced their use of COMPASS findings more than knowledge brokering (discussing fewer facilitators than challenges). Factors identified by researchers and knowledge users aligned with those that influence implementation of school health interventions. School and public health staff used school-specific findings to inform programming and planning; knowledge exchange provided a platform for partnerships between researchers, schools, and public health units; and also resulted in outcomes for the study and researchers. Further, outcomes suggest knowledge exchange could provide a mechanism to help schools implement a health-promoting schools approach. Altogether, the mixed methods findings raise two considerations: how can we increase school engagement in knowledge exchange and how can we ensure knowledge exchange strategies reach schools that have lower capacity to implement school health initiatives?

This research makes substantive, theoretical, methodological, and practical contributions. Substantively, it provides an evaluation of knowledge translation in school health research. Theoretically, it integrates social constructionism and social ecological theory, addressing the need for theory in evaluating knowledge translation strategies. Further, a mixed methods approach was used to examine both implementation and outcomes, which has been advocated in the literature. Practice implications are discussed related to future knowledge translation strategies in school health and public health research. Lastly, areas for future research are identified.

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List of Abbreviations

BMI	Body Mass Index
Cq	COMPASS Student Questionnaire
GRAMMS	Good Reporting of a Mixed Methods Study guidelines
KB	Knowledge Broker(ing)
KTA	Knowledge to Action framework
OSIS	Online Survey Implementation System database
PH	Public Health staff
PI	Principal Investigator
SES	Socioeconomic status
SHAPES	School Health Action, Planning, and Evaluation System
SHP	School Health Profile
SPP	School Policies and Practices questionnaire
VP	Vice Principal

Chapter 1
Introduction

1.1 Research Problem

Adolescence is a time in which many health behaviours related to chronic disease risk (e.g., physical activity, healthy eating, and substance use) are established and carried into adult life (World Health Organization, 2014). Additionally, adolescence presents a period of rapid developmental change, including a shift in the factors that influence health decisions (e.g., from parents to peers and the media) (World Health Organization, 2014). Recent research has identified an alarming prevalence of risk factors (i.e., binge drinking, marijuana use, overweight/obesity, physical inactivity, sedentary behaviour, and low fruit and vegetable consumption) among Canadian high school students, and particularly concerning is that many students report multiple risk factors (Laxer et al., 2017; Leatherdale & Rynard, 2013; Leatherdale, 2015). Additionally, the prevalence of binge drinking, smoking, marijuana use, physical inactivity, and obesity increased from grade 9 to grade 12 (Leatherdale & Rynard, 2013; Leatherdale, 2015). Clearly, interventions are needed to improve adolescent health and decrease chronic disease risk in this population.

Schools are considered key settings for adolescent health interventions because the target population can be regularly reached (Veugelers & Schwartz, 2010). Additionally, evidence continues to build regarding the association between student health behaviours and academic outcomes (Bradley & Greene, 2013; Ickovics et al., 2014; Langford et al., 2015; Patte, Qian, & Leatherdale, 2017). The World Health Organization (1998) endorses the health-promoting schools approach, in which a health-promoting school is "constantly strengthening its capacity as a healthy setting for living, learning, and working" (p. 2). This approach is also referred to as

Comprehensive School Health (Canada) and Coordinated School Health (United States) (Veugelers & Schwartz, 2010). Despite the extensive literature in this area, schools face challenges implementing these approaches (Keshavarz, Nutbeam, Rowling, & Khavarpour, 2010; Sulz, Gibbons, Naylor, & Wharf Higgins, 2016), and there is limited evidence regarding what school-based health interventions are effective (Gard & Wright, 2014; Leatherdale, 2016).

The mandate of schools (and the staff within them) is education; often, this is not reflected in the development of school-based health interventions, leading to poor implementation in school settings (Gard & Wright, 2014; McCuaig & Hay, 2014). Further, schools are not only being asked to provide more public health interventions, but to address complex issues such as obesity and mental health (Gard & Wright, 2014). Collaboration between public health and school stakeholders is needed to plan and understand how school-based health interventions can be implemented successfully (Hunt, Barrios, Telljohann, & Mazyck, 2015; Langford et al., 2017; McCuaig & Hay, 2014; Schee & Gard, 2014). More recently, models aligning health and educational priorities in schools (Hunt et al., 2015; Lewallen, Hunt, Potts-Datema, Zaza, & Giles, 2015; Samdal & Rowling, 2015) aim to enhance public health researchers' and practitioners' understanding of school environments; however, these have not yet been translated into practice at the local level.

1.2 Knowledge Translation

The "knowledge to action gap" (Bowen & Graham, 2013; Graham et al., 2006) between school health research and practice aligns with the observation that public health evidence is not being integrated into practice (Ammerman, Smith, & Calancie, 2014; McVay, Stamatakis, Jacobs, Tabak, & Brownson, 2016; Van Den Driessen Mareeuw, Vaandrager, Klerkx, Naaldenberg, & Koelen, 2015). Knowledge translation refers to various strategies for enhancing

the uptake of research findings into policy and practice (Rychetnik et al., 2012); knowledge exchange is one strategy, in which researchers and knowledge users discuss research problems and findings (Canadian Foundation for Healthcare Improvement, 2015) (Box 1).

Box 1 Knowledge translation key terms.

Knowledge translation: "a dynamic and iterative process that includes synthesis, dissemination, exchange and ethically sound application of knowledge to improve the health of Canadians, provide more effective health services and products and strengthen the health care system" (Canadian Institutes of Health Research, 2012, p. 1).

Knowledge exchange*:*

- "interactions between knowledge users and researchers resulting in mutual learning" (Canadian Institutes of Health Research, 2012, p. 1).
- "collaborative problem-solving between researchers and decision-makers that happens through linkage and exchange" (Canadian Foundation for Healthcare Improvement, 2015).

Knowledge user*:* "an individual who is likely to be able to use research results to make informed decisions about health policies, programs and/or practices" (Canadian Institutes of Health Research, 2012, p. 1).

The knowledge to action gap may not only be caused by ineffective dissemination of research findings, but also a mismatch between research objectives and the issues practitioners are facing (Bowen & Graham, 2013). The Canadian Institutes of Health Research (2012) define two types of knowledge translation: integrated and end-of-grant. *Integrated knowledge translation* involves knowledge users throughout the research process, aiming to increase the relevance and use of research findings by knowledge users (Canadian Institutes of Health Research, 2012). Hence, integrated knowledge translation provides an opportunity to address the mismatch between research objectives and practice needs. This dissertation can be classified as *knowledge translation research,* which Rychetnik and colleagues (2012) define as research that

evaluates the value, effectiveness, and impact of knowledge translation initiatives, and examines "what research is being used, by whom, and how it is used" (Rychetnik et al., 2012, p. 1189).

1.2.1 Knowledge Brokering

Knowledge brokering is a knowledge translation strategy that "links researchers and decision-makers, facilitating their interaction so that they are better able to understand each other's goals and professional culture, influence each other's work, forge new partnerships and use research-based evidence" (Canadian Foundation for Healthcare Improvement, 2015). Knowledge brokers work with knowledge users to determine challenges applying evidence in the local setting, and through this process, new research questions may be developed (Dobbins, Robeson, et al., 2009; Ward, House, & Hamer, 2009). The rationale for knowledge brokering is that "interpersonal contact improves the likeliness of behaviour change" (Traynor, DeCorby, & Dobbins, 2014, p. 534). Strong relationships between researchers and knowledge users have been identified as a key facilitator to effective evidence use (Oliver, Innvar, Lorenc, Woodman, & Thomas, 2014).

The use of knowledge brokering in public health is growing (e.g., see Bornbaum et al., 2015; Dagenais et al., 2015; Dobbins, Robeson, et al., 2009; Kramer et al., 2015; Rosella et al., 2014; Traynor et al., 2014; Ward et al., 2009); however, limited evidence of effectiveness exists (Salsberg & Macaulay, 2013). This is likely because evaluations of these approaches are only beginning to emerge (Dagenais, Laurendeau, & Briand-Lamarche, 2015; Ward, House, & Hamer, 2009). Bornbaum and colleagues (2015) reviewed outcomes of knowledge brokering in health-related settings; however, the findings were inconclusive due to few studies meeting their criteria for methodological rigour. One of the studies deemed of acceptable rigour found that knowledge brokering impacted participants' knowledge and practices. The authors argued mixed

methods research is needed to examine knowledge brokering outcomes and the conditions in which these outcomes emerge (Bornbaum et al., 2015).

A review of five knowledge translation studies in public health (including four randomized controlled trials) highlighted that characteristics of the information, intervention setting, researchers, and knowledge users greatly influence knowledge translation, so it is difficult to determine the most effective strategy (LaRocca, Yost, Dobbins, Ciliska, & Butt, 2012). However, the authors concluded that passive strategies (e.g., distribution of electronic and print resources) were less effective than active (e.g., consultant support and educational workshops), and single strategies could be as effective as more complex ones (LaRocca et al., 2012). One of these randomized controlled trials compared three strategies: knowledge brokering, access to an online research database, and tailored messages to knowledge users (Dobbins, Hanna et al., 2009). While tailored messages were found to be most effective, the authors argued that knowledge brokering might be more effective in organizations with low perceived research use at baseline, and the one-year duration may have been inadequate to show impact (Dobbins, Hanna, et al., 2009; Dobbins, Robeson, et al., 2009).

Traynor et al. (2014) compared the initiative described above to a 22-month knowledge brokering strategy; the increased time allowed for developing rapport with knowledge users and participants felt more competent in knowledge synthesis and application to practice. Frequent and user-specific communication is important for developing rapport with knowledge users (Dagenais et al., 2015; Traynor et al., 2014); additionally, knowledge users must understand the knowledge broker role and how (s)he can help them (Traynor et al., 2014). Key characteristics of effective knowledge brokers include public health experience, expertise in evidence-informed decision making, approachability, patience, and the abilities to understand practice issues, remain

objective, and communicate clearly (Traynor et al., 2014). Directions for future research included investigating training for knowledge brokers, required dose, and strategies for engaging knowledge users (Dobbins, Hanna, et al., 2009; Dobbins, Robeson, et al., 2009).

1.2.2 Knowledge Translation & Schools

Knowledge translation initiatives in school health research are emerging, yet few evaluations have been published (Murnaghan et al., 2013; Riley, Wong, & Manske, 2014; Short, Weist, Manion, & Evans, 2012). The literature is mainly descriptive; examples of knowledge translation initiatives in school health research are detailed below.

The School Health Action, Planning, and Evaluation System (SHAPES) (Cameron, Manske, Brown, & Jolin, 2007; Leatherdale, Manske, Wong, & Cameron, 2009; Planinac, Leatherdale, Manske, & Arbour, 2008) provides school-specific information regarding student health behaviours (i.e., tobacco use, physical activity, healthy eating), school facilities, programs, policies, and the social environment, as well as evidence-based recommendations for addressing these outcomes (Leatherdale et al., 2009). Additionally, in an Ontario-based SHAPES study, public health staff received training and support to conduct analyses of study data for local schools (Planinac et al., 2008). Although SHAPES has been described and the authors mentioned the challenges of motivating change (Cameron et al., 2007), evaluations of its use as a knowledge exchange tool have not been reported. Similarly, the Action Schools! BC physical activity and healthy eating program includes partnerships between researchers, schools, and government; and knowledge brokers provide resources, training, and support to school stakeholders (McKay et al., 2015). However, no evaluations of these knowledge translation components have been reported. While not specifically knowledge translation, APPLE Schools, a research program in Alberta that involves trained facilitators helping schools to implement

health programming, led to schools integrating health content into the curriculum and increased teachers' and students' knowledge (Storey, Spitters, Cunningham, Schwartz, & Veugelers, 2011).

Articles exploring knowledge translation initiatives in youth health highlight the utility of research summaries (e.g., reports, fact sheets, websites, newsletters) to spark conversations with knowledge users, partnerships, and adapting initiatives to meet specific stakeholder needs (Colley, Brownrigg, & Tremblay, 2012; Murnaghan et al., 2013; Riley et al., 2014; Short et al., 2012). While knowledge brokers who can access and translate data for knowledge users are considered valuable, a common language between stakeholders is desired (Riley et al., 2014). The need for evaluation of youth health knowledge translation initiatives has also been emphasized (Riley et al., 2014; Short et al., 2012).

Studies of knowledge translation and research use have also been conducted in the education literature. Canadian administrators' and teachers' use of educational research is low, but the importance of accessible evidence and the value of tailored products and researcher-practitioner partnerships have been emphasized (Dagenais et al., 2012; Dagenais et al., 2016; Lysenko, Abrami, Bernard, & Dagenais, 2015; Lysenko, Abrami, Bernard, Dagenais, & Janosz, 2014). Further, knowledge brokering initiatives related to evidence-based educational methods have led to changes in classroom practices (Sharples & Sheard, 2015), and the importance of face-to-face interaction has been highlighted (Sheard & Sharples, 2016).

In sum, knowledge translation research in public health and school health is emerging. Active strategies (LaRocca et al., 2012) and tailored messages (Dagenais et al., 2015; Dobbins, Hanna, et al., 2009; Traynor et al., 2014) have been shown to be effective. Knowledge brokering has been highlighted as a useful strategy, particularly when there is adequate time and frequent

communication to develop rapport with knowledge users (Dagenais et al., 2015; Riley et al., 2014; Traynor et al., 2014). Context (i.e., information, setting, researchers, knowledge users) is a key influence on the effectiveness of knowledge translation strategies (LaRocca et al., 2012), and the need for evaluation has been emphasized.

1.3 Research Context

COMPASS is a longitudinal study of student health behaviours and secondary school environments in Ontario and Alberta. Researchers are investigating changes in student health behaviours over time and whether changes to the school environment influence these behaviours (Leatherdale, 2016; Leatherdale et al., 2014). Two knowledge exchange strategies were integrated in the first phase of COMPASS (2012-2016) to help schools improve student health and the school environment:

- **School Health Profile (SHP):** Each year, schools received a tailored summary of their students' health behaviours. Where feasible, data were compared to provincial and national benchmarks. The SHP included recommended interventions and changes a school could implement to improve these health behaviours, and contact information for the local public health unit and a COMPASS researcher (i.e., knowledge broker) (Leatherdale et al., 2014).
- **Knowledge brokering:** Each school was linked with a COMPASS researcher, who contacted the school after receiving the SHP each year (Thompson-Haile, Laxer, Ledgley, & Leatherdale, 2015). The knowledge broker discussed findings from the school's SHP, followed up regarding information in the school-level questionnaire, and provided ongoing support to the school to improve student health behaviours (Leatherdale et al., 2014). Knowledge brokers kept journals to record all school-based interactions (Thompson-Haile et al., 2015).

Both COMPASS knowledge exchange strategies are considered integrated knowledge translation. Schools receive a SHP annually throughout the study, and intervention recommendations have been changed based on feedback from school stakeholders. Further, researchers and knowledge users are in contact throughout the research project via the knowledge brokering strategy. The school (i.e., administrators, teachers, and other staff) and public health stakeholders are the knowledge users.

1.4 Research Question and Objectives

Clearly, a gap between school health research and practice exists (Gard & Wright, 2014). While school health knowledge translation initiatives are emerging to fill this gap, few evaluations of these strategies have been conducted, despite the need (Murnaghan et al., 2013; Riley et al., 2014; Short et al., 2012). Further, the COMPASS team has highlighted the importance of evaluating the COMPASS knowledge exchange strategies and their impact (Leatherdale et al., 2014). Mixed methods have been highlighted as a useful approach to evaluate school health interventions and knowledge translation strategies because researchers can examine process, contextual factors, and outcomes (Bornbaum et al., 2015; LaRocca et al., 2012; Tjomsland, Wold, Krumsvik, & Samdal, 2015).

This dissertation used a mixed methods approach (integrating quantitative and qualitative methods) to answer the overarching research question:

- How do the COMPASS knowledge exchange strategies (i.e., School Health Profile and knowledge brokering) influence school health policies/practices and student health behaviours?

In doing so, the research addressed three objectives:

1. To investigate factors associated with schools' engagement in the COMPASS knowledge brokering strategy and whether this engagement influenced school health policies/practices and student health behaviours;
2. To explore the experiences and perspectives of key COMPASS personnel regarding factors that shaped the knowledge brokering process, perceived outcomes, and suggestions for change; and,
3. To explore the experiences and perceived outcomes of school and public health stakeholders (knowledge users) regarding the COMPASS School Health Profile (SHP) and knowledge brokering strategies.

Methodologically, this research addressed the following mixed methods research question:

- What results emerge from comparing the perspectives of COMPASS researchers and knowledge users with the quantitative analysis of influential factors and school- and student-level changes?

1.5 Theoretical Context

The overarching framework informing this research is Graham and colleagues' (2006) knowledge to action (KTA) framework, which is based on planned action theories. KTA describes the process of integrating research into practice through two main concepts: knowledge creation and action (Figure 1.1). The knowledge creation component shows that as knowledge moves through the "funnel" (in the center of Figure 1.1), it becomes more tailored (and hopefully useful) to knowledge users (Graham et al., 2006; Straus, Tetroe, & Graham, 2013). At the end of the "funnel" are *knowledge tools and products* in which information is presented "in clear, concise, and user-friendly formats" (Graham et al. 2006, p. 119) tailored to knowledge users in

order to facilitate the application of this information into practice. Based on this framework, the COMPASS SHP would be considered a knowledge tool. The KTA framework does not end when these tools are disseminated: the action cycle depicts how this knowledge becomes implemented and applied into practice (Graham et al., 2006). The action cycle is shown in the outer circle of Figure 1.1; in COMPASS, knowledge brokering is the mechanism for moving through the action cycle. Additionally, the objectives of this dissertation align with the action cycle (specifically the steps from "assess barriers/facilitators to knowledge use" to "evaluate outcomes"), by exploring whether the COMPASS findings were used, and the school- and student-level outcomes resulting from this knowledge use and application.

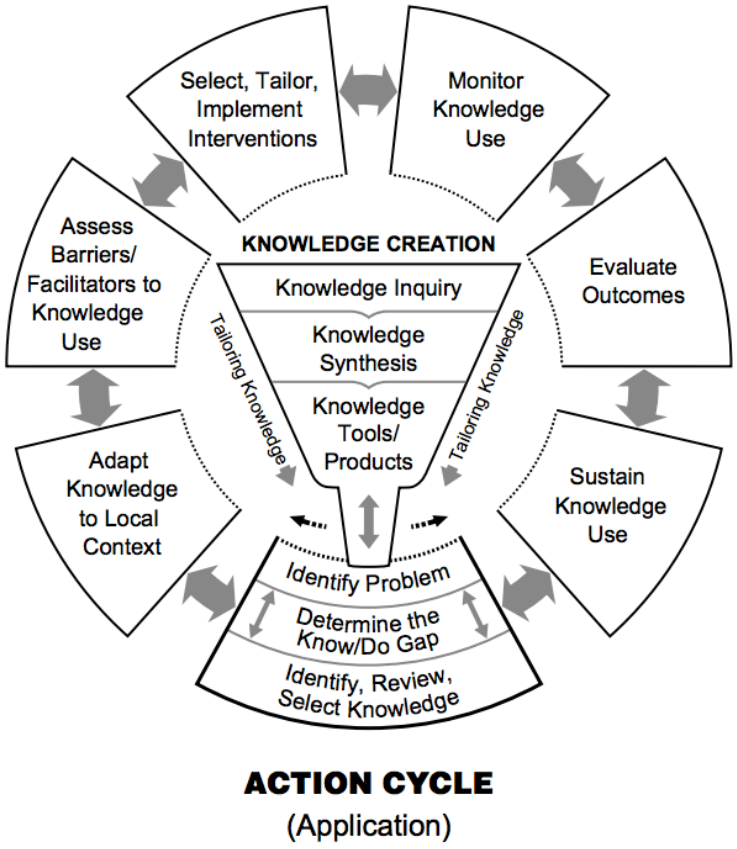

Figure 1.1 Knowledge to action process (Straus et al., 2013).

Bowen and Graham (2013) acknowledge that changes in practice are not solely based on evidence; this evidence must be considered within the context of the local environment. Hence, the KTA cycle aligns with the two theories informing this research: social constructionism and social ecological theory. Social constructionism (also known as social interactionism) posits that *"*...meanings are *constructed* out of the interactions (which may be conversations or encounters) that we have with each other in everyday life…. people are continually engaged in the construction of such knowledge" (Gatrell & Elliott, 2009, p. 30). All individuals have their own experiences and perspectives, which shape the way we think, what we believe, and how we view the world. In the context of evaluation, social constructionism implies that in order to understand a program or intervention, we must understand the perspectives of all stakeholders involved (Patton, 2015). We can then compare perspectives of individuals within and between stakeholder groups and explore how individuals' experiences and perceptions are shaped by their relationships with others (Patton, 2015).

Social constructionism has been linked to knowledge translation. Nutley, Walter, and Davies (2003) explain that because "research evidence cannot be separated from its social context, what we need to understand is the social construction of knowledge" (p. 133). Hence, examining the social context will help to understand how individuals interact to create and exchange knowledge (Thomas, Menon, Boruff, Rodriguez, & Ahmed, 2014). Patton (2015) states that social constructionism can be used to explore the question, "How do the experiences of people being studied and their perceptions about the researcher or evaluator affect what is learned and how it is communicated (represented)?" (p. 127). In the context of this research, social constructionism implies that stakeholders' (i.e., knowledge brokers', school and public health participants') understanding and interpretations of information gained from knowledge

brokering and the SHP are influenced by their previous experiences. Additionally, the relationships between a knowledge broker and a knowledge user, or their perceptions of each other, can shape their understandings of this information.

Social ecological theory states that environmental changes (from face-to-face interactions [microsystem] to cultural values within a population [macrosystem]) lead to individual behaviour changes (Bronfenbrenner, 1977; McLeroy, Bibeau, Steckler, & Glanz, 1988). Further, intervention effectiveness depends on the fit between individuals and their environment, as well as the characteristics of the intervention setting (Green, Richard, & Potvin, 1996; Stokols, 1996). In the context of population health interventions, social ecological theory implies that individuals' environments influence their health behaviours and changes to these environments can lead to the improved health of individuals (Penhollow & Rhoads, 2014). The COMPASS knowledge exchange strategies aim to support school and public health stakeholders in changing school environments to improve student health. Hence, in this research, social ecological theory was used to capture environmental factors that influenced i) knowledge use by school and public health stakeholders, ii) participation in knowledge brokering, and iii) changes to school health policies and practices.

1.6 Chapter Outline

This dissertation is composed of six chapters, including this introduction. Chapter 2 describes the methods used in this convergent parallel mixed methods study. Chapters 3, 4, and 5 consist of manuscripts submitted for publication (substantive chapters), which combine to answer the overarching research question. Chapter 3 includes a quantitative analysis of influential factors and outcomes of knowledge brokering, addressing the first research objective. Chapters 4 and 5 address the second and third research objectives; however, these chapters

combine the researcher and knowledge user perspectives regarding two content areas. Specifically, Chapter 4 focuses on facilitators and barriers to COMPASS knowledge exchange, while Chapter 5 focuses on outcomes and suggestions for change. Lastly, Chapter 6 summarizes and compares the findings from the three manuscripts, contextualizes findings within the existing literature, and identifies contributions and directions for future research.

Chapter 2
Methodology

2.1 Introduction

This chapter outlines the overall convergent parallel mixed methods research design of this dissertation as a whole, providing justification and description that was not included in the substantive chapters due to word limitations.

2.2 Overall Design

This research used a mixed methods approach (integrating quantitative and qualitative methods), and is aligned with the pragmatic worldview. In parallel with the theories informing this research, pragmatism views "knowledge as both constructed and as a function of organism-environment interactions" (Greene & Hall, 2010, p. 131). Pragmatism focuses on the research question and emphasizes using the best method(s) to answer this question (Creswell, Klassen, Plano Clark, & Smith, 2011; Curry & Nunez-Smith, 2015). It values and uses both quantitative and qualitative methods, leading to stronger evidence (Curry & Nunez-Smith, 2015; Sammons, 2010). Curry and Nunez-Smith (2015) highlighted two reasons that mixed methods are appropriate for health research: i) the complexity of the topics being researched, and ii) the emphasis on research application to policy and practice. Mixed methods approaches can be used to understand the contextual and environmental factors that influence behaviour, health, policies, and programs, including facilitators and barriers to implementation (Brown, Elliott, Leatherdale, & Robertson-Wilson, 2015; Creswell et al., 2011; Ivankova & Kawamura, 2010; Zhang & Watanabe-Galloway, 2013). Mixed methods approaches allow researchers to compare and triangulate findings, provide context for quantitative results, consider multiple perspectives and ecological levels, and examine both processes and outcomes (Ivankova & Kawamura, 2010).

A convergent parallel mixed methods design was used; that is, both quantitative and qualitative methods were implemented concurrently, with equal priority, and integrated once independent analyses of each method were complete (Creswell & Plano Clark, 2011). The convergent parallel design was chosen because the methodological components were analyzed separately. However, the findings from the qualitative interviews informed later stages of the secondary quantitative analysis (e.g., inclusion of additional school characteristics). Figure 2.1 and Table 2.1 provide an overview of the research design, which used two qualitative methods and one quantitative method. Methodological details are described in the following sub-sections. Both the COMPASS Study and the qualitative component of this research received ethics clearance through a University of Waterloo Research Ethics Committee and further approval from participating school boards.

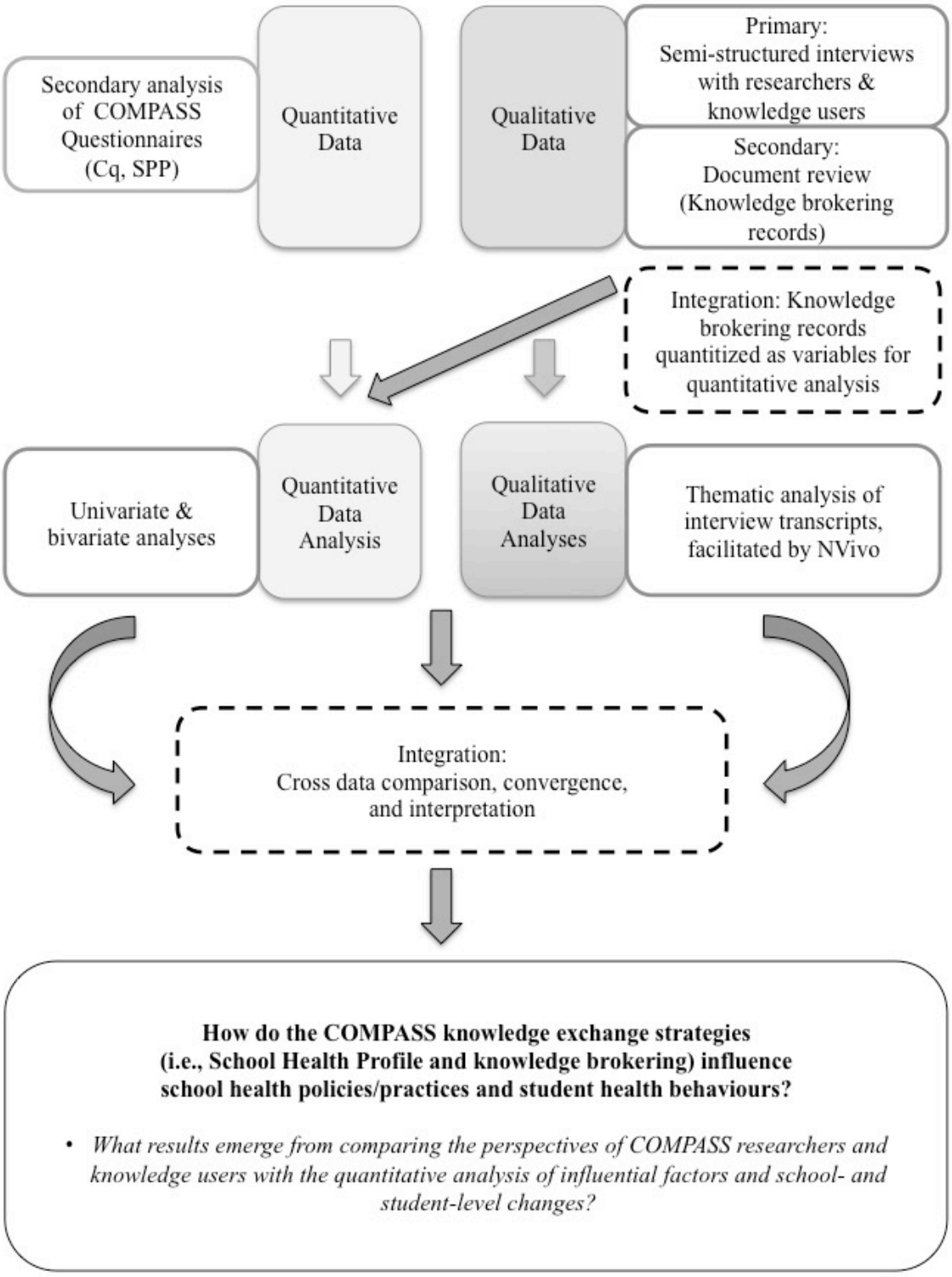

Figure 2.1 Overview of research design.

Table 2.1 Overview of objectives, methodological components, and questions of interest.

<u>Overarching Question:</u> How do the COMPASS knowledge exchange strategies (i.e., School Health Profile and knowledge brokering) influence school health policies/practices and student health behaviours?

Objectives	Methods/Instruments	Questions of Interest
1) Investigate factors associated with schools' engagement in the COMPASS knowledge brokering strategy and whether this engagement influenced school health policies/practices and student health behaviours	Secondary analysis of: • **School Policies and Practices Questionnaire (SPP)** • **Student Questionnaire (Cq)** • **Knowledge brokering records**	• What are the characteristics of schools that engage in knowledge brokering? • Is there an association between knowledge brokering engagement and changes to school policies and practices? • Is there an association between knowledge brokering engagement and improvements in school-aggregated student health behaviours?
2) Explore the experiences and perspectives of key COMPASS personnel regarding factors that shaped the knowledge brokering process, perceived outcomes, and suggestions for change	• **Qualitative semi-structured interviews** with knowledge brokers, COMPASS Principal Investigator, Project Manager, and Co-Investigators	• What factors influence schools' engagement in knowledge brokering? • What outcomes have resulted from schools' engagement in COMPASS knowledge brokering? Have there been any outcomes for the COMPASS team and/or study (e.g., current and future research)? • What challenges are involved in knowledge brokering? • What suggestions for change do they recommend for current and future knowledge brokering practices?
3) Explore the experiences and perceived outcomes of school and public health stakeholders (knowledge users) regarding the COMPASS School Health Profile (SHP) and knowledge brokering strategies	• **Qualitative semi-structured interviews** with school and public health knowledge users (i.e., COMPASS contacts)	• Have school and public health stakeholders used their school-specific findings (from the SHP) to make school-level changes? • What components of the SHP do school stakeholders perceive as most/least useful? What suggestions for change do school and public health stakeholders recommend for the SHP? • What outcomes have resulted from schools' engagement in COMPASS knowledge brokering? • What suggestions for change do they recommend for knowledge brokering?

2.3 Secondary Quantitative Analysis

Secondary analysis of the COMPASS Student Questionnaire (Cq) (student-level data), School Policies and Practices Questionnaire (school-level data), and knowledge brokering records from the first three years of COMPASS (2012-2015) was conducted to address the first objective: to investigate factors associated with schools' engagement in the COMPASS knowledge brokering strategy and whether this engagement influenced school health policies/practices and student health behaviours. For detailed descriptions regarding the methodology and recruitment of the COMPASS study, please see the following references (Bredin & Leatherdale, 2014; Bredin, Thompson-Haile, & Leatherdale, 2015; Leatherdale, 2016; Leatherdale et al., 2014; Thompson-Haile & Leatherdale, 2013a; Thompson-Haile & Leatherdale, 2013b; Thompson-Haile & Leatherdale, 2013c; Wagner, Bredin, Thompson-Haile, & Leatherdale, 2015).

2.3.1 Data Sources

Four main data sources were used for the secondary quantitative analysis; specific measures are described in Chapter 3 and Appendix A.

a) Knowledge brokering records: COMPASS knowledge brokers maintained journal entries for each contact with each school, recording notes on the details discussed. Information was recorded in three forms: in a Word document for each school (recording all knowledge brokering communication over the duration of the COMPASS study); in a summary Excel file for each school year (2012-2013; 2013-2014; 2014-2015); and some communication was stored in the Online Survey Implementation System (OSIS) database (see below). Knowledge brokering records from the first three years of COMPASS (2012-2015) were analyzed. Information from the three sources was compiled to create variables for knowledge

brokering participation intensity, position of school contact, the COMPASS knowledge broker assigned to the school, and whether there was a change in school contact, school administrator, or knowledge broker between two years. Variables were created for each year.

b) COMPASS Student Questionnaire (Cq): Student survey data from the first three years of COMPASS (2012-2013; 2013-2014; 2014-2015) were analyzed. The analysis focused on whether knowledge brokering was associated with changes in school-aggregated student outcomes the following year (i.e., knowledge brokering in year 1→ change in school-aggregated Cq data from year 1 to year 2). Knowledge brokering records for the first two years of COMPASS (as of July 2015) were reviewed to determine topics discussed; the most frequently discussed were healthy eating, physical activity, binge drinking, marijuana use, tobacco use, sedentary behaviour, obesity, and energy drink consumption. Hence, these behaviours were chosen for school-aggregated student outcomes.

c) School Policies and Practices Questionnaire (SPP): School-level survey data from the first three years of COMPASS (2012-2013; 2013-2014; 2014-2015) were used in this analysis. The analysis focused on whether knowledge brokering engagement was associated with school-level changes in the following year (i.e., knowledge brokering engagement in year 1→ SPP data in year 2). Variables from the SPP data included the school's baseline relationship with the local public health unit, a baseline school health indicator, as well as school-level changes (policy, practice, environment/equipment, and relationship with public health) for each of the following health behaviours: healthy eating, physical activity, tobacco use, alcohol/drug use, bullying, and sedentary behaviour.

d) Online Survey Implementation System (OSIS) database: Lastly, information regarding school characteristics (e.g., postal code to determine urban/rural status and socioeconomic

status of the area surrounding the school, number of students in the school, month of school Cq data collection, and year of COMPASS participation) was extracted from the OSIS database to derive variables.

2.3.2 Analysis

Figure 2.2 outlines the secondary analysis conducted using SPSS Statistics 23 (IBM). An exploratory (univariate) analysis of the Cq variables was conducted in order to determine the variation within outcomes and ultimately, which variables were included in the final analysis. Secondly, bivariate analyses were conducted to examine the relationship between knowledge brokering frequency with i) school characteristics, ii) changes in school policies and practices, and iii) changes in school-aggregated student outcomes. Details of the analysis are described in Chapter 3.

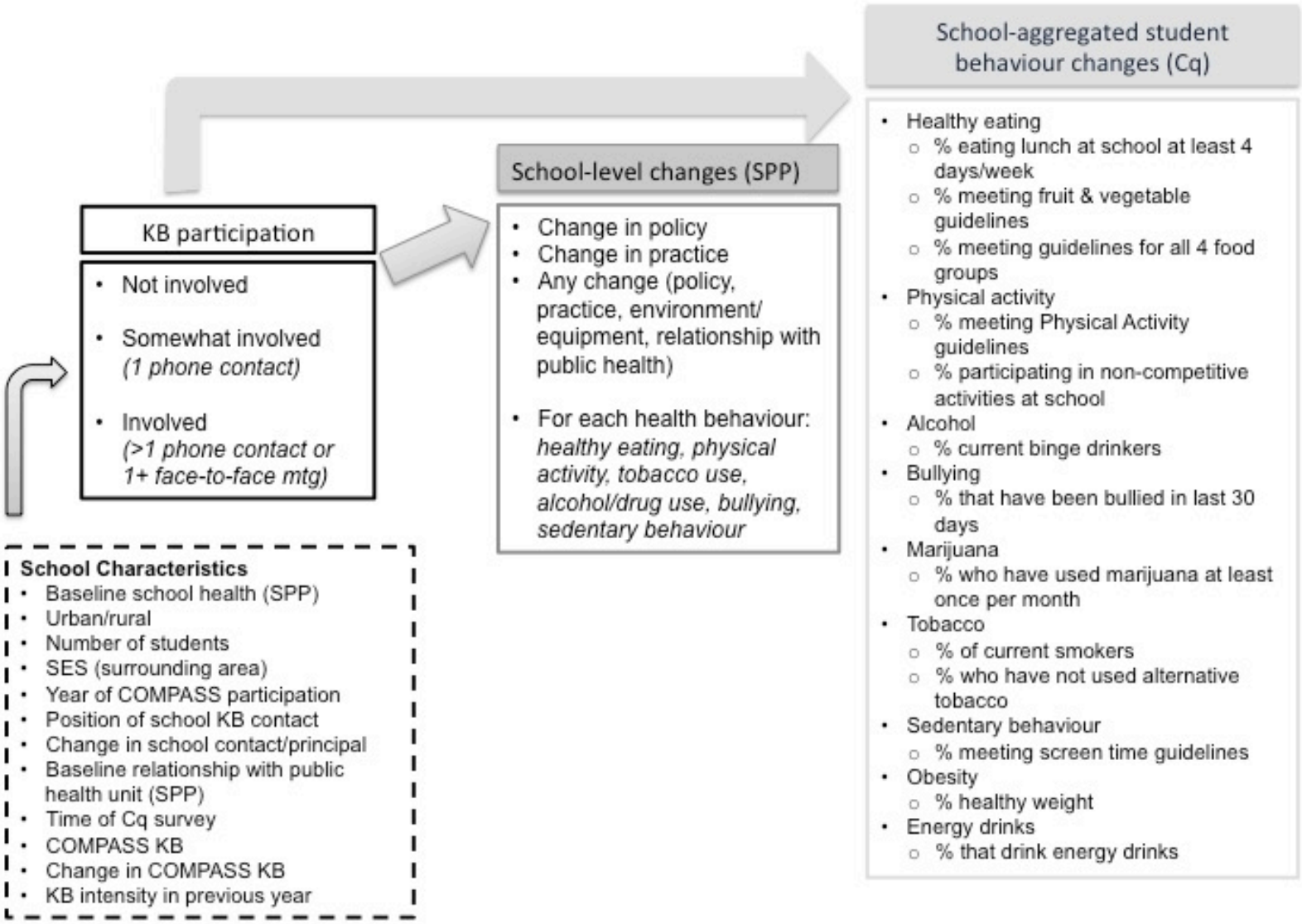

Figure 2.2 Outline of secondary quantitative analysis.

2.4 Key Informant Interviews with Researchers

Key informant interviews were conducted to address the second research objective: to explore the experiences and perspectives of key COMPASS personnel regarding factors that shaped the knowledge brokering process, perceived outcomes, and suggestions for change.

2.4.1 Sample

Semi-structured interviews were conducted with members of the core COMPASS team (knowledge brokers, Principal Investigator, and Project Manager) and Co-Investigators. Purposeful sampling was used to include the perspectives of these groups to understand their experiences with knowledge brokering:

- COMPASS knowledge brokers contacted and provided ongoing support to the schools. This group consisted of five individuals from an Ontario university (knowledge brokers to Ontario schools) and one individual from an Alberta university (knowledge broker to Alberta schools).
- The Principal Investigator and Project Manager were responsible for the organization and oversight of the COMPASS study, including the knowledge exchange strategies.
- COMPASS Co-Investigators included faculty members from three Canadian universities. All Co-Investigators (n=8) were invited to participate.

2.4.2 Procedure

Once ethics clearance was received, the COMPASS Principal Investigator notified potential participants they would be contacted by the student investigator to participate in the study. The student investigator then invited potential participants and scheduled interviews for those interested. Each key informant was interviewed individually, for 20-90 minutes, at a time, location, and format (phone or in-person) of their choice. All interviews were digitally audio-recorded (with permission). Interviews with knowledge brokers (Appendix B) and COMPASS staff (Appendix C) focused on understanding the COMPASS knowledge brokering process, their

experiences with knowledge brokering, facilitators and challenges, perceived outcomes, and suggestions for change. Interviews with the Co-Investigators (Appendix D) focused on their understanding of knowledge translation and knowledge brokering, perceived outcomes, and suggestions for change.

2.5 Key Informant Interviews with Knowledge Users

Key informant interviews were used to address the third objective: to explore the experiences and perceived outcomes of school and public health stakeholders (knowledge users) regarding the COMPASS School Health Profile (SHP) and knowledge brokering strategies.

2.5.1 Participant Sample

To understand the experiences of school stakeholders, schools from four Ontario school boards served as cases. Purposeful sampling was used to incorporate perspectives from school stakeholders that were engaged in knowledge brokering to varying degrees. Schools that were "involved" in knowledge brokering (in-person meeting and/or more than one phone call per school year) during the 2012-2013 and 2013-2014 school years were identified through preliminary analysis of the knowledge brokering records. Other schools within their school boards were then categorized by knowledge brokering engagement (i.e., "involved", "somewhat involved" [one successful phone call per year], or "not involved"). Four Ontario school boards were identified that had at least one involved school and a mix of schools that were somewhat and not involved. Table 2.2 provides characteristics of the COMPASS schools and potential participants within the four school boards.

All public health contacts (e.g., managers, nurses, and dietitians) engaged in COMPASS knowledge brokering (i.e., affiliated with any school participating in COMPASS) were also

invited to participate in an interview (n=9). These individuals were from three health units, one of which was affiliated with one of the participating school boards.

Table 2.2 Characteristics of invited schools.

School[a]	Knowledge Brokering Engagement	Urban/Rural[b]	Enrolment[c]	Administrator Contacts (n)	Teacher Contacts (n)
A1	Involved	Medium urban	Medium	1*	
A2	Involved	Large urban	Large	3*	
A3	Somewhat	Large urban	Large	1*	
A4	Somewhat	Small urban	Small	1*	1*
A5	Not	Medium urban	Medium	1	
B1	Involved	Large urban	Large		2*
B2	Involved	Large urban	Large	2*	1*
B3	Somewhat	Large urban	Large	1*	
B4	Not	Large urban	Large	1	
B5	Not	Large urban	Large	1	
B6	Not	Large urban	Large	1	
C1	Involved	Large urban	Large	1*	
C2	Involved	Large urban	Large	2*	
C3	Somewhat	Medium urban	Medium	2*	
C4	Somewhat	Medium urban	Small		1*
D1	Involved	Large urban	Large		1*
D2	Somewhat	Medium urban	Medium	1*	
D3	Not	Large urban	Large		1
D4	Not	Large urban	Large	1	
D5	Not	Large urban	Medium	1	

[a] Letters (A-D) in this column distinguish between school boards
[b] Urban/rural classifications based on Statistics Canada (2011)
[c] Small enrolment≤500 students; medium enrolment=501-900 students; large enrolment>900 students
*Individual was involved in knowledge brokering.

2.5.2 Recruitment

The four school boards described above were approached for approval after receiving ethics clearance through a University of Waterloo Research Ethics Committee (ORE #21163). Approval was received from all four school boards; the student investigator then approached school principals within these boards that were participating in COMPASS. Once principals granted permission, the student investigator invited the COMPASS contact(s) (e.g., principals,

vice principals, teachers) from each school (identified through the OSIS database) to participate in an interview. Hence, multiple individuals were interviewed for some schools. Characteristics of participants' schools are provided in Table 2.3. Additionally, the student investigator invited the public health contacts (identified through OSIS) upon receiving ethics clearance through a University of Waterloo Research Ethics Committee (ORE #21163).

Table 2.3 Participating school characteristics.

Characteristic	Number of Schools
Knowledge brokering engagement level[a]	
• School Involved	6
• School Somewhat Involved	2
• School Not Involved	1
Rural/Urban[b]	
• Small urban	1
• Medium urban	1
• Large urban	7
School enrolment[c]	
• Small	1
• Medium	2
• Large	6
Number of years school participated in COMPASS	
• 4 (2012-2013 start)	6
• 3 (2013-2014 start)	2
• 1 (2015-2016 start)	1

[a] Involved= in-person meeting and/or >1 phone call per year; somewhat involved= 1 phone call per year; not involved= no knowledge brokering participation

[b] Urban/rural classifications based on Statistics Canada (2011)

[c] Small enrolment≤500 students; medium enrolment=501-900 students; large enrolment>900 students.

2.5.3 Procedure

Each participant was interviewed over the phone, at a time of his or her choice. Interviews ranged from 20 to 50 minutes in duration. Interviews with teachers were conducted at a time of their convenience (i.e., preparatory periods, lunch, after school) as to not disrupt instructional time. While the initial intent was for participants to be interviewed individually, three schools

with multiple invitees requested to participate in the same phone interview (School 2: 1 principal, 2 teachers; School 6: 1 principal, 1 vice-principal; School 4: 2 teachers). Group interviews were conducted to meet these requests, aligning with a health-promoting schools approach and the important role of leadership among school staff (Samdal & Rowling, 2011). Group interviews allowed participants to expand on other's ideas and created a more comprehensive picture of the school's experience with COMPASS knowledge exchange. Interviews were digitally audio-recorded with permission, and focused on school and public health stakeholders' experiences with the School Health Profile (SHP) and knowledge brokering (Appendices E and F). Questions about the SHP focused on use, perceived outcomes, utility, and suggestions for change. Questions about knowledge brokering focused on their experiences communicating with the knowledge broker, facilitators and barriers to participation, perceived utility, and suggestions for change.

2.6 Qualitative Interview Analysis

The audio recording from each interview was transcribed *verbatim* for subsequent thematic analysis using NVivo for Mac 11 (QSR International). A template organizing style (Crabtree & Miller, 1999) was used to code the transcripts, consisting of the following steps. First, transcripts were scanned in order to determine codes to compose a coding manual. Codes were established using a deductive approach, which explored the data for themes related to the research objectives (e.g., facilitators and barriers to COMPASS knowledge exchange, perceived outcomes, and suggestions for change), and an inductive approach, which determined themes emerging from the data. Second, the coding manual was used to identify relevant data within the transcripts (i.e., transcripts were coded). Third, the constant comparative method (Corbin & Strauss, 2008; Glaser & Strauss, 1967) was used to determine similarities and differences within the data, to refine

codes and ensure proper categorization of themes. These themes were then compared, connected, and interpreted in relation to the research objectives (Crabtree & Miller, 1999).

To enhance qualitative rigour of the findings, inter-rater reliability was assessed for the knowledge broker, Co-Investigator, school, and public health interviews by determining between-researcher agreement using the methods described by Miles and Huberman (1994). For each participant group, a second researcher trained in qualitative analysis coded two transcripts and the researchers' coding of the same transcript were compared to calculate agreement (whether the same codes were applied to a section of text) using the calculation: (# of agreements)/(Total # of agreements + disagreements). Agreements were defined as the same code applied to the exact same section of text. When there was a disagreement, the two researchers discussed why they applied each code and came to a resolution, leading to changes to the coding manual before coding the remaining transcripts. Inter-rater reliability was calculated to be greater than 70% for all participant groups and was deemed acceptable (Miles & Huberman, 1994).

Peer examination (Baxter & Eyles, 1997) was employed for the Principal Investigator and Project Manager interviews; because there were only two participants with different perspectives due to their roles, we determined inter-rater reliability was not feasible. Instead, the second researcher reviewed the coding manual and transcripts, and changes were made to the manual based on this review before further coding ensued.

2.7 Integration of Findings

Fetters et al. (2013) define three levels of integration in mixed methods research: integration at the design level, methods level, and interpretation and reporting levels. This model was used to integrate the quantitative and qualitative findings. At the design level, a convergent

parallel design was used; at the methods level, merging was employed; and at the interpretation and reporting levels, data were integrated narratively (Fetters et al., 2013).

As indicated in Figure 2.1, qualitative data from the knowledge brokering records was quantitised (converted to quantitative data) and incorporated into the secondary quantitative analyses (Bazeley, 2009). The qualitative findings were triangulated; interview findings for each stakeholder group were compared, allowing for validation and clarification (Patton, 2015). Further, the results of the independent analyses of the interviews and knowledge brokering records influenced the secondary analysis (e.g., inclusion of additional school characteristic variables). Subsequently, merging involved comparing the independent quantitative and qualitative analyses to identify areas of similarities and differences (Creswell & Plano Clark, 2011; Curry & Nunez-Smith, 2015). Through this process, areas of confirmation (agreement between the individual findings), expansion (findings from one method explain findings of another), and discordance (inconsistencies and contradictions) were identified (Fetters et al., 2013). When discordance occurred, the individual methods were re-examined and potential explanations for these differences were suggested (Curry & Nunez-Smith, 2015; Fetters et al., 2013; Moffatt, White, Mackintosh, & Howel, 2006).

During reporting, narrative integration occurred. Initially, a *staged approach* was used to report findings from each individual method in separate articles (Chapters 3-5) (Fetters et al., 2013). However, a *weaving approach* was subsequently used, in which quantitative and qualitative findings related to the overlapping themes were compared (Chapter 6) (Fetters et al., 2013). “Crosswalking”, as defined by Curry and Nunez-Smith (2015), was used to ensure that links between the articles were explicitly described to ensure readers understood the mixed methods approach and findings.

2.8 Methodological Rigour

Techniques to address the criteria for quantitative (i.e., internal validity, reliability, generalizability, and objectivity) (Curry & Nunez-Smith, 2015) and qualitative rigour (i.e., credibility, dependability, transferability, and confirmability) (Lincoln & Guba, 1985) were used for the individual methods within the design. Additionally, considerations for mixed methods beyond the criteria for quantitative and qualitative rigour were employed throughout the research process, aligning with the Good Reporting of a Mixed Methods Study (GRAMMS) guidelines (O'Cathain, Murphy, & Nicholl, 2008) and the critical appraisal framework outlined by Curry and Nunez-Smith (2015). However, as noted by Brown et al. (2015), there is limited discussion in the mixed methods literature regarding practical techniques for establishing rigour. An audit trail was maintained to record all data collection and analysis decisions and the reasons for these decisions, as recommended by Curry and Nunez-Smith (2015).

Chapter 3

Researchers Supporting Schools to Improve Health: Influential Factors & Outcomes of Knowledge Brokering in the COMPASS Study

Status: Revised manuscript under review in *Journal of School Health*.

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Overview

BACKGROUND: Although schools are considered opportune settings for youth health interventions, a gap between school health research and practice exists. COMPASS, a longitudinal study of Ontario and Alberta secondary students and schools (2012-2021), used integrated knowledge translation to enhance schools' uptake of research findings. Schools received annual summaries of their students' health behaviours and suggestions for action, and were linked with COMPASS knowledge brokers to support them in making changes to improve student health. This research examines the factors that influenced schools' participation in knowledge brokering and associated outcomes.

METHODS: School- and student-level data from the first three years of the COMPASS study (2012-2013; 2013-2014; 2014-2015) were used to examine factors that influenced knowledge brokering participation, school level changes, and school-aggregated student health behaviours.

RESULTS: Both school characteristics and study-related factors influenced schools' participation in knowledge brokering. Knowledge brokering participation was significantly associated with school-level changes related to healthy eating, physical activity, and tobacco programming, but the impact of those changes was not evident at the aggregate student level.

CONCLUSIONS: Knowledge brokering provided a platform for collaboration between researchers and school practitioners, and led to school-level changes. These findings can inform future researcher-school practitioner partnerships to ultimately enhance student health.

Key words: child & adolescent health; public health; evaluation; health communication

3.1 Introduction

While schools have been described as key settings for adolescent health interventions (Veugelers & Schwartz, 2010), the main priority of schools is education; to be implemented sustainably, school health interventions must fit within this context (McCuaig & Hay, 2014). Additionally, there is minimal interaction between schools and health researchers, leaving schools with little feedback regarding their health promotion efforts (Keshavarz, Nutbeam, Rowling, & Khavarpour, 2010); collaboration is needed to understand how these interventions can be implemented successfully (McCuaig & Hay, 2014; Schee & Gard, 2014). A gap between school health research and practice exists, aligning with the observation that public health (Ammerman, Smith, & Calancie, 2014; Van Den Driessen Mareeuw, Vaandrager, Klerkx, Naaldenberg, & Koelen, 2015) and educational (Dagenais et al., 2012; Lysenko, Abrami, Bernard, & Dagenais, 2015; Lysenko, Abrami, Bernard, Dagenais, & Janosz, 2014) evidence are not being integrated into practice. This is known as the "knowledge to action gap" (Bowen & Graham, 2013; Graham et al., 2006), and knowledge translation initiatives have emerged to address this issue (Ammerman et al., 2014; Lifsey, Cash, Anthony, Mathis, & Silva, 2015). Knowledge translation encompasses various strategies to increase the uptake of research findings into policy and practice (Rychetnik et al., 2012); knowledge exchange is one approach, in which researchers and knowledge users (individuals who could use the research to inform policy or practice) discuss research problems and findings (Canadian Foundation for Healthcare Improvement, 2015). Knowledge exchange provides an opportunity to help schools implement evidence-based interventions and enhance health-promoting factors in school environments.

Knowledge brokering is a knowledge exchange strategy that "links researchers and decision-makers, facilitating their interaction so that they are better able to understand each

other's goals and professional culture, influence each other's work, forge new partnerships and use research-based evidence" (Canadian Foundation for Healthcare Improvement, 2015). The underlying rationale for knowledge brokering is that "interpersonal contact improves the likeliness of behaviour change" (Traynor, DeCorby, & Dobbins, 2014, p. 534). Knowledge brokering is particularly useful when there is adequate time and frequent communication to develop rapport with knowledge users (Dagenais, Laurendeau, & Briand-Lamarche, 2015; Riley, Wong, & Manske, 2014; Traynor et al., 2014). Knowledge brokering is increasing in public health (see Dagenais et al. [2015]; Dobbins, Robeson, et al. [2009]; Kramer et al. [2015]; Rosella et al. [2014]; Traynor et al. [2014]; Ward, House, & Hamer [2009]) and education (see Ng-A-Fook, Kane, Butler, Glithero, & Forte [2015]; Sharples & Sheard [2015]; Sheard & Sharples [2016]); however, the need for evaluation has been emphasized (Bornbaum, Kornas, Peirson, & Rosella, 2015; Dagenais et al., 2015).

Similarly, in school health research, developing and evaluating knowledge exchange strategies has been identified as a priority (Moore, Littlecott, Fletcher, Hewitt, & Murphy, 2016); while initiatives are beginning to emerge, few evaluations have been published (Murnaghan et al., 2013; Riley et al., 2014; Short, Weist, Manion, & Evans, 2012). However, three strategies have been recommended for youth health research: using research summaries (e.g., reports, websites, newsletters) to spark conversations with knowledge users; building research-practice-policy partnerships; and adapting initiatives to meet specific stakeholder needs (Murnaghan et al., 2013; Riley et al., 2014). Hence, knowledge brokering has been proposed as a useful approach (Riley et al., 2014), and researchers in higher education have been identified as well positioned to work with schools as knowledge brokers (Sharples & Sheard, 2015).

COMPASS is an ongoing longitudinal study (2012-2021) on student health behaviours

and secondary school environments in Ontario and Alberta (Leatherdale et al., 2014). Researchers are investigating changes in student health behaviours over time and whether changes to the school environment influence these behaviours (Leatherdale et al., 2014). Knowledge exchange strategies are integrated, allowing researchers to help schools improve student health and the school environment. After students complete surveys each year, the school receives a tailored summary of their students' health behaviours, which includes recommended changes a school can implement to improve student health, and contact information for the local public health unit and a COMPASS researcher (knowledge broker) (Leatherdale et al., 2014). The knowledge broker then contacts the school to discuss their summary and provides ongoing support as needed (including identifying health priorities within the school, potential funding opportunities, and connecting them to community agencies such as public health units). Further information regarding knowledge brokering procedures can be found online (Thompson-Haile, Laxer, Ledgley, & Leatherdale, 2015).

This research is part of a larger mixed-methods study exploring the implementation and outcomes of the COMPASS knowledge exchange strategies; findings will be used to adapt and strengthen these activities as the COMPASS study progresses. This paper presents the quantitative component, which aims to answer the following questions: (1) what factors influenced schools' participation in COMPASS knowledge brokering? and (2) did participating in knowledge brokering influence changes in school health policies and practices and/or student health behaviours?

3.2 Methods

3.2.1 Participants

Detailed descriptions of the COMPASS study methodology and recruitment are available in print (Leatherdale et al., 2014) and online (www.compass.uwaterloo.ca). Briefly, this research used data collected during the first three years of COMPASS (from October 2012 to May 2015). Forty-three Ontario secondary schools were purposefully recruited in Year 1 (Y1 2012-2013; N=24,173 students), 89 Ontario and Alberta schools in Year 2 (Y2 2013-2014; 46 additional schools recruited, N=45,298 students), and 87 Ontario and Alberta schools in Year 3 (Y3 2014-2015; one school added and three schools lost, N=42,355 students). For the analysis of knowledge brokering outcomes, 43 schools were included in the comparison of Y1 and Y2 outcomes, and 86 schools were included in the comparison of Y2 and Y3 outcomes. Characteristics of participating schools are provided in Table 3.1. In each year of COMPASS, all grade 9-12 students in participating schools were invited to participate in the student-level survey (Cq) using active-information passive consent procedures (Leatherdale et al., 2014).

3.2.2 Instruments

Three data sources were used for this analysis: (1) the COMPASS Student questionnaire [Cq] (a self-report survey completed by students), (2) the School Policies and Practices Questionnaire (SPP) (a self-report survey completed by school staff), and (3) COMPASS knowledge brokering records (journal entries knowledge brokers wrote for each contact with each school). The Cq measures were based on national standards or public health guidelines and psychometric properties are reported elsewhere (Leatherdale, Laxer, & Faulkner, 2014; Leatherdale & Laxer, 2013; Leatherdale et al., 2014). The SPP measured the presence of health programs and policies within schools, as well as changes related to programs, policies, or

resources within the past year. COMPASS knowledge brokers then followed up with schools to verify information provided.

3.2.3 Measures

Knowledge brokering measures. Knowledge brokering records from the first three years of COMPASS were reviewed and the type of communication (email, phone, and in-person), number of successful contacts, assigned knowledge broker, and school participants' positions were recorded via a data extraction tool. Data were managed using Microsoft Excel. The first author consulted with individual knowledge brokers to ensure data accuracy. For each year, schools were categorized into three participation levels: "not involved", "somewhat involved" (at least one successful phone contact), and "involved" (more than one successful phone contact or at least one in-person meeting). For example, if a school participated in one phone call, it was classified as "somewhat involved". However, if a school followed up after the phone call (via email or phone) requesting further information, it was classified as "involved".

The school contact for the COMPASS study was the individual who communicated with the knowledge broker or the individual invited to participate in knowledge brokering. Variables were also included to identify whether there was a change in (1) school contact, (2) school administrator, or (3) knowledge broker assigned to the school between two consecutive years.

School-level measures. Urban/rural status was determined using 2011 Canadian Census data and the definitions outlined by Statistics Canada (2011). School enrolment was classified using the Ontario Federation of School Athletic Associations 2014-2015 guidelines (Ontario Federation of School Athletic Associations, 2014). The socioeconomic status of the area surrounding the school was measured using the Quebec social and material deprivation index

(Canadian Institute for Health Information, 2008) and 2006 Canadian Census data (due to the high non-response rate of the 2011 National Household Survey).

Baseline SPP data were used to indicate schools' relationships with local public health units before the study and classified as no involvement (no contact), passive involvement (public health provided information/resources/programs), or active involvement (school and public health solved problems or implemented programs together). To measure the health initiatives in each school at baseline, an index was created using SPP data from each school's first year of participation. The index was scored out of 5, measuring whether the school had written policies, programs, and professional development opportunities related to healthy eating, physical activity, tobacco, alcohol, drugs, and bullying; whether they had worked with external agencies to promote health; and whether they had used student health data in the past two years to inform school planning. Schools with scores closer to 5 were considered "more healthy" at baseline, while schools with scores closer to 0 were considered "less healthy".

Year 2 and 3 SPP data were used to measure school-level outcomes for six health behaviours: healthy eating, physical activity, tobacco, alcohol and drug use, bullying, and sedentary behaviour. For each behaviour, the school contact reported whether there were changes in policy, practice, environment/equipment, or their relationship with public health in the past year. For this analysis, three types of changes were included: policy changes, practice changes, or any changes (policy, practice, environment/equipment, or public health).

School-aggregated student measures. Student outcomes were analyzed for eight modifiable health-related behaviours (healthy eating, physical activity, obesity, sedentary behaviour, tobacco, alcohol and drug use, bullying, and energy drink consumption) that were the most frequently discussed topics upon review of the Y1 and Y2 knowledge brokering records.

Self-reported student data were aggregated at the school level by calculating the percentage of students within a school that achieved the guidelines or health behaviours described below. For healthy eating, the percentage of students meeting Canada's Food Guide recommendations for fruit and vegetable consumption and all food groups were measured based on the following minimum number of daily servings: fruit and vegetables (7 for girls, 8 for boys), meat and alternatives (2 for girls, 3 for boys), milk and alternatives (3 for boys and girls), grain products (6 for girls, 7 for boys) (Health Canada, 2016). Additionally, the percentage of students eating lunch at school at least four days per week was included.

The percentage of students that reported meeting the Canadian Physical Activity (i.e., at least 60 minutes of moderate to vigorous intensity physical activity daily) and Sedentary Behaviour guidelines (i.e., no more than 120 minutes of screen time daily) (Canadian Society for Exercise Physiology, 2016) and the percentage of students participating in non-competitive activities at school (e.g., intramural sports) were included. Body mass index (BMI) was computed from student-reported height and weight, and then categorized using the World Health Organization BMI cut points (World Health Organization, 2007), adjusting for age and sex. The percentage of students in a school categorized as healthy weights was used in this analysis.

Students were defined as current smokers if they reported ever smoking 100 cigarettes and any smoking in the previous 30 days, consistent with previously validated measures (Wong, Shields, Leatherdale, Malaison, & Hammond, 2012). The percentage of students who had not used alternative tobacco products (i.e., pipe tobacco, cigarillos/little cigars, cigars, roll-your-own, loose tobacco with marijuana, bidis [year 1], e-cigarettes [year 2-3], smokeless tobacco, nicotine products, hookah, and blunt wraps) in the past 30 days was indicated by those who responded, *"I have not used any of these things in the last 30 days"*. The percentage of students who were

current binge drinkers corresponded to those who reported drinking five or more alcoholic drinks on one occasion at least monthly. The percentage of students who were current marijuana users was measured as those reporting using marijuana at least once per month. The percentage of students who had been bullied in the past 30 days represented those responding they were bullied by other students once per week or more. Lastly, the percentage of students consuming energy drinks during weekdays indicated those who responded they drank beverages such as Red Bull, Monster, or Rock Star 1-5 days in a usual school week.

3.2.4 Data Analysis

Analyses were conducted using SPSS Statistics 23. The first analysis focused on school-level factors that influenced knowledge brokering participation in the first three years of COMPASS. The school- and student-level outcomes of knowledge brokering in Y1 and Y2 were then analyzed. First, knowledge brokering participation in Y1 and Y2 was compared to school-level changes in the subsequent year. Second, knowledge brokering participation was compared to school-aggregated student outcomes in the current and subsequent year (e.g., Y2 knowledge brokering participation was compared to outcomes in Y2 and Y3) using mixed-model ANOVAs.

3.3 Results

3.3.1 Characteristics that Influence Knowledge Brokering Participation

During the first three years of COMPASS, about half of the schools participated ("involved" or "somewhat involved") in knowledge brokering. Participation frequencies are provided in Table 3.1. Across all years, schools with more than 900 students were more likely to be "involved" in knowledge brokering compared to schools with fewer students (Table 3.1). In Y1, no schools with fewer than 500 students participated in knowledge brokering; however, in Y2 and Y3, these schools were more likely to participate than medium-enrolment schools (501-

900 students) (Table 3.1). Additionally, in Y2, schools with more than 900 grade 9-12 students were more likely to participate in knowledge brokering than schools with fewer grade 9-12 students (Table 3.1).

Interestingly, in Y2, schools whose surrounding area was of average socioeconomic status were less likely to participate in knowledge brokering than those of low or high socioeconomic status (Table 3.1). In Y1, schools whose baseline relationship with public health was "active" were more likely to be "involved", and 80% of schools that had no contact with local public health units in the past year participated in knowledge brokering (Table 3.1). This relationship was not significant in Y2 or Y3. In Y2, schools that had a lower school health score at baseline (e.g., fewer health programs, policies, partnerships, and professional development opportunities) were more likely to participate (Table 3.2). No difference in knowledge brokering participation was found between urban and rural schools, and there was no relationship between whether the school contained younger grades and knowledge brokering participation (Table 3.1).

In Y2, schools with principals or vice-principals as the main contact for the COMPASS study were less likely to participate in knowledge brokering. As well, schools in their first year of the study were more likely to be "somewhat involved" in knowledge brokering, while those in their second year were more likely to be "involved" (Table 3.3). However, the time of year that the school participated in the student survey did not affect their knowledge brokering participation (Table 3.3). The knowledge broker assigned to a school influenced its participation level. Generally, those assigned to the knowledge broker with the majority of schools were less likely to participate. Additionally, none of the schools assigned to the Alberta knowledge broker were "involved" (Table 3.3); this is because Alberta schools wanting support beyond the follow-up call were referred to an external agency.

Table 3.1 Characteristics of Schools Related to Level of Knowledge Brokering Participation.

Variable	2012-2013 (Y1) Not involved (N=22) N (%)	2012-2013 (Y1) Somewhat Involved (N=12) N (%)	2012-2013 (Y1) Involved (N=9) N (%)	2013-2014 (Y2) Not involved (N=41) N (%)	2013-2014 (Y2) Somewhat Involved (N=38) N (%)	2013-2014 (Y2) Involved (N=10) N (%)	2014-2015 (Y3) Not involved (N=47) N (%)	2014-2015 (Y3) Somewhat Involved (N=30) N (%)	2014-2015 (Y3) Involved (N=10) N (%)
Urban/rural		p = .25			p = .10			p = .29	
Large urban	9 (43)	6 (29)	6 (29)	14 (45)	9 (29)	8 (26)	13 (42)	11 (35)	7 (23)
Medium urban	1 (17)	3 (50)	2 (33)	7 (50)	6 (43)	1 (7)	7 (54)	5 (38)	1 (8)
Small urban	9 (75)	2 (17)	1 (8)	16 (46)	18 (51)	1 (3)	23 (66)	10 (29)	2 (6)
Rural	3 (75)	1 (25)	0 (0)	4 (44)	5 (56)	0 (0)	4 (50)	4 (50)	0 (0)
Grades in school		p = .89			p = .35			p = .79	
Grades 9-12	18 (53)	9 (26)	7 (21)	30 (47)	25 (39)	9 (14)	34 (55)	20 (32)	8 (13)
Includes students grades 8 and younger	4 (44)	3 (33)	2 (22)	11 (44)	13 (52)	1 (4)	13 (52)	10 (40)	2 (8)
Total student enrolment		**p < .05**			**p < .01**			**p < .01**	
Small (<500 students)	7 (100)	0 (0)	0 (0)	8 (42)	11 (58)	0 (0)	10 (46)	12 (54)	0 (0)
Medium (501-900)	9 (43)	9 (43)	3 (14)	27 (59)	17 (37)	2 (4)	30 (70)	10 (23)	3 (7)
Large (>900)	6 (40)	3 (20)	6 (40)	6 (25)	10 (42)	8 (33)	7 (32)	8 (36)	7 (32)
Grade 9-12 enrolment		p = .10			**p < .01**			p = .34	
Small (<500 students)	9 (82)	2 (18)	0 (0)	15 (48)	16 (52)	0 (0)	19 (54)	14 (40)	2 (6)
Medium (501-900)	7 (39)	7 (39)	4 (22)	20 (54)	15 (41)	2 (5)	18 (56)	11 (34)	3 (9)
Large (>900)	6 (43)	3 (21)	5 (36)	6 (29)	7 (33)	8 (38)	10 (50)	5 (25)	5 (25)
SES of area surrounding school		p = .95			**p < .05**			p = .65	
Low	4 (67)	1 (17)	1 (17)	5 (36)	7 (50)	2 (14)	6 (50)	4 (33)	2 (17)
Average	13 (46)	9 (32)	6 (21)	32 (52)	27 (43)	3 (5)	36 (58)	20 (32)	6 (10)
High	5 (56)	2 (22)	2 (22)	4 (31)	4 (31)	5 (38)	5 (39)	6 (46)	2 (15)
Baseline relationship with public health		**p < .05**			p = .32			p = .37	
No contact	1 (20)	3 (60)	1 (20)	3 (27)	6 (55)	2 (18)	6 (54)	4 (36)	1 (9)
Passive involvement	14 (67)	6 (29)	1 (5)	21 (53)	17 (42)	2 (5)	24 (63)	12 (32)	2 (5)
Active involvement	7 (41)	3 (18)	7 (41)	17 (45)	15 (40)	6 (16)	17 (45)	14 (37)	7 (18)

p values derived from Fisher's exact tests; bold formatting indicates a significant association.

Table 3.2 Baseline Indicator of School Health Related to Level of Knowledge Brokering Participation.

	2012-2013 (Y1)			2013-2014 (Y2)			2014-2015 (Y3)		
	Not involved (Mean rank)	**Somewhat Involved (Mean rank)**	**Involved (Mean rank)**	**Not involved (Mean rank)**	**Somewhat Involved (Mean rank)**	**Involved (Mean rank)**	**Not involved (Mean rank)**	**Somewhat Involved (Mean rank)**	**Involved (Mean rank)**
Baseline school health indicator	24.93	p = .23 17.25	21.17	51.05	**p < .05** 42.76	28.70	48.36	p = .18 37.50	43.00

p values derived from Kruskal-Wallis tests; bold formatting indicates a significant association.

Table 3.3 COMPASS Study Factors Related to Schools' Level of Knowledge Brokering Participation.

	2012-2013 (Y1)			2013-2014 (Y2)			2014-2015 (Y3)		
Variable	**Not involved N (%)**	**Somewhat Involved N (%)**	**Involved N (%)**	**Not involved N (%)**	**Somewhat Involved N (%)**	**Involved N (%)**	**Not involved N (%)**	**Somewhat Involved N (%)**	**Involved N (%)**
Position of school contact		p = .38			**p < .01**			p = .70	
Teacher	2 (25)	3 (38)	3 (38)	6 (25)	17 (71)	1 (4)	13 (50)	8 (31)	5 (19)
Principal	13 (62)	4 (19)	4 (19)	18 (55)	11 (33)	4 (12)	18 (58)	11 (35)	2 (7)
Vice-Principal	7 (50)	5 (36)	2 (14)	12 (63)	7 (37)	0 (0)	16 (53)	11 (37)	3 (10)
Other	-	-	-	3 (60)	1 (20)	1 (20)	-	-	-
Multiple contacts	-	-	-	2 (25)	2 (25)	4 (50)	-	-	-
Year of COMPASS participation		-			**p < .05**			p = .06	
First year	-	-	-	20 (44)	24 (52)	2 (4)	1 (100)	0 (0)	0 (0)
Second year	-	-	-	21 (49)	14 (33)	8 (19)	23 (51)	20 (44)	2 (4)
Third year	-	-	-	-	-	-	23 (56)	10 (24)	8 (20)
Time of student survey		p = .07			p = .24			p = .68	
Sept, Oct, Jan, Feb, March, April	17 (63)	7 (26)	3 (11)	23 (47)	23 (47)	3 (6)	27 (57)	16 (34)	4 (9)
Nov, Dec, May, June	5 (31)	5 (31)	6 (38)	18 (45)	15 (38)	7 (18)	20 (50)	14 (35)	6 (15)

COMPASS KB		**p < .05**			**p < .001**			**p < .001**	
Knowledge Broker 1	10 (40)	11 (44)	4 (16)	3 (25)	1 (8)	8 (67)	1 (9)	3 (27)	7 (64)
Knowledge Broker 2	12 (67)	1 (6)	5 (28)	2 (13)	12 (80)	1 (7)	-	-	-
Knowledge Broker 3	-	-	-	34 (65)	17 (33)	1 (2)	36 (59)	23 (38)	2 (3)
Knowledge Broker 4	-	-	-	2 (20)	8 (80)	0 (0)	9 (100)	0 (0)	0 (0)
Subject-specific KBs*	-	-	-	-	-	-	1 (17)	4 (67)	1 (17)
KB participation intensity in previous year		-			**p < .001**			**p < .001**	
Not involved	-	-	-	15 (68)	7 (32)	0 (0)	29 (72)	10 (25)	1 (3)
Somewhat involved	-	-	-	4 (33)	6 (50)	2 (17)	17 (47)	16 (44)	3 (8)
Involved	-	-	-	2 (22)	1 (11)	6 (67)	0 (0)	4 (40)	6 (60)
KB participation intensity two years ago		-			-			**p < .01**	
Not involved	-	-	-	-	-	-	15 (75)	4 (20)	1 (5)
Somewhat involved	-	-	-	-	-	-	6 (50)	5 (42)	1 (8)
Involved	-	-	-	-	-	-	2 (22)	1 (11)	6 (67)
Change in knowledge broker from previous year		-			**p < .01**			**p < .05**	
No change	-	-	-	4 (33)	2 (17)	6 (50)	38 (61)	19 (31)	5 (8)
Change	-	-	-	17 (55)	12 (39)	2 (6)	8 (33)	11 (46)	5 (21)
Change in school contact from previous year		-			p = .42			p = .46	
No change	-	-	-	14 (44)	12 (38)	6 (19)	35 (57)	20 (33)	6 (10)
Change	-	-	-	7 (64)	2 (18)	2 (18)	11 (44)	10 (40)	4 (16)
Change in school principal from previous year		-			p = .20			p = .52	
No change	-	-	-	17 (49)	13 (37)	5 (14)	39 (56)	24 (34)	7 (10)
Change	-	-	-	4 (50)	1 (12)	3 (38)	7 (44)	6 (38)	3 (19)

p values derived from Fisher's exact tests; bold formatting indicates a significant association.
* Subject-specific KBs represents 2 knowledge brokers that began in year 3 and were assigned to 3 schools each based on their subject expertise.
- Not relevant to the year measured

Schools that were "involved" in knowledge brokering in Y1 were more likely to be "involved" in Y2 and Y3 (Table 3.3). Similarly, schools that were "involved" in knowledge brokering in Y2 were more likely to be "involved" in Y3 (Table 3.3). In general, the majority of schools remained at the same participation level as previous years. Interestingly, in Y2 and Y3, a change in knowledge broker from the previous year had contrasting effects. In Y2, schools that had a change in knowledge broker were less likely to participate, while in Y3, schools with a change in knowledge broker were more likely to participate (Table 3.3). No relationship was found between a change in school contact or school principal and knowledge brokering participation (Table 3.3).

3.3.2 School Outcomes of Knowledge Brokering Participation

Knowledge brokering participation was associated with school-level changes related to healthy eating, physical activity, and tobacco (Table 3.4). Schools that were "involved" in knowledge brokering in Y1 were more likely to make healthy eating policy changes and physical activity practice changes in the following year (Table 3.4). Schools that were "somewhat involved" in knowledge brokering in Y2 were more likely to make healthy eating and tobacco practice changes in Y3 (Table 3.4). These schools were also more likely to make changes in healthy eating and tobacco generally (i.e., any change in policy, practice, environment/equipment, or relationship with public health) in Y3 (Table 3.4).

No relationships were found between knowledge brokering participation and school-level changes related to alcohol and drugs, bullying, or sedentary behaviour (Table 3.4). However, very few schools made policy changes that were not associated with knowledge brokering, irrespective of participation level (i.e., policy changes related to physical activity [Y1 and Y2],

tobacco [Y1], alcohol and drug use [Y1 and Y2], and bullying [Y1]). Schools may not have prioritized these health behaviours or been interested in making changes in these areas.

Table 3.4 School-level Outcomes Related to Level of Knowledge Brokering Participation.

School-level change*	2012-2013 (Y1) KB participation			2013-2014 (Y2) KB participation		
	Not involved (N=22) N (%)	Somewhat Involved (N=12) N (%)	Involved (N=9) N (%)	Not involved (N=40) N (%)	Somewhat Involved (N=36) N (%)	Involved (N=10) N (%)
Healthy Eating						
Policy Changes		**p < .05**			p = .06	
Yes	1 (5)	2 (17)	4 (44)	2 (5)	6 (17)	3 (30)
No	21 (95)	10 (83)	5 (56)	38 (95)	30 (83)	7 (70)
Practice Changes		p = .29			**p < .05**	
Yes	12 (55)	5 (42)	7 (78)	17 (42)	27 (75)	5 (50)
No	10 (45)	7 (58)	2 (22)	23 (58)	9 (25)	5 (50)
Any Change		p = .41			**p < .05**	
Yes	14 (64)	9 (75)	8 (89)	23 (58)	30 (83)	7 (70)
No	8 (36)	3 (25)	1 (11)	17 (42)	6 (17)	3 (30)
Physical Activity						
Policy Changes		p = .40			p = .32	
Yes	4 (18)	1 (8)	3 (33)	1 (2)	3 (8)	1 (10)
No	18 (82)	11 (92)	6 (67)	39 (98)	33 (92)	9 (90)
Practice Changes		**p < .05**			p = .12	
Yes	13 (59)	7 (58)	9 (100)	25 (62)	14 (39)	6 (60)
No	9 (41)	5 (42)	0 (0)	15 (38)	22 (61)	4 (40)
Any Change		p = .10			p = .19	
Yes	14 (64)	8 (67)	9 (100)	21 (52)	26 (72)	7 (70)
No	8 (37)	4 (33)	0 (0)	19 (48)	10 (28)	3 (30)
Tobacco						
Policy Changes		p = .72			p = .14	
Yes	3 (14)	1 (8)	2 (22)	2 (5)	6 (17)	2 (20)
No	19 (86)	11 (92)	7 (78)	38 (95)	30 (83)	8 (80)
Practice Changes		p = .84			**p < .05**	
Yes	7 (32)	4 (33)	4 (44)	7 (18)	16 (44)	1 (10)
No	15 (68)	8 (67)	5 (56)	33 (82)	20 (56)	9 (90)
Any Change		p = 1.00			**p < .05**	
Yes	11 (50)	6 (50)	5 (56)	13 (32)	22 (61)	5 (50)
No	11 (50)	6 (50)	4 (44)	27 (68)	14 (39)	5 (50)
Alcohol & Drug Use						
Policy Changes		p = .11			p = .24	
Yes	3 (14)	0 (0)	3 (33)	1 (2)	4 (11)	0 (0)
No	19 (86)	12 (100)	6 (67)	39 (98)	32 (89)	10 (100)
Practice Changes		p = .60			p = .07	
Yes	7 (32)	4 (33)	1 (11)	6 (15)	13 (36)	1 (10)
No	15 (68)	8 (67)	8 (89)	34 (85)	23 (64)	9 (90)
Any Change		p = 1.00			p = .08	
Yes	10 (46)	5 (42)	4 (44)	10 (25)	17 (47)	2 (20)
No	12 (54)	7 (58)	5 (56)	30 (75)	19 (53)	8 (80)

Bullying						
Policy Changes		p = .31			p = .73	
Yes	3 (14)	1 (8)	3 (33)	5 (12)	4 (11)	2 (20)
No	19 (86)	11 (92)	6 (67)	35 (88)	32 (89)	8 (80)
Practice Changes		p = .16			p = .87	
Yes	6 (27)	7 (58)	5 (56)	18 (45)	15 (42)	5 (50)
No	16 (73)	5 (42)	4 (44)	22 (55)	21 (58)	5 (50)
Any Change		p = .22			p = 1.00	
Yes	7 (32)	7 (58)	5 (56)	22 (55)	19 (53)	5 (50)
No	15 (68)	5 (42)	4 (44)	18 (45)	17 (47)	5 (50)
Sedentary Behaviour[†]						
Any Change		p = .80			p = .79	
Yes	6 (27)	3 (25)	1 (11)	7 (18)	8 (22)	1 (10)
No	16 (73)	9 (75)	8 (89)	33 (82)	28 (78)	9 (90)

p values derived from Fisher's exact tests; bold formatting indicates a significant association.

[*]School-level outcome variables are measured in the subsequent year (e.g., comparing knowledge brokering participation in 2012-2013 to school-level outcomes in 2013-2014).

[†]Few schools made sedentary behaviour policy changes (N=3 schools in 2013-2014; N=1 in 2014-2015) and practice changes (N=4 in 2013-2014; N=7 in 2014-2015). Hence, only the combined (any change) sedentary behaviour variable was included in analyses.

3.3.3 School-aggregated Student Outcomes of Knowledge Brokering Participation

Between Y1 and Y2, across all schools, there was a significant decrease in the mean percentage of students consuming energy drinks on weekdays (t_{42}=5.45, $p < .001$), not using alternative tobacco products (Z=-3.38, $p < .01$) (i.e., higher percentage of students using alternative tobacco), and meeting screen time guidelines (Z=-3.61, $p < .001$). Between Y2 and Y3, there was a significant decrease in the mean percentage of students at a healthy weight (t_{86}=4.37, $p < .001$) and a significant increase in the mean percentage of students meeting screen time guidelines (Z=-6.73, $p < .001$) (Table 3.5). Additionally, the main effect of knowledge brokering participation was significant for fruit and vegetable guidelines and screen time guidelines. In Y3, a higher percentage of students in "involved" schools were achieving fruit and vegetable guidelines compared to schools not involved in knowledge brokering ($p < .05$) and in

Y2, a higher percentage of students in "somewhat involved" schools were meeting the screen time guidelines compared to schools that were not involved ($p < .05$) (Table 3.5).

The only significant interaction between temporal health behaviour outcomes and knowledge brokering participation was for energy drink consumption between Y1 and Y2 (Table 3.5). While the mean percentage of students consuming energy drinks decreased in all knowledge brokering participation groups between Y1 and Y2, the decrease was greater in schools not involved in knowledge brokering compared to schools that participated. Despite the association between knowledge brokering participation and school changes in healthy eating, physical activity, and tobacco, there was no association at the student level.

Table 3.5 School-aggregated Student Outcomes Related to Level of Knowledge Brokering Participation.

School-aggregated student outcome	2012-2013 (Y1) Not involved (N=22) Mean (SD)	Somewhat Involved (N=12) Mean (SD)	Involved (N=9) Mean (SD)	ANOVA (Yr1-2) p	2013-2014 (Y2) Not involved (N=40) Mean (SD)	Somewhat Involved (N=36) Mean (SD)	Involved (N=10) Mean (SD)	ANOVA (Yr2-3) p
% of students in school meeting fruit & vegetable guidelines								
2012-2013	5.13 (1.76)	4.83 (1.36)	4.66 (0.97)	.64				
2013-2014	5.30 (1.50)	5.08 (1.48)	5.50 (1.92)		5.03 (1.30)	5.06 (1.72)	5.77 (1.58)	.39
2014-2015					4.45‡ (1.15)	4.99 (1.73)	5.86‡ (1.16)	
% of students in school meeting Canada's Food Guide recommendations								
2012-2013	1.51 (0.85)	1.69 (0.84)	1.31 (0.39)	.25				
2013-2014	1.47 (0.70)	1.93 (1.09)	1.87 (0.68)		1.50 (0.82)	1.64 (0.86)	1.82 (0.67)	.67
2014-2015					1.54 (0.77)	1.87 (0.93)	1.91 (0.30)	
% of students in school eating lunch at school at least 4 days/week								
2012-2013	62.42 (17.21)	70.64 (11.72)	70.91 (8.05)	.69				
2013-2014	61.85 (16.42)	69.56 (11.84)	71.12 (7.63)		64.35 (11.97)	65.02 (14.02)	74.01 (8.11)	.60
2014-2015					65.32 (10.49)	64.42 (14.75)	73.36 (7.67)	
% of students in school meeting physical activity guidelines								
2012-2013	50.43 (6.16)	44.63 (4.79)	47.65 (3.96)	.19				
2013-2014	48.03	45.11	47.32		49.64	46.76 (5.47)	45.58	.49

	(6.4)	(6.05)	(5.98)		(6.22)		(3.96)	
2014-2015					48.98 (6.50)	47.47 (5.82)	46.10 (4.79)	
% of students in school that participate in non-competitive activities at school								
2012-2013	39.73 (11.64)	38.27 (18.06)	35.46 (5.32)	.92				
2013-2014	39.84 (9.80)	38.37 (18.38)	36.27 (5.82)		37.25 (8.87)	36.40 (9.11)	40.54 (17.57)	.74
2014-2015					37.80 (9.21)	35.98 (8.72)	39.95 (16.45)	
% of students in school meeting screen time guidelines*†								
2012-2013	4.50 (1.76)	4.56 (2.01)	5.20 (1.91)	.39				
2013-2014	3.80 (1.76)	3.38 (1.37)	3.62 (1.28)		3.46‡ (1.55)	4.51‡ (1.51)	3.63 (1.24)	.08
2014-2015					5.12 (1.79)	5.90 (2.41)	6.48 (2.27)	
% of students in school at healthy weight†								
2012-2013	56.43 (5.30)	55.16 (6.55)	56.11 (4.59)	.52				
2013-2014	55.22 (6.13)	55.67 (6.23)	55.25 (4.76)		55.96 (4.06)	54.98 (7.38)	57.70 (5.04)	.80
2014-2015					52.79 (6.38)	52.68 (6.84)	55.17 (4.90)	
% of students in school who are current smokers								
2012-2013	7.58 (4.97)	6.64 (3.90)	5.93 (2.89)	.61				
2013-2014	7.70 (4.56)	7.46 (3.89)	6.05 (2.89)		6.92 (3.53)	8.58 (4.33)	5.16 (1.84)	.60
2014-2015					7.16 (4.02)	8.32 (4.95)	5.47 (3.03)	
% of students in school that have NOT used alternative tobacco in last 30 days*								

	2012-2013	76.32 (4.42)	78.48 (3.59)	77.42 (3.10)	.42			
	2013-2014	74.68 (3.50)	75.19 (5.40)	75.84 (3.64)		74.28 (4.11)	74.23 (4.94)	76.87 (2.58)	.12
	2014-2015					74.65 (4.33)	73.88 (5.28)	74.05 (4.47)	
% of students in school that are current binge drinkers									
	2012-2013	26.20 (7.81)	22.76 (8.04)	25.78 (5.42)	.87				
	2013-2014	25.20 (5.93)	22.69 (3.45)	23.70 (3.88)		24.08 (4.65)	25.14 (5.61)	24.03 (3.14)	.74
	2014-2015					24.58 (0.76)	24.86 (7.94)	22.04 (3.64)	
% of students in school that are current marijuana users									
	2012-2013	18.46 (5.43)	16.76 (6.12)	17.53 (1.86)	.25				
	2013-2014	17.38 (5.52)	17.48 (6.39)	16.67 (2.10)		16.21 (4.19)	16.59 (5.77)	15.71 (2.82)	.81
	2014-2015					16.06 (3.95)	17.00 (4.88)	15.80 (3.50)	
% of students in school that were bullied in last 30 days									
	2012-2013	19.36 (3.82)	16.80 (3.93)	17.85 (4.17)	.96				
	2013-2014	18.49 (5.61)	16.19 (4.16)	16.91 (4.13)		18.34 (5.18)	18.44 (4.33)	15.65 (3.20)	.69
	2014-2015					18.48 (3.94)	17.86 (4.22)	14.88 (4.18)	
% of students in school consuming energy drinks during weekdays*									
	2012-2013	19.13 (6.01)	15.09 (5.08)	14.63 (4.01)	**p < .05**				
	2013-2014	15.96 (5.70)	13.70 (3.20)	13.69 (3.16)		15.63 (4.65)	17.72 (6.71)	12.58 (2.13)	.31

2014-2015	15.57 (4.92)	16.84 (6.31)	12.96 (3.87)

*Denotes that the school-aggregated student outcome was significantly different between 2012-2013 and 2013-2014 (determined by paired t-test or Wilcoxon signed ranks tests) ($p < .05$)
†Denotes that the school-aggregated student outcome was significantly different between 2013-2014 and 2014-2015 (determined by paired t-test or Wilcoxon signed ranks tests) ($p < .05$)
‡Denotes a significant difference in the percentage of students achieving the respective guidelines between the indicated knowledge brokering participation levels (determined by Tukey's HSD post hoc test) ($p < .05$)

3.4 Discussion

This research provides insight into factors that influence whether schools access researcher support and the associated outcomes. Several factors appeared to influence schools' participation in COMPASS knowledge brokering. Schools with large student enrolment were more likely to be "involved" in knowledge brokering, consistent with findings that large schools are more committed to improving student health (Moore et al., 2016). Larger schools may have more staff and resources to allocate towards student health compared to smaller schools. However, small enrolment schools were more likely to participate than medium enrolment schools; smaller schools may have accessed knowledge broker support because they had fewer internal resources. In Y1, schools actively involved with local public health agencies prior to study participation were more likely to be "involved" in knowledge brokering; however, the majority of schools who had no contact with public health in the past year also participated. Schools may have perceived knowledge brokering as different from support provided by public health agencies. Lastly, schools with fewer health programs, policies, partnerships, and professional development at baseline were more likely to participate. The tailored summary may have provided new information that motivated these schools to access support to improve their students' health (Riley et al., 2014).

Across all years, the knowledge broker assigned to a school influenced its participation level; generally, those assigned to the knowledge broker with the majority of schools were less likely to participate in knowledge brokering. This aligns with extant literature indicating individual knowledge broker attributes influence their practice (Bornbaum et al., 2015; Ziam, Landry, & Amara, 2013), and could imply that knowledge brokers are more effective when assigned to fewer schools, given the importance of developing rapport with knowledge users

(Dagenais et al., 2015; Oliver, Innvar, Lorenc, Woodman, & Thomas, 2014; Traynor et al., 2014). However, the opposite effects of a change in knowledge broker on schools' participation levels between Y1-Y2 and Y2-Y3 require further investigation.

In Y2, schools with principals or vice-principals as the main contact for the COMPASS study were less likely to participate in knowledge brokering. This is particularly interesting given the critical role of administrators in the implementation of school health initiatives (Deschesnes, Drouin, Tessier, & Couturier, 2014; Hunt, Barrios, Telljohann, & Mazyck, 2015; Roberts et al., 2016; Storey, Spitters, Cunningham, Schwartz, & Veugelers, 2011). Hence, it emphasizes the importance of developing strategies to engage administrators in knowledge brokering to enhance school outcomes. However, there was no relationship between a change in school contact or school principal and knowledge brokering participation. This contradicts findings from research in Alberta, which identified staff turnover as a key challenge in implementing school health interventions (Storey, Cunningham, Spitters, Schwartz, & Veugelers, 2012).

Overall, schools remained at the same knowledge brokering participation level throughout the study, indicating the importance of reaching out to schools in the first year. Further, in Y2, schools in their first year were more likely to be "somewhat involved" in knowledge brokering, while those in their second year were more likely to be "involved". Schools' readiness for implementing school health initiatives (Roberts et al., 2016; Samdal & Rowling, 2011) may affect knowledge brokering participation, highlighting the role of organizational context (Bornbaum et al., 2015).

Schools that participated in knowledge brokering were more likely to make school-level changes in healthy eating, physical activity, and tobacco the following year. Interestingly, school-level outcomes appeared for both "involved" and "somewhat involved" schools; hence,

further research should investigate the amount of interaction required to create change. While no association was found for alcohol and drug use, sedentary behaviour, or bullying, few schools made policy changes related to these behaviours (or any change in sedentary behaviour), irrespective of knowledge brokering participation level. As Table 3.5 indicates, very few students were meeting the Canada's Food Guide recommendations and only half were meeting the physical activity guidelines, so schools likely prioritized changes in these areas. Additionally, alcohol and drug use frequently occur outside of school hours (so schools may not have prioritized these behaviours), and schools may have targeted sedentary behaviour through physical activity initiatives. Despite the association between knowledge brokering participation and school changes in healthy eating, physical activity, and tobacco, there was no association at the student level. However, student outcomes were not expected given that knowledge brokering focused on school-level changes, and school-aggregated student outcomes would likely require more than one year to emerge.

The association between knowledge brokering and school-level outcomes in the current study parallels a knowledge brokering initiative that resulted in participating teachers implementing evidence-based teaching approaches (Sheard & Sharples, 2016). As well, our findings align with a more resource-intensive intervention that placed full-time staff in schools to support healthy eating and active living promotion, which led to curriculum integration, and increased knowledge and awareness among staff and students (Storey et al., 2011). Overall, our research provides evidence for the impacts of knowledge brokering, supplementing inconclusive findings in a recent review of knowledge brokering outcomes in health-related settings (Bornbaum et al., 2015).

3.5 Limitations

COMPASS uses a convenience sample of Ontario and Alberta schools; therefore, the results may not be generalizable across all schools. The knowledge brokering records were not designed for research analyses; however, the first author consulted with individual knowledge brokers to ensure records were complete for the purpose of this analysis. The student- and school-level questionnaires rely on self-report data; however, student measures have been validated (Elton-Marshall et al., 2011; Leatherdale et al., 2014; Leatherdale & Laxer, 2013) and the SPP was based on a previously validated tool (www.hsp.uwaterloo.ca). Additionally, given the longitudinal nature of the study, the potential bias is partially mitigated in that over- and under-reporting should be consistent over time (Diggle, Liang, & Zeger, 2002). The school outcome variables did not indicate whether these changes were health promoting (e.g., adding an intramural sport) or suppressing (e.g., removing a breakfast program). While this analysis included school-aggregated changes in student behaviour, future research could analyze changes in individual student behaviour longitudinally. Lastly, one year may not have been enough time for change to occur. Despite these limitations, this research provides an evaluation of a knowledge brokering initiative in schools, filling a gap identified in the literature (Bornbaum et al., 2015; Dagenais et al., 2015; Lemire, Souffez, & Laurendeau, 2013; Riley et al., 2014; Van Eerd et al., 2011).

3.6 Conclusions

Knowledge exchange provides a platform for collaboration between researchers and school practitioners, leading to school-level changes. We found that schools' participation in knowledge brokering was associated with changes to healthy eating, physical activity, and tobacco initiatives. Additionally, we identified factors that influenced schools' participation in

knowledge brokering, with student enrolment and the knowledge broker assigned being significant in all years examined. However, given the individualized nature of researcher-knowledge user interactions and that schools are complex social systems (Keshavarz, Nutbeam, et al., 2010; Van Eerd et al., 2011), qualitative research is necessary to unpack these findings and explore how and why these factors and outcomes emerged (Bornbaum et al., 2015). Future research is needed to assess whether or not these changes were sustainable.

3.7 Implications for School Health

This research provides evidence for the value of schools participating in research-practice partnerships and collaborative research projects, such as the COMPASS study (Leatherdale, Stefanczyk, & Kirkpatrick, 2016). Considering the demands school practitioners face in their roles, accessing support from school health researchers provides both an opportunity and rationale for implementing evidence-based interventions to improve student health. We encourage school health researchers to provide tailored data summaries of survey results to participating schools and welcome requests for support from school practitioners. Additionally, we encourage school practitioners to ask researchers for school-specific results from studies they participate in, to allow for the identification of school-specific health needs and priorities. Ultimately, these actions will enhance our ability to reach our shared goals of improving student health.

Human Subjects Approval Statement

This research was reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee and approved by the participating school districts. Informed consent was obtained from all participants.

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Chapter 4

"Now what?" Perceived factors influencing knowledge exchange in school health research

Status: Accepted to *Health Promotion Practice*.

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Overview

Increasing the uptake of school health research into practice is pivotal for improving adolescent health. COMPASS, a longitudinal study of Ontario and Alberta secondary students and schools (2012-2021), used a knowledge exchange process to enhance schools' use of research findings. Schools received annual summaries of their students' health behaviours and suggestions for action, and were linked with a knowledge broker to support them in making changes to improve student health. The current research explored factors that influenced COMPASS knowledge exchange activities. Semi-structured interviews were conducted with researchers (n=13), school staff (n=13), and public health stakeholders (n=4). Interestingly, knowledge users focused more on factors that influenced their use of COMPASS findings than factors that influenced knowledge brokering. The factors identified by participants are similar to those that influence implementation of school health interventions (e.g., importance of school champions, competing priorities, inadequate resources). While knowledge exchange offers a way to reduce the gap between research and practice, schools that need the most support may not engage in knowledge exchange; hence, we must consider how to increase engagement of these schools to ultimately improve student health.

Key words: school health; knowledge translation; knowledge brokering; qualitative research

4.1 Introduction

The World Health Organization (2014) recognizes adolescent health as a key priority; many health behaviours related to chronic disease risk (e.g., physical activity, nutrition, and substance use) are established during adolescence and carried into adult life. Schools have been described as key settings for adolescent health interventions (Veugelers & Schwartz, 2010). However, school health interventions developed without consideration for the realities of the school environment are often implemented with limited fidelity (Keshavarz Mohammadi, Rowling, & Nutbeam, 2010; McCuaig & Hay, 2014). The gap between school health research and practice aligns with the notion that public health evidence is not integrated into practice (Ammerman, Smith, & Calancie, 2014; Van Den Driessen Mareeuw, Vaandrager, Klerkx, Naaldenberg, & Koelen, 2015). Knowledge exchange, in which researchers and knowledge users collaboratively disseminate and apply research findings (Canadian Foundation for Healthcare Improvement, 2017), represents one way to fill this gap. However, evaluation of these initiatives remains limited, despite an identified need (Murnaghan et al., 2013; Riley, Wong, & Manske, 2014).

Developing and evaluating knowledge exchange strategies in school health research is a priority (Moore, Littlecott, Fletcher, Hewitt, & Murphy, 2016). Recommended strategies include using research summaries (e.g., reports, websites, newsletters) to engage knowledge users, building research-practice-policy partnerships, and adapting initiatives to meet specific stakeholder needs (Murnaghan et al., 2013; Riley et al., 2014). Knowledge brokering, a relational approach that involves individuals or organizations providing a link between researchers and knowledge users to translate research findings (Canadian Foundation for Healthcare Improvement, 2015; Meyer, 2010), is proposed as a useful strategy (Riley et al., 2014). While

knowledge brokering strategies may seem similar to those used in technical assistance (McVay et al., 2016), the intent of the former is for both researchers and practitioners to influence each other's work through relationship (Canadian Foundation for Healthcare Improvement, 2015). Researchers in higher education have been identified as appropriate knowledge brokers for school settings (Sharples & Sheard, 2015).

The COMPASS Study (COMPASS) is an ongoing longitudinal study (2012-2021) of student health behaviours and secondary school environments in Ontario and Alberta, Canada (Leatherdale et al., 2014). Aside from traditional knowledge transfer mechanisms (e.g., publications, presentations, websites), COMPASS also uses customized feedback reports and knowledge brokers to enhance prevention action to promote youth health. As described elsewhere (Leatherdale et al., 2014), each school receives an annual customized School Health Profile that provides a risk behaviour profile of their student population and evidence-based suggestions to address each outcome of interest. Each school is assigned a knowledge broker who provides ongoing support as needed (e.g., clarifying school-specific findings; identifying health priorities within the school, appropriate action strategies, and potential community partners). Further information regarding COMPASS knowledge brokering procedures can be found online (Thompson-Haile, Laxer, Ledgley, & Leatherdale, 2015).

Considering the limited evaluation of knowledge exchange in school health research and the important role that context plays in influencing the effectiveness of knowledge exchange (LaRocca, Yost, Dobbins, Ciliska, & Butt, 2012), the current research sought to understand factors influencing COMPASS knowledge exchange activities. This research was informed by social constructionism and social ecological theory. Social constructionism posits that understanding a program or intervention requires understanding all stakeholders' perspectives

and how individuals' experiences and perceptions are shaped by their relationships (Patton, 2015). Nutley, Walter, and Davies (2003) explain that because "research evidence cannot be separated from its social context, what we need to understand is the social construction of knowledge" (p. 133). The interview guide and analysis were informed by social constructionism in order to examine the extent to which interpersonal relationships and previous experience influenced knowledge users' and knowledge brokers' experiences with COMPASS knowledge exchange activities.

Social ecological theory asserts that changes to the environment lead to changes in individual behaviour (McLeroy, Bibeau, Steckler, & Glanz, 1988). Individuals' behaviours are influenced by multiple environmental levels, from interactions between individuals (microsystem) to cultural beliefs and values within a population (macrosystem) (Bronfenbrenner, 1977). Additionally, individuals influence their environments (Green, Richard, & Potvin, 1996); to implement changes, individuals within that population must be supportive (McLeroy et al., 1988; Richard, Gauvin, & Raine, 2011). Social ecological theory constructs were integrated into the interview guide and analysis to capture environmental factors that influenced school and public health stakeholders' knowledge use and knowledge brokering participation.

This research is part of a larger convergent parallel mixed-methods study exploring the implementation and outcomes of the COMPASS knowledge exchange strategies (see Brown, Elliott, & Leatherdale, under review for quantitative findings). This paper focuses on the qualitative component, and explores factors that influenced COMPASS knowledge exchange activities, from the perspective of researchers and knowledge users (i.e., school and public health stakeholders).

4.2 Method

Qualitative semi-structured interviews were conducted with researchers (n=13), school staff (n=13), and public health stakeholders (n=4) between January and October 2016. Data collection tools were similar, while allowing for role differences to be captured. For example, all participants were asked about factors influencing knowledge brokering, while only knowledge users were asked about factors influencing their use of COMPASS findings (interview guides available upon request). Interviews with researchers were conducted in person (n=8) or by phone (n=5) and interviews with public health and school stakeholders were conducted by phone. After receiving ethical approval from [institutional research ethics board], the COMPASS Principal Investigator notified researchers the first author would invite them to participate in an interview. All members of the core COMPASS team (knowledge brokers, Principal Investigator, and Project Manager) and all Co-Investigators were invited to participate.

The COMPASS Study sample consisted of 90 schools from 33 Ontario and Alberta school boards. Purposeful sampling was used to include schools engaged in knowledge brokering to varying degrees. Four Ontario school boards were identified that had at least one "involved" school (more than one phone call annually) and a mix of "somewhat involved" (one phone call annually) and "not involved" schools. Each of these boards had 4-6 schools participating in COMPASS. After receiving approval from respective school boards, staff from 19 schools participating in COMPASS were invited for an interview. Each school was provided with a $30 honorarium per participant. Staff from three public health units involved in COMPASS knowledge brokering were also invited to participate.

The researcher sample consisted of eight members of the core COMPASS team and five Co-Investigators; in total, there were eight females and five males representing three Canadian

universities. The school sample consisted of six teachers, five principals, and two vice-principals from nine schools in four Ontario school boards (8 male, 5 female). Six schools were involved in knowledge brokering, two schools were somewhat involved, and one school was not involved (Table 4.1). Eight of thirteen school participants had participated in knowledge brokering. Lastly, two public health nurses working directly in schools and two coordinators overseeing school initiatives within public health units were interviewed; three had participated in knowledge brokering. One of the public health units worked with two schools represented in the sample.

Table 4.1 Characteristics of schools participating in interviews.

School	School Knowledge Brokering Engagement Level	Number of Interview Participants (n=13)	Number of Participants Involved in Knowledge Brokering
1	Involved	1	1
2	Somewhat Involved	3	1
3	Not Involved	1	0
4	Involved	2	2
5	Involved	1	1
6	Involved	2	1
7	Involved	1	1
8	Somewhat involved	1	1
9	Involved	1	0

Interviews were audio-recorded with permission and transcribed verbatim for subsequent thematic analysis using computer assisted qualitative data analysis software, NVivo for Mac 11 (QSR International). A template organizing style was used to code the data (Crabtree & Miller, 1999); for each participant group, the first author read all of the transcripts to determine thematic codes (arising deductively and inductively) to compose a coding manual. Examples of deductive codes included themes that aligned with the interview questions, theories (e.g., relationship between researcher and knowledge user), and previous literature (e.g., challenges relating to time and limited resources). Once the coding manual for each participant group was composed, inter-rater reliability (Miles & Huberman, 1994) and peer examination (Baxter & Eyles, 1999) were

employed to enhance qualitative rigour of the findings. For each participant group, two transcripts were coded by the first author and an additional researcher. Coding agreement for each participant group was calculated as greater than 70% (Miles & Huberman, 1994). Coding differences were discussed and the revised coding manuals for each participant group were used to code the respective transcripts and identify relevant data. The constant comparative method (Corbin & Strauss, 2008; Glaser & Strauss, 1967) was used to determine similarities and differences within the data and ensure proper categorization of themes.

4.3 Results

Findings are organized into factors that influenced: a) knowledge users' use of COMPASS findings, b) knowledge users' participation in knowledge brokering, and c) effective knowledge brokering practice.

4.3.1 Factors Influencing Knowledge Users' Use of Study Findings

Public health and school participants discussed factors influencing their use of the School Health Profile, reporting far fewer facilitators (factors that made it easier to use findings) than challenges (factors that made it difficult to use findings) (Table 4.2). Facilitators included the principal assigning value to student health and a strong relationship between the school and public health personnel:

> *"I feel that because I involve myself so much… and the staff see that this is valuable to me… the time that [teachers are] going to give [their] classes and allow [their] classes to do [the survey], that there is value to it. And that the results will be used in some way, it's just not another task."* (Principal, School 1 [S1])

> *"I don't know if all schools that are involved with COMPASS connect with public health… Or if there's as close a relationship between public health nurses and administrators at schools as we have in [community name]."* (Public Health Nurse)

Table 4.2 Perceived factors influencing knowledge users' use of COMPASS findings.

Theme	Number of Participants		
	School (n=13)	Public Health (n=4)	Total (n=17)
Facilitators			
• Principal sees value in student health	2	1	3
• Importance of strong relationship between public health unit and school	1	1	2
Challenges			
• Perceived limitations of findings	9	1	10
○ Student-level findings not changing over time	5	1	6
○ Discrepancy between findings and what's being seen in school	4	-	4
• School-related factors	5	4	9
○ Competing demands in school	3	2	5
○ Change in school administrators over course of study	2	2	4
○ Limited time and resources	3	-	3
• Barriers to understanding findings	4	1	5
○ Schools not sure where to start, how to prioritize health behaviours once they receive data	3	1	4
• Influence of home environment on student health behaviours	5	-	5
• Schools not using public health unit support as much as they could	-	2	2

Challenges included perceived differences between findings and the school environment, school-related factors, difficulty understanding the findings, and the influence of the home environment. School and public health participants discussed their frustration that despite making changes in their schools, changes in student health behaviours were not evident in subsequent School Health Profiles:

> *"I guess at this point, personally, I'm kind of at a loss for what other things we could do to help educate our students or the families. So we're recognizing ourselves, that with this report, what the students are saying are issues, and we've tried a variety of interventions over the year with little success. My kind of thought is just, 'now what?' "* (Teacher, S2)

Additionally, some school participants discussed discrepancies between the findings and what they were seeing "on the ground" in their schools:

> *"In 2012, 4% were smokers and in 2014, 4% were smokers and it shows no change. But if you ask anybody in my school, they'd say they hardly see kids out in the smoking pit anymore whereas they used to see a lot."* (Vice principal [VP], S3)

School-related factors included competing demands in schools, change in school administrators during the study, as well as limited time and resources:

> *"The unfortunate part was that when we were first enrolled in this, we were on our first principal, and in the course of the four years, I think we're on our fourth principal, so it lost a lot of potential speed having to bring each new principal up to speed on what we were doing."* (Teacher, S4)

Knowledge users also mentioned schools were not sure how to prioritize health behaviours after receiving the findings, and public health participants felt schools did not use available public health unit support to capacity:

> *"[Schools] see their results but that's a lot, what are they going to do with it? Well give it over to me, I can look at that, and then I can, you know, talk to staff about the results, I can talk to parents about the results, I can talk to you about it, and we can say 'OK what is our goal going to be?"* (Public Health Nurse)

Lastly, school participants discussed how the home environment also played a role in students' health behaviours, particularly related to substance use:

> *"We have an issue with parents who seem to, you know, what you permit you promote, and they don't seem to understand that by allowing kids to drink freely in the home, that kind of transcends into their school life."* (Principal, S2)

4.3.2 Factors Influencing Knowledge Users' Participation in Knowledge Brokering

When discussing facilitators to knowledge brokering participation, knowledge users and researchers focused on different aspects (Table 4.3). Knowledge users described characteristics of knowledge brokers (i.e., approachability, availability, and expertise):

> *"She was very approachable in the sense that I could feel like I could ask her anything, I was comfortable when speaking with her, and she offered a lot of other ideas as well, like*

when she would get in touch with me or vice versa, she was always able to offer suggestions." (Teacher, S5)

Table 4.3 Perceived factors influencing knowledge users' participation in knowledge brokering.

Theme	Number of participants				
	School (n=13)	Public Health (n=4)	COMPASS Team (n=8)	Co-Investigators (n=5)	Total (n=30)
Facilitators					
• School staff value student health, want to make change	-	-	8	2	10
○ Administrator values student health	-	-	6	-	6
○ COMPASS contact in school has role related to school health (e.g., school health/wellness coordinator)	-	-	2	-	2
• Characteristics of Knowledge Brokers	5	1	-	1	7
○ Approachability	3	1	-	-	4
○ Availability, Persistence	4	1	-	-	4
○ Expertise in school health research	2	-	-	-	2
• Positive relationships	-	-	4	2	6
○ Between knowledge broker and school contact	-	-	1	2	3
○ Past (positive) experience with COMPASS knowledge brokering	-	-	2	-	2
• Consistency in knowledge broker assigned to school, face-to-face meetings	1	1	1	-	3
Challenges					
• School factors					
○ Limited time	4	-	6	-	10
○ Limited resources within the school (e.g., limited funds to put ideas into action)	1	-	6	-	7
○ Low priority assigned to COMPASS, school health	-	-	6	-	6
• COMPASS study factors		-		-	
○ Time of (school) year that knowledge broker reaches out to school	1	-	3	-	4
○ Change in school administrator between study years	-	-	4	-	4
○ Change in school contact between study years	-	-	4	-	4
○ Change in knowledge broker between study years	-	-	1	1	2
• None	3	-	-	-	3

In contrast, researchers focused on characteristics of school staff and relationships between the school and their knowledge broker. Researchers highlighted the importance of school staff, especially the school administrator, valuing student health: *"I think where KB does really work, in a situation where there are really committed people on the school end, that really do want to make some sort of positive change within the school"* (Knowledge Broker [KB]1). *"And almost always, it had to be an administrator. Because at times we'd get a phys. ed. teacher that was really excited, but it didn't go anywhere because their administrator was kind of the gatekeeper to change"* (KB2). Both groups mentioned consistency in knowledge broker assignments to schools and face-to-face meetings as facilitators.

Knowledge users mentioned fewer challenges to knowledge brokering participation than researchers. Both researchers and knowledge users discussed limited time and resources: *"We don't have any spare minutes, so you have to book this stuff into your calendar and commit to it or it might not happen"* (VP, S6). In particular, they described limited funds for implementing ideas generated from knowledge brokering:

> *"I remember one really good meeting we had with the public health officials, we brainstormed lots of things… but there are no funds to support any of these ideas that we generated. So they didn't go anywhere."* (VP, S6)

Additionally, researchers discussed how schools that assigned low priority to COMPASS and school health were less likely to participate in knowledge brokering:

> *"I think some schools are excited to be part of the study and the School Health Profile that they get out of it, but don't necessarily want too much more; whether it means they're too busy, they have more things on their plate, it's getting close to the end of the year." (KB3)*

> *"Where it becomes a challenge is if, you have a principal who doesn't necessarily see the value of advancing a health agenda, and if there's no stakeholder, that's kind of worse case scenario."* (PI)

Changes in school administrators, school contacts, or knowledge brokers, and the time of year schools received their results also presented challenges: *"The principal kept changing, and even now, I have a new contact that's the fourth contact"* (KB4).

4.3.3 Factors Influencing Effective Knowledge Brokering Practice

Members of the research team also described factors that enhanced or diminished knowledge brokering practice (Table 4.4). Facilitators focused on internal components of the study such as communicating with other knowledge brokers: *"The knowledge brokers each have their schools that they are responsible for, but they also work as a team. So they do bounce ideas off each other as well – that, I think, is helpful"* (Project Manager). Being involved with other study aspects was also a facilitator: *"I've gone to some data collections of schools that I knowledge broker for, so I couldn't really do a KB meeting on the spot because we didn't have the data, but I got to know my contact there"* (KB5). Lastly, they described the value of previous experience working in schools and/or school health research, and that many schools were open to receiving support:

> *"I think part of what has made this a useful endeavour is the appetite that schools seem to have, mostly, for this type of support. I think a lot of the schools really love having a knowledge broker to help them sort through stuff, or to meet with public health, or to help them with grant applications, things like that. So I think that has helped the process along."* (Project Manager)

The most frequently-mentioned challenge associated with knowledge brokering was record keeping. Initially, researchers did not realize the value of information generated from knowledge brokering, and hence did not implement systematic record keeping procedures:

> *"We were coming up with this more or less as we went along. And it becomes an afterthought sometimes, to say, 'we've got all these notes but how are we storing them, how are we presenting them to people, how are we making them user friendly?' And the answer was we weren't doing a very good job of that."* (Project Manager)

Hence, knowledge brokers explained they were unsure about the quality of their records and whether they were recording them in a similar way to others: *"I think we could probably be charting our calls a little better…. I think my notes are pretty good, but that's just how I've been doing it"*(KB1). Researchers found it difficult when schools were unresponsive to their requests or were not interested in participating: *"If [schools] don't want our help, then we obviously have a challenge in communicating with them, keeping the dialogue going"* (KB5). Limited funding to support intervention implementation was also a barrier:

> *"I think one of the biggest challenges I hear from them is they don't have the resources to really do what they want. It'd be phenomenal if they had pots of money where when schools that really want to do something… but there's no resources to actually implement it."* (PI)

Lastly, researchers discussed the challenge of defining tasks and expectations for the knowledge broker role:

> *"There's also a limit to what I can do as well, with my own studies and own limitations of schools being far away, so how much time can I realistically put into driving there and helping to coordinate things when I'm one person too?.... And how far it should extend?"* (KB6)

Table 4.4 Researchers' perspectives regarding factors that influence effective knowledge brokering practice.

Theme	COMPASS Team (n=8)
Facilitators	
• Communicating with other COMPASS team members	6
• Being involved with other aspects of the study (i.e., data collection, recruitment)	4
• Previous experience in schools or school health research	4
• Supporting resources (e.g., knowledge brokering literature, other knowledge brokers' notes)	4
• Schools seem to want support	3
• Characteristics of COMPASS study (i.e., longitudinal research design, School Health Profile is effective knowledge translation tool)	2
Challenges	
• Record Keeping	8
○ Quality of notes is not consistent	3
○ Knowledge brokers unsure as to whether they are recording notes the same way as others	3
• School responses to knowledge brokering	7
○ Schools slow to respond to knowledge broker contact	5
○ Schools not wanting support	4
• Limited resources to help schools	5
○ Limited funding to help schools implement interventions	5
○ Limited evidence-based health interventions for secondary schools	2
• Knowledge brokers balancing knowledge brokering duties with other roles (e.g., graduate students)	4
• Unsure of specific tasks and expectations within knowledge broker role	3
• Priorities of other stakeholder groups (i.e., school boards, Ministry of Education, public health units)	3
• Geographic distance between knowledge broker and school	3

4.4 Discussion

This study extends a quantitative analysis of factors influencing COMPASS knowledge brokering participation (Brown et al., under review) in three ways. First, while the quantitative analysis focused on answering *"what factors influenced knowledge exchange?",* the qualitative analysis allowed for understanding *"how"* and *"why"* these factors were influential. Second, the results highlight additional factors that influenced knowledge brokering (e.g., limited funding, record keeping, communicating with other knowledge brokers), incorporating perspectives from both researchers and knowledge users. Third, the qualitative results include factors that influenced school and public health staff's use of COMPASS findings (whereas the quantitative analysis focused on knowledge brokering participation). Interestingly, knowledge users discussed factors that influenced their use of COMPASS findings more than factors that influenced knowledge brokering. This research identifies factors that researchers should consider when designing knowledge exchange activities for schools.

In the context of social ecological theory, factors within the microsystem (e.g., interactions within the research team and schools), mesosystem (e.g., interactions between researchers and schools), exosystem (e.g., resources from public health units and school boards), and the macrosystem (e.g., limited funding from government ministries) influenced knowledge users' use of COMPASS findings and knowledge brokering participation. Findings suggest that even when schools understood and used COMPASS findings to set priorities, structural factors prevented translation into action. Hence, in addition to focusing at the school level, macro-level changes (i.e., increased government funding for school-based health interventions) are required to increase school action on research findings (Deschesnes, Drouin, Tessier, & Couturier, 2014; Hung, Chiang, Dawson, & Lee, 2014; McIsaac, Hernandez, Kirk, & Curran, 2016). For

knowledge exchange to be effective, structural supports (e.g., funding within the education and research sectors) need to be in place to translate knowledge into action; these issues will be explored in further research.

The key role of relationships in knowledge exchange and school participants' interpretations of findings align with constructs from social constructionism. Specifically, strong relationships between schools, public health practitioners, and researchers were seen as facilitators. The importance of strong relationships between researchers and knowledge users has been described in the context of knowledge translation (Dobbins, Robeson, et al., 2009; Oliver, Innvar, Lorenc, Woodman, & Thomas, 2014) and educators' research use (Dagenais et al., 2016). The positive relationships observed between public health practitioners and schools are consistent with our quantitative findings (Brown et al., under review). Further, relationships within schools and with external partners have been identified as strengthening implementation of school health initiatives (Hung et al., 2014). However, the misalignment between COMPASS findings and school staff's perceptions of student behaviours at school was a barrier to knowledge exchange. This finding supports research indicating teachers have difficulty accepting evidence that is inconsistent with their experiences (Sheard & Sharples, 2016). Taken together, this highlights the value in discussing the findings with a knowledge broker to increase understanding.

The importance of school staff valuing student health fits with both the knowledge translation and school health literature. Organizational context (e.g., readiness for change, research culture) influences evidence use (Bornbaum, Kornas, Peirson, & Rosella, 2015; Dobbins, Hanna et al., 2009; Traynor, DeCorby, & Dobbins, 2014), and school culture influences educators' research use and implementation of health interventions (Dagenais et al.,

2016; Hung et al., 2014; Sheard & Sharples, 2016). Emphasis on the principal valuing student health provides further evidence of the principal's key role in implementing school health initiatives (Deschesnes et al., 2014; Hung et al., 2014; Storey, Spitters, Cunningham, Schwartz, & Veugelers, 2011). However, it contradicts quantitative findings that schools with administrators as the COMPASS contact were less likely to participate in knowledge brokering (Brown et al., under review); this discrepancy could be explained if those administrators assigned a lower priority to school health compared to schools that had teachers as their COMPASS contacts. While changes in school administrators and staff were identified as challenges, no relationship was found in the quantitative results (Brown et al., under review). Nonetheless, changes in school staff have been identified as a challenge to sustaining school health interventions (Storey et al., 2011).

The characteristics of knowledge brokers (i.e., approachability, availability, and expertise) and the value of face-to-face meetings are consistent with previous research (Dagenais et al., 2015; Dobbins, Robeson, et al., 2009; Traynor et al., 2014) and quantitative findings that the knowledge broker assigned to a school was associated with its knowledge brokering participation (Brown et al., under review). Additionally, the utility of communicating with other knowledge brokers aligns with findings from a similar initiative in Alberta (Storey et al., 2015). Lastly, the challenge of record keeping emphasizes the importance of effective information management for knowledge brokering practice (Dobbins, Robeson, et al., 2009).

A limitation of this research is that only 9 of the 90 schools participating in COMPASS (2012-2016) were represented in the sample. However, perspectives of schools that participated in knowledge brokering to varying degrees were represented. Secondly, we only invited public health stakeholders who had communicated with COMPASS researchers to participate; hence,

we potentially missed perspectives of public health personnel who received the School Health Profile but did not communicate with COMPASS researchers. Nonetheless, the purpose of this study was to gain an in-depth understanding of individual experiences to expand on the breadth of the quantitative findings (Brown et al., under review).

Interestingly, factors that influenced schools' use of COMPASS findings and knowledge brokering participation (e.g., importance of school champions, competing priorities, inadequate resources) align with factors that influence implementation of school health interventions (Deschesnes et al., 2014; Hung et al., 2014; McCuaig & Hay, 2014; Storey et al., 2011). While the intent of knowledge exchange is to help schools implement evidence-based practices, if similar factors influence schools' knowledge exchange participation and intervention implementation, this goal may not be reached. Hence, in order to truly move evidence to action, researchers must consider how to address larger structural issues (e.g., form partnerships with government organizations to increase funding for school interventions).

Additionally, some of the challenges of using results (i.e., perceived limitations of findings, difficulty prioritizing health behaviours) indicate the value in a knowledge broker helping schools to articulate – and potentially operationalize – their findings. But schools must access this support. While knowledge brokering is associated with school-level changes (Brown, et al., under review), schools that need the most support may not be engaging with knowledge brokers. Hence, we need to consider how knowledge brokering recruitment can be modified to increase engagement of schools that are less likely to participate. This is especially important considering that knowledge brokering benefits organizations with less capacity to use evidence (Dagenais, Laurendeau, & Briand-Lamarche, 2015; Dobbins, Hanna, et al., 2009).

Considering COMPASS was designed to be a learning system, these findings are already

being used to shift the approach to COMPASS knowledge brokering (e.g., testing new strategies to foster action in schools with low levels of engagement, strengthening links to external stakeholders for schools that are already highly engaged, and enhancing record keeping). Findings identify considerations for researchers interested in engaging schools in knowledge exchange. First, researchers must be prepared to adapt to the changing nature of the school environment and form new partnerships as staffing changes occur. Second, researchers should communicate to school staff that behaviour change takes time, in order to motivate them to continue to make change in their schools. Given the limited number of published evaluations of knowledge exchange initiatives, these findings can inform similar activities in school health and public health research.

Chapter 5

Can knowledge exchange support the implementation of a health-promoting schools approach? Perceived outcomes of knowledge exchange in the COMPASS Study

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Overview

Background: Despite the potential population-level impact of a health-promoting schools approach, schools face challenges in implementation, indicating a gap between school health research and practice. Knowledge exchange provides an opportunity to reduce this gap; however, there has been limited evaluation of these initiatives. This research explored researchers' and knowledge users' perceptions of outcomes associated with a knowledge exchange initiative within COMPASS, a longitudinal study of Canadian secondary students and schools. Schools received annual tailored summaries of their students' health behaviours and suggestions for action, and were linked with knowledge brokers to support them in taking action to improve student health.

Methods: Qualitative semi-structured interviews were conducted with COMPASS researchers (n=13), school staff (n=13), and public health stakeholders (n=4) to explore their experiences with COMPASS knowledge exchange. Key issues included how knowledge users used school-specific findings, perceived outcomes of knowledge exchange, and suggestions for change.

Results: Outcomes for both knowledge users and researchers were identified. School and public health participants indicated school-specific findings informed their programming and planning. Importantly, knowledge exchange provided a platform for partnerships between researchers, schools, and public health units. Knowledge brokering allowed researchers to gain feedback from knowledge users to enhance the study and a better understanding of the school environment. Interestingly, COMPASS knowledge exchange activities led to achievement in each of Samdal and Rowling's eight theory-driven implementation components for health-promoting schools. Hence, knowledge exchange may provide a mechanism to help schools implement a health-promoting schools approach.

Conclusions: This research contributes to the limited literature regarding outcomes of knowledge brokering in public health and knowledge exchange in school health research. However, since not all schools engaged in knowledge brokering, and not all schools that engaged experienced these outcomes, we need to examine the process of COMPASS knowledge brokering to consider how to increase school engagement.

Keywords: school health; knowledge translation; knowledge exchange; knowledge brokering; qualitative research

5.1 Background

The World Health Organization defines a health-promoting school as "a school constantly strengthening its capacity as a healthy setting for living, learning and working" (World Health Organization, 1998, p. 2). A health-promoting schools approach, also referred to as Comprehensive School Health (Canada) and Coordinated School Health (United States) (Veugelers & Schwartz, 2010), is a whole-school approach that promotes health in school environments, through policy and community partnerships (Deschesnes, Martin, & Hill, 2003). Despite the potential population-level impact of a health-promoting schools approach (Langford et al., 2015), schools face challenges regarding implementation (Keshavarz, Nutbeam, Rowling, & Khavarpour, 2010; Sulz, Gibbons, Naylor, & Wharf Higgins, 2016).

A key implementation challenge is that while the health-promoting schools approach prioritizes health, schools prioritize education (Keshavarz Mohammadi, Rowling, & Nutbeam, 2010; McCuaig & Hay, 2014; Valois, Slade, & Ashford, 2011), which leads to poor implementation fidelity of the health-promoting schools approach. These competing priorities align with Graham's knowledge to action gap (Bowen & Graham, 2013; Graham et al., 2006), which depicts a misalignment of research and practice. Knowledge exchange, in which researchers and knowledge users collaboratively disseminate and apply research findings (Canadian Foundation for Healthcare Improvement, 2015), provides an opportunity to reduce this gap. Despite an emphasis on knowledge translation in public health research (Ammerman, Smith, & Calancie, 2014; Canadian Institutes of Health Research, 2012; Kitson et al., 2013), evaluation of these initiatives and their outcomes are still emerging (Lemire, Souffez, & Laurendeau, 2013; Van Eerd et al., 2011). The need for evaluation of these strategies in school

health research has also been recognized (Murnaghan et al., 2013; Riley, Wong, & Manske, 2014; Short, Weist, Manion, & Evans, 2012).

The COMPASS Study (COMPASS) is an ongoing longitudinal study (2012-2021) of student health behaviours and secondary school environments in Ontario and Alberta, Canada (Leatherdale et al., 2014). In addition to traditional dissemination mechanisms (e.g., publications and presentations), two knowledge translation strategies were integrated during the first phase (2012-2016) to support school prevention efforts to enhance student health. Each year, schools received a School Health Profile (SHP), a tailored summary of their students' health behaviours based on survey data, including evidence-based recommendations to address student outcomes and contact information for their local public health unit (Leatherdale, 2016; Leatherdale et al., 2014). Each school was assigned a knowledge broker, who discussed the school's summary and provided ongoing support, as needed (e.g., identifying health priorities within the school and connecting school personnel to community agencies). Further information regarding COMPASS knowledge brokering procedures can be found online (Thompson-Haile, Laxer, Ledgley, & Leatherdale, 2015).

COMPASS provided a case study to explore the potential impact of knowledge exchange in school health research, as well as knowledge brokering, an emerging method for which limited evaluation has been conducted (Salsberg & Macaulay, 2013). This research is part of a larger convergent parallel mixed-methods study exploring the implementation and outcomes of COMPASS knowledge exchange strategies (see Brown, Elliott, Robertson-Wilson, Vine, & Leatherdale [in press]; Brown, Elliott, & Leatherdale [under review]), and expands upon a quantitative analysis of knowledge brokering outcomes (Brown et al., under review). This paper explores researchers' and knowledge users' experiences with COMPASS knowledge exchange

activities, with particular focus on perceived outcomes and suggestions for change.

5.2 Methods

Qualitative in-depth semi-structured interviews were conducted with researchers (n=13), school staff (n=13), and public health stakeholders (n=4) between January and October 2016, as described by Brown et al. (in press). Interview guides (available upon request) were similar for each participant group, while also capturing role differences. For example, all participants were asked about outcomes associated with knowledge user engagement in COMPASS knowledge exchange, but researchers were also prompted regarding whether there were outcomes for the research team. The COMPASS Principal Investigator notified all members of the core COMPASS team (knowledge brokers and Project Manager) and all Co-Investigators that they would be invited to participate in an interview by the first author. The first author then extended invitations to participate.

We purposefully sampled schools engaged in knowledge brokering to varying degrees. From the COMPASS (2012-2016) sample, we identified four Ontario school boards that had at least one "involved" school (in-person meeting and/or more than one phone call with knowledge broker annually) and a mix of "somewhat involved" (one phone call annually) and "not involved" schools. Each of these boards had 4-6 schools participating in COMPASS. After gaining approval from respective school boards, we invited staff from 19 COMPASS schools for an interview; each school received a $30 honorarium per participant. Staff from three public health units involved in COMPASS knowledge brokering were also invited to participate.

Researchers were interviewed in person (n=8) or by phone (n=5), while public health and school stakeholders were interviewed by phone. Interviews ranged from 20-90 minutes in duration. Eight members of the core COMPASS team and five Co-Investigators (8 female, 5

male) participated, representing three Canadian universities. Six teachers, five principals, and two vice-principals (8 male, 5 female) from nine schools in four Ontario school boards participated. Six schools were involved in knowledge brokering, two schools were somewhat involved, and one school was not involved. Eight of thirteen school participants had engaged in knowledge brokering. The public health participants consisted of two nurses working in schools and two coordinators overseeing school initiatives within public health units. All public health participants had received SHPs for their corresponding school(s) and three had engaged in knowledge brokering. One of the public health units worked with two schools in the sample.

Interviews were audio-recorded with permission and transcribed verbatim for subsequent thematic analysis using NVivo for Mac 11 (QSR International). A template organizing style was used to code the data (Crabtree & Miller, 1999); for each participant group, the first author read all of the transcripts to determine thematic codes (arising deductively and inductively) to compose a coding manual. The coding manuals for each participant group were used to code the respective transcripts and identify relevant data. Inter-rater reliability (Miles & Huberman, 1994) and peer examination (Baxter & Eyles, 1997) were employed to enhance qualitative rigour of the findings. For each participant group, a second researcher coded two transcripts and the researchers' coding of the same transcript was compared. For the knowledge broker, Co-Investigator, school, and public health transcripts, coding agreement (whether the same codes were applied to a section of text) was calculated using the methods described by Miles and Huberman (1994). Differences in coding were discussed and changes to the coding manual were made before coding the remaining transcripts.

Upon preliminary analysis of the results, Samdal and Rowling's (2011) eight theory-driven implementation components for health-promoting schools were chosen to explore how

COMPASS knowledge exchange outcomes aligned with a health-promoting schools approach. Themes arising from the qualitative analysis were mapped onto Samdal and Rowling's (2011) eight components (see Discussion). *Preparing and planning for school development* describes tasks required before implementation, including identifying policies and practices to anchor the approach within the school, and establishing a team to lead implementation (Samdal & Rowling, 2011). *Policy and institutional anchoring* involves integrating action items to target student health in school documents (e.g., school strategic plan). Both *professional development* (e.g., formal training organized by the school board) and *professional learning* (e.g., daily practices directed by school needs) are necessary to build staff capacity for adopting the health-promoting schools approach. Next, *leadership* (motivation) and *management* (logistics that allow for change) are required for organizational change, and must be integrated using both *relational* (interpersonal) and *organizational* (e.g., funding and resources) *support*. *Student participation* and *partnerships* between schools and health practitioners are also critical. Lastly, in order to ensure *sustainability*, monitoring, evaluation, and continued resource allocation are required (Samdal & Rowling, 2011). Samdal and Rowling's (2011) components allowed for assessment of whether COMPASS knowledge exchange could impact a school's readiness for implementing a health-promoting schools approach, and ultimately reduce the gap between school health research and practice.

5.3 Results

Results are presented according to five key issues: i) feedback on the SHP, ii) how schools and public health units used COMPASS findings, iii) perceived outcomes of receiving school-specific COMPASS findings, iv) perceived outcomes of knowledge brokering, and v) suggestions for change.

5.3.1 School Health Profile feedback

Knowledge users discussed the value of COMPASS findings for their schools and health units, specifically the value in school-specific, local, and longitudinal data (Table 5.1):

> *"It's been really useful, it's filled a gap. We didn't have health behaviours for youth data, there's nowhere else we can obtain these kind of statistics, so it's been incredibly useful for our health unit."* (Public Health staff [PH1])

> *"The other thing is it's a, I don't know if the right word is, longitudinal study. So we have data over a number of years and we're able to compare that data."* (Principal, School 6 [S6])

Administrators perceived COMPASS data as equally valuable to academic data about their schools:

> *"It really talks about issues that affect kids' wellbeing; kids [who] are at school, happy, not being bullied, not suffering from addiction and mental health, they're going to be successful…. And that will affect literacy and numeracy way more, you know, than making sure that they read a series of paragraphs, right? I mean healthy kids are well-adjusted, self-actualized kids who are going to do well."* (Principal, S7)

Knowledge users praised the layout of the SHP, finding it easy to read and understand. Participants specifically discussed the value in having i) a year-to-year comparison of student health behaviours to indicate whether, and in what direction, they were changing, ii) a gender comparison of student health behaviours, and iii) recommended interventions that schools could implement to improve student health:

> *"I really appreciate the last page where you're comparing year by year, so our first year to this year just to see, thinking back to what we may have done, what's been successful, what's not really made a change."* (Teacher, S2)

> *"The physical activity one was really helpful to have it broken down by gender, because we could see that girls really were far behind in the amount of physical activity, so that's something that we did highlight to some of the schools to say, 'there's quite a gap here, especially for females.'"* (PH1)

> *"Well just overall in the report what stands out is that you have recommendations listed, which I think is a real strength of this report. And just knowing where it comes from and that, you know, it's evidence based."* (PH2)

Table 5.1 Knowledge users' feedback regarding the School Health Profile (SHP).

Theme	Number of Participants		
	School (n=13)	Public Health (n=4)	Total Knowledge Users (n=17)
SHP sections that participants valued	7	3	10
Year-to-year comparison	5	1	6
Gender comparison	3	2	5
Recommended interventions	2	2	4
Positive feedback about layout, content	6	2	8
Value of COMPASS findings	6	4	10
Value of school-specific and local data	4	4	8
COMPASS data perceived as equally valuable to academic data about school	3	0	3
Value of longitudinal data	1	1	2

5.3.2 How did knowledge users use COMPASS findings?

Seven participants read from the SHP during their interviews, indicating they used, and had access to, the resource. When asked how they used their school-specific COMPASS findings, knowledge users discussed their utility for planning purposes (e.g., School Improvement Plans, public health strategic plans, and community plans) (Table 5.2):

> "*So we have a School Improvement Plan process… so that's where we use this data, it gives us something to sort of ground our decision making on, and obviously we don't use everything in the survey but we select, go through it, we analyze it, we highlight where we see a particular need*." (Principal, S6)

Additionally, findings were used in grant applications for school- and community-based programming, and informed public health programming:

> *"I think it's given us a lot of leverage at [school 1]. Because, yes we were using the data before the big healthy eating grant, but it gave us the data we needed to be able to apply for that grant, and then we got this huge chunk of money so we've really been able to do a lot of activities in the last two years, which students, staff and parents saw value in, so we're continuing to do some of those initiatives*." (PH3)

> *"One example is I was writing a briefing note on how we were going to tackle the topic of marijuana with our student population at the secondary level, and that was part of it. We included the COMPASS results from the two schools, anonymously of course*." (PH4)

When asked who they shared the findings with, knowledge users discussed several groups including school staff, students, school (parent) councils, public health staff, school boards, parents, and community groups:

> *"I think our school council is very pleased, our trustee is very pleased, our superintendent and director are very pleased at what's going on here…. I share every year, so again, I shared with my school council and parents this year, we put it up on our school website."* (Principal, S1)

> *"[At] parent council meetings, we pick one topic and look at those results, and discuss different ideas and what we could do to make those results better. So you know we've been able to use the results not only to engage students in their own health and wellbeing, staff in the students' and their own health and wellbeing as well, because they know they're role models. But also parents, so it's fantastic."* (PH3)

> *"So we have been able to use the COMPASS survey results for [school name] specifically, to bring that into the conversation with the committees, to kind of highlight the fact that we do have high rates here in the community, of underage drinking. So it's like a prevention committee made up of enforcement, school staff, the public health unit, the hospital."* (PH1)

Table 5.2 How knowledge users used school-specific COMPASS findings.

Theme	Number of Participants		
	School (n=13)	Public Health (n=4)	Total Knowledge Users (n=17)
COMPASS findings were used for:			
School planning	7	0	7
School planning documents (i.e., School Improvement Plan)	5	0	5
Grant applications	1	2	3
Public health planning documents & reports	-	2	2
Public health programming	-	2	2
Community planning documents	-	1	1
Participant shared COMPASS findings with:	11	3	14
School Staff	11	1	12
Students	6	1	7
School (parent) council	3	1	4
Public health staff	2	2	4
School board	2	0	2
Parents	2	0	2
Community groups	0	1	1

- Not relevant to participant group

5.3.3 Perceived outcomes of using COMPASS findings

Outcomes of using COMPASS findings were mainly discussed by knowledge users and were manifold (Table 5.3). The most frequently mentioned outcomes were programming changes, particularly related to healthy eating, substance use, and bullying/mental health:

> *"I mean we had 10% of our kids eating the recommended doses of fruits and vegetables, so that was the sole focus for 10 months of the [nutrition initiative]. So there were different fruits, different vegetables, cut up, with hummus, without hummus, in a yogurt…. So that we could hopefully maybe get the kids to like them and maybe go home and ask their parents for them, or cut them up themselves."* (Vice principal [VP], S6)

Secondly, both knowledge users and researchers described an enhanced school culture focused on health, including an increased awareness of student health in schools, motivation among school staff to make change, increased student engagement, and creating School Health Committees:

> *"I have like [number] people on this [School Health] committee, I didn't expect them all to say yes but they did. And some community members, admin, I have guidance counsellors, foods teacher, Phys. Ed. teachers, the athletic director, the health nurse from our community, the parent council chair, I've got five students on it, lots of people!"* (Teacher, S9)

> *"I asked [school contact] some of the benefits that they've seen from COMPASS, and he said something along the lines of their participation providing a sense of the big picture. [School contact] said that often times within schools they're so focused on the academic bubble… and standardized testing… and sometimes having that focus can make them forget that their job is to be looking after all aspects of students' experience."* (KB1)

Knowledge users also discussed identifying health priorities to address within the school, developing health promotion and communication initiatives, collaborating with public health units, and implementing physical environment and curriculum changes:

> *"We do daily announcements on the TV so we have a news casting class. I had taken the information that you have given us, and picked out facts and points, so there was 'daily tip' on body weight or body image … and I wrote announcements for that, and they actually, I sent them the document that you guys sent me and they would flash the actual picture. Ya, so it was really neat so kids could see it."* (Teacher, S5)

> *"We had a smoking cessation program that we ran here with the [local health unit]."* (Principal, S8)

Table 5.3 Perceived outcomes of receiving school-specific COMPASS findings.

	Number of Participants			
	School (n=13)	**Public Health (n=4)**	**Researchers (n=13)**	**Total Participants (n=30)**
Programming changes	9	1	0	10
Healthy Eating	6	1		7
Substance use	4			4
Bullying, Mental health	3			3
Enhanced school climate, culture	4	3	7	14
Increased staff engagement and motivation for change	2	3	7	12
Increased student engagement	3	1		4
Created School Health Committee	3			3
Increased awareness of student health issues in schools	0	0	4	4
Identify health priorities to address	7	0	0	7
Health promotion and communication initiatives	4	1	0	5
Working with public health unit	4	1	0	5
Changes to physical environment	3	1	0	4
Curriculum impacts	4	0	0	4
Physical Education	3			3
Other	2			2
Prompted further investigation into findings by school	3	0	0	3

Interestingly, knowledge users mentioned the results prompted further investigation by the schools, with students from two schools conducting follow-up surveys:

> *"After sharing the COMPASS report, a couple classes conducted their own surveys. So they went in to some of the elements from the COMPASS survey a little bit more deeply and asked some more probing questions of the students."* (Principal, S2)

5.3.4 Perceived outcomes of knowledge brokering

All public health staff that engaged in knowledge brokering remembered doing so. However, only two school staff were familiar with, and could describe, the term "knowledge brokering" and five of seven school staff that engaged in knowledge brokering remembered doing so. Perceived outcomes of knowledge brokering were mainly discussed by COMPASS team researchers. Nonetheless, all participant groups described the added value that knowledge brokering offered beyond simply receiving the results (Table 5.4):

> *"I can see the data just being put in a binder and then we'll wait until next year. I think having that personal piece, that human piece, that contact, reflection, sharing, suggesting, meeting, again walking around the school to get a better idea of the school. I think that really kind of painted a better picture and made me commit to it, because I had some people who were committed to me."* (Principal, S1)

Participants discussed the value in receiving additional survey findings (not included in the SHP) from the knowledge broker, gaining an understanding of how their students' health behaviours compared to the rest of the schools in the sample, and receiving clarification about the findings:

> *"I think it just created that opportunity to have that meeting with the school…. and then just having somebody who had more of the background on the study, and the school could ask questions, and the nurses could ask questions, so I felt that was a real strength."* (PH2)

Further, participants mentioned the value of knowledge brokers to motivate and support schools in determining their next steps and implementing change:

> *"And it seems like in some of those schools, not all of them but some of them, the knowledge broker is almost more of an impetus for them to take additional action.… we've*

> *had a few schools go exceptionally far beyond what we ever would have thought would be realistic for a school to want to do to try to change."* (Principal Investigator [PI])

Relationship building between schools and public health units, researchers, and community resources was a key outcome discussed by all participant groups:

> *"I think it's also helped them create better relationships with community partners and health units. And other projects or research surveys won't do that. 'Cause they don't have anyone in place that's all about connecting school stakeholders. So I think that's one of the best parts about it."* (KB4)

School-level changes were mainly mentioned by researchers, including school facilities (i.e., creating yoga studios, modifying cafeterias) and implementing new programs. During the second year of COMPASS, the provincial government offered grants for improving school nutrition and physical activity environments, and schools were able to collaborate with knowledge brokers to submit successful grants:

> *"I helped with grant writing, and sending additional information, and doing some additional analyses. So a couple of my schools got pretty hefty grants, one in [city name] got [funding] to build an [nutrition initiative]. Another one of my schools got two grants, actually … to incorporate a [nutrition initiative], and then a … grant to [change physical environment to promote physical activity]."* (KB5)

However, researchers were unsure as to whether knowledge brokering would lead to changes at the student level and whether school-level impacts would be long-term:

> *"…at the level of the student, I don't know how much impact [knowledge brokering] would have had…. You kind of feel like 'oh the school did their one week of health, did that do anything?' Well, I mean, it got some people thinking about health for a week. You know, if they may not have before, but did that actually do anything long term? I don't know."* (KB2)

Additionally, the COMPASS team described positive outcomes of knowledge brokering for the study and researchers. The feedback received through knowledge brokering informed changes to the first phase of COMPASS (2012-2016) and will inform the next phase (2017-2021):

> *"I think that process with the knowledge brokering has been helpful in that they've been getting feedback from schools and hearing 'this is what schools really, really want, and [this is] what they're able to do,' kind of thing. So I think we've got a better idea now of what… policy/practice/environment changes are feasible, and are desirable basically, from the school standpoint."* (Project Manager)

> *"We've gotten very clear feedback from schools, especially through the knowledge brokers, like one of our biggest gaps is indicators related to mental health. We knew that kind of going in, we've got a much better picture of why we need to fill this gap moving forward."* (PI)

Researchers attributed knowledge brokering as one of the reasons COMPASS had a low school attrition rate, with only 10 of 90 schools leaving the study over four years:

> *"One of the reasons schools aren't dropping out is that they're recognizing that we're really trying to do things to help advance their agenda. Answering our own research questions obviously, but also advancing their agenda. The knowledge brokers have played a big role in that. We have had some schools who've debated, because of competing priorities, leaving the study, and it's often the knowledge broker interacting with them where they recognize it's worthwhile staying in."* (PI)

Further, through their role as knowledge brokers, graduate students were actively involved in a study where their role would normally be limited to secondary data analysis, and gained an enhanced understanding of the implementation process and context of school interventions:

> *"I think it's a great experience for students just to be able to have that interaction with schools, especially when we do school-based research. You get a better understanding of what the school environment is like, what is and is not possible given constraints on the school."* (KB6)

Finally, knowledge brokers were exposed to various career prospects, and began thinking about knowledge exchange in their own research:

> *"I'm still in the data analysis and 'writing the thesis' side of things, in my own research. So I haven't quite gotten to 'how am I going to share this information with people?' side of things yet, but I'm definitely starting to think about it and using some stuff I've learned through this role."* (KB3)

Table 5.4 Perceived outcomes of knowledge brokering.

	Number of Participants				
	School (n=13)	**Public Health (n=4)**	**COMPASS Team (n=8)**	**Co-Investigators (n=5)**	**Total Participants (n=30)**
i) Outcomes for Knowledge Users					
Added value of knowledge brokering over SHP	3	1	7	3	14
Motivation, support for next steps	1	1	4	3	9
Access to additional data, further analyses, comparison data	1	1	5		7
Clarification of findings	2	1			3
Ideas for programming	3				3
Find out about opportunities	3				3
Relationship building	2	3	5	0	10
School-public health unit	1	1	4		6
School-researcher	0	0	3	0	3
School-level changes	1	0	7	0	8
Schools winning healthy school grants, awards	1		7		8
Changes to school facilities, new programs implemented			2		2
Increased awareness and priority of school health issues	0	0	5	0	5
Unsure if KB led to change at student-level			3		3
Unsure of long-term impacts			3		3
ii) Outcomes for COMPASS Team & Study	**-**	**-**	**8**	**-**	**8**
Feedback led to changes within study, will lead to future changes			5		5
Keeping schools engaged & returning year-to-year			4		4
Active involvement of graduate students in research project			4		4
Understanding implementation and context of interventions			3		3
Will incorporate knowledge brokering into future research			3		3
iii) Outcomes for Knowledge Brokers	**-**	**-**	**7**	**-**	**7**
Greater understanding of realities of school environment			3		3
Influenced future career prospects			3		3
Thinking about knowledge translation in own research			3		3

- Not relevant to participant group

5.3.5 Suggestions for change

Given that the COMPASS knowledge exchange initiatives were a pilot, we asked knowledge users and researchers for recommendations for change. Knowledge users made two suggestions for the SHP. Firstly, they would like to know what interventions other COMPASS schools have implemented:

> *"But someone might be inspired, if you said, 'like here's some success stories about what other schools are doing with this information'. And all of a sudden, you know, you can start networking, maybe help that school connect with this school, because they said 'ok I want to contact that person and find out what they did and how that was organized.'"* (Teacher, S4)

Despite the inclusion of provincial and national averages for health outcomes in the SHP, schools specifically wanted to know how their school compared to other COMPASS schools:

> *"Comparisons I think are important because, like I see it in some of the [findings], but I think it gives you a frame of reference. A number by itself means nothing and numbers can be skewed anyway you want, but I mean, you need a frame of reference from the larger sample size to be able to assess."* (VP, S3)

Both researchers and knowledge users discussed the need to increase understanding of the knowledge broker role among knowledge users, including the opportunity to access additional data:

> *"It took me a couple years to really understand the role of the knowledge broker. So maybe initially, I could have utilized the knowledge broker a little bit more."* (Principal, S8)

> *"So I think if people that are using [the SHP] know that they can call and get more information. I think [having access to] the [survey] questions [was] really important…. so I know what I can get, right?.... I know what I can say to [knowledge broker]. 'OK can you pull this number, can you pull that number?' so that further helps us to do the work that we do."* (PH3)

Both groups mentioned it would be ideal to increase opportunities for in-person knowledge brokering, and school staff discussed their preference for pre-packaged resources to aid in making changes:

> *"So the easier it would be to deal with an issue that comes up in the survey, you know more support in pre-packaged things that you can give us, the more likely we would be able to implement it."* (Teacher, S4)

Overall, knowledge users were satisfied with COMPASS knowledge exchange; six participants requested to participate in the next phase of the study without prompting:

> *"I would really like to put a plug in that [University name] continue with this study. I think it's valuable that more principals in my system get on board with this…. I don't want to give more work for the knowledge brokers, if you're able to do that and if the funding extends, I would like to see this go for another four years."(Principal, S2)*

5.4 Discussion

These results expand on a quantitative analysis of knowledge brokering outcomes, which found school-level changes associated with knowledge brokering participation (Brown et al., under review). These qualitative results indicate the value in providing school-specific findings to participants in school health research (especially in longitudinal studies), and illustrate how the findings were used, providing a deeper understanding of the breadth of outcomes from both researcher and knowledge user perspectives. Similar to the factors influencing COMPASS knowledge exchange (Brown et al., in press), knowledge users focused on outcomes related to their use of COMPASS findings, while researchers focused on outcomes of knowledge brokering. This raises a question as to whether engaging in knowledge brokering leads to additional outcomes for knowledge users compared to receiving school-specific findings. However, previous research suggests that determining optimal knowledge translation methods is context-dependent (Dobbins, Hanna, et al., 2009; LaRocca, Yost, Dobbins, Ciliska, & Butt, 2012); hence, individual schools may benefit from different knowledge exchange strategies, one of which is knowledge brokering. Further, knowledge brokering may enhance the process of knowledge uptake and application in some schools, even if knowledge users do not associate it with school-level outcomes.

Outcomes for both knowledge users and researchers were identified. In addition to the value of COMPASS findings for schools, public health units gained a sense of adolescent health behaviours in their regions, which informed their programming and planning. Importantly, knowledge exchange provided a platform for partnerships between researchers, schools, and public health units. Knowledge brokering allowed researchers to gain feedback from knowledge users to enhance the study, and a better understanding of the school environment, consistent with previous research (Conklin, Lusk, Harris, & Stolee, 2013; Sharples & Sheard, 2015). For example, feedback from schools led COMPASS researchers to apply for, and receive, funding to develop a COMPASS Mental Health Module (PJT-149092). As well, knowledge brokering contributed to the retention of participating schools throughout the four-year study. However, Co-Investigators mentioned few outcomes of COMPASS knowledge exchange, as the majority were not involved with these components; considerations for the role of Co-Investigators in COMPASS knowledge exchange will be explored in future research.

Interestingly, COMPASS knowledge exchange outcomes align with factors influencing the implementation of a health-promoting schools approach (Hung, Chiang, Dawson, & Lee, 2014; Samdal & Rowling, 2011; Storey et al., 2016). Table 5.5 illustrates how COMPASS knowledge exchange activities led to achievement in each of Samdal and Rowling's eight theory-driven implementation components for health-promoting schools (Samdal & Rowling, 2011), and incorporates opportunities to further improve the implementation of these components in the study's next phase (2017-2021). COMPASS provides key baseline data that allow schools to assess their students' health status, identify priorities, create action items, and establish an individual or team to lead school action. Achieving the first implementation component can be enhanced by including means for all schools in the COMPASS sample (to allow individual

schools to assess how their students' health behaviours compare) and examples of activities from other schools. Schools were able to incorporate COMPASS findings into their School Improvement Plans to identify student health priorities, integrating them with other (academic) priorities. This is a fundamental strategy for health-promoting schools (Deschesnes et al., 2003; Samdal & Rowling, 2015).

COMPASS knowledge exchange presented opportunities for *professional learning*, as school contacts were able to communicate with knowledge brokers and public health practitioners to determine action items. *Professional learning* and *leadership and management* were reached through sharing COMPASS findings with school staff to increase awareness of student health issues and discuss possible action items. Further, principals and school champions played a key role in COMPASS knowledge exchange engagement (Brown et al., in press). More formal *professional development* activities such as training in school health intervention implementation could be offered (Hung et al., 2014; Storey et al., 2016); however, funding is limited in both school and research settings (Brown et al., in press).

COMPASS knowledge exchange impacted both *student participation* and *partnerships*, with the inclusion of students, parents, researchers, public health, and community agencies. However, opportunities to further develop these partnerships were identified: i) COMPASS schools could form a community of practice to share ideas for addressing similar student health behaviours, ii) increase in-person knowledge brokering meetings to strengthen partnerships, and iii) increase understanding of the knowledge broker role so schools recognize that researcher support is available. Developing a community of practice for COMPASS schools would allow for knowledge transfer between knowledge users, aligning with current educator practices of sharing resources and ideas informally (Dimmock, 2016; Samdal & Rowling, 2015). Based on

this recommendation, the COMPASS team is beginning to establish this network. While the timeframe of this research did not allow for assessing outcomes after the first four years of COMPASS, potential indicators of *sustainability* could include knowledge users continuing to incorporate student health in their School Improvement Plans, making changes to improve student health, and participating in the next phase of COMPASS. Additionally, evaluating the link between school-level changes and academic outcomes would increase school buy-in for adopting a health-promoting schools approach (Langford et al., 2015; Samdal & Rowling, 2015).

The alignment of COMPASS knowledge exchange outcomes with Samdal and Rowling's implementation components (Samdal & Rowling, 2011) suggests that knowledge exchange in longitudinal studies may provide a mechanism for schools to implement a health-promoting schools approach. However, not all schools engaged in knowledge brokering (Brown et al., under review), and not all schools that engaged experienced these outcomes, or even remembered participating in knowledge brokering. Further research could investigate alternative knowledge exchange approaches to engage these schools. By considering factors that influenced knowledge users' use of study findings and knowledge brokering engagement (Brown et al., under review; Brown et al., in press), we can increase research uptake and ultimately, the number of schools adopting a health-promoting schools approach. The importance of knowledge brokers reaching schools in the first year has been identified (Brown et al., under review); sharing case studies of how phase one schools used COMPASS findings may provide motivation for schools in the next phase to use their findings and access researcher support, enhancing subsequent outcomes. However, due to funding restrictions, COMPASS knowledge brokering may proceed differently in the second phase (2017-2021).

While only nine of the ninety COMPASS schools (2012-2016) were represented in this

research, perspectives of schools that engaged with knowledge brokering to varying degrees were included. Still, it is possible that study participants were from schools that viewed school health as a priority. Second, we potentially missed perspectives of public health stakeholders that received the SHP but did not communicate with COMPASS researchers, since only public health personnel that communicated with COMPASS researchers were invited to participate. Nonetheless, the purpose of this study was to gain an in-depth understanding of individual experiences to expand on quantitative findings (Brown et al., under review).

Table 5.5 Alignment of COMPASS knowledge exchange outcomes with Samdal and Rowling's (2011) implementation components of health-promoting schools.

Implementation component (Samdal & Rowling, 2011)	Corresponding COMPASS knowledge exchange outcome	Opportunities for COMPASS knowledge exchange (next phase)
Preparing and planning for school development	Receiving school-specific findings and communicating with knowledge brokers allowed schools to: -have baseline data of student health behaviours -identify priorities related to student health (and action items) -integrate student health as a priority in their School Improvement Plans, create specific action items -establish a school contact for the COMPASS study and a School Health Committee	For each student health outcome in the SHP, include the mean for all COMPASS schools so individual schools can understand how their results compare to other participating schools. Include examples of interventions COMPASS schools have implemented in the SHP, to provide ideas for how to address student health outcomes.
Policy and institutional anchoring	By incorporating COMPASS findings into strategic planning documents (e.g., school improvement plans, public health unit strategic plans), knowledge users are more likely to commit to school health initiatives because school health is aligned with their organizational goals.	Schools could specifically incorporate the health-promoting schools approach into strategic planning documents and create school health policies.
Professional development and learning	By providing the opportunity for schools to communicate with knowledge brokers and public health practitioners, school stakeholders can gain support in implementing school health interventions. Opportunities for professional learning were provided when COMPASS findings were shared with school staff, which in some cases led to further health education opportunities.	Offer additional professional development opportunities related to student health behaviours and implementing school health interventions (i.e., training at the school or school board level).
Leadership and management practices	Distributed leadership was evident when school contacts shared their results with their fellow staff, public health units, and other community contacts in order to delegate action items.	Increased resource allocation (many schools have limited budgets to allocate to school health initiatives).

Relational and organizational context	Schools used their COMPASS findings to show need for funding in grant applications, which they used to fund school health initiatives. After receiving their COMPASS findings, schools made changes to the physical environment (e.g., new activity spaces, changes to cafeteria).	Increased resource allocation (many schools have limited budgets to allocate to school health initiatives).
Student participation	Students were involved in School Health Committees, health promotion initiatives, and collecting additional data about student health behaviours to expand upon COMPASS results.	Include examples of student-led initiatives and ways to involve students in school health in the SHP.
Partnerships and networking	Schools shared COMPASS findings with parents and involved school (parent) council in determining action items. Schools partnered with researchers, public health practitioners, and other community agencies to implement school health initiatives.	COMPASS could serve as a platform to create partnerships between schools (e.g., schools sharing intervention ideas to improve student health behaviours). Increase understanding of knowledge broker role so schools recognize that support is available. Increase in-person knowledge brokering opportunities.
Sustainability	Annual SHPs allow schools the opportunity to monitor student health behaviours over time, assess whether school-level changes had an effect, and identify priorities. Sustainability beyond the four-year study would be evident if knowledge users continue to incorporate student health into strategic planning documents, participate in the next phase of COMPASS, and continue to make changes to improve student health in their school.	Increased resource allocation (many schools have limited budgets to allocate to school health initiatives). In order to provide stronger rationale for addressing student health in schools, COMPASS could evaluate the links between school-level changes and academic outcomes.

5.5 Conclusions

This research addresses gaps in the literature related to outcomes of knowledge brokering in public health research (Salsberg & Macaulay, 2013) and knowledge translation in school health research (Murnaghan et al., 2013; Riley et al., 2014; Short et al., 2012). Findings highlight the value in providing tailored summaries to schools participating in longitudinal school health research, as schools actually used these findings to make changes. Partnerships between schools, researchers, and public health were formed, leading to benefits for all groups. Knowledge brokering provided feedback to researchers to enhance the study, contributed to low school attrition, and increased researchers' understanding of school environments. Knowledge exchange may provide a mechanism to help schools achieve the components needed for implementing a health-promoting schools approach, increasing implementation fidelity. However, further research is needed to examine the process of knowledge brokering and consider how to increase engagement of schools. Findings from this study are being used to strengthen knowledge exchange in the next phase of COMPASS, and can also inform similar activities in school health and public health research.

List of abbreviations

KB: knowledge broker; PH: public health staff; PI: Principal Investigator; SHP: School Health Profile; VP: Vice principal

Declarations

Ethics approval and consent to participate

Both the overarching COMPASS Study and the specific qualitative data collection for this paper have received ethics clearance through a University of Waterloo Research Ethics Committee and participating school boards. Interview participants were provided with a letter of information before participating and gave written consent (in-person interview) or verbal consent (phone interview) to participate, have the interview audio recorded, and for the use of quotes. At any time during data collection, participants were allowed to decline from answering any questions or withdraw from the study.

Consent for publication

All participants gave consent for the use of anonymous quotes in resulting publications and presentations from this research. The Principal Investigator and Project Manager gave permission for their quotes to be identified in this publication.

Availability of data and material

Data will not be shared as ethics approval does not permit the sharing of data due to issues of confidentiality.

Competing interests

The authors declared they have no competing interests.

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Authors' contributions

Brown and Elliott developed the research question, Brown conducted the qualitative interviews and data analysis and drafted the manuscript, and Elliott, Robertson-Wilson, Vine, and Leatherdale provided feedback and guidance.

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Chapter 6
Discussion and Conclusion

6.1 Introduction

Adolescence is a critical period for developing health behaviours and schools are influential settings in adolescent lives; hence, evidence-based public health practices should be implemented in these settings to maximize population impact. However, the misalignment between research-based evidence and characteristics of school settings has posed a barrier to effective implementation (Keshavarz, Nutbeam, et al., 2010; Sulz et al., 2016). This research indicates the value of researchers, school staff, and public health practitioners working together to integrate evidence, and shape research to become more relevant to practice settings. This dissertation contributes to the limited evaluation of knowledge exchange strategies, particularly in school settings, and provides evidence that knowledge exchange can reduce the gap between school health research and practice, and enhance school environments. Additionally, it points to considerations for enhancing and evaluating knowledge exchange practice in future research.

This concluding chapter will summarize the main findings of the research, designed to address the following objectives:

1. To investigate factors associated with schools' engagement in the COMPASS knowledge brokering strategy and whether this engagement influenced school health policies/practices and student health behaviours;
2. To explore the experiences and perspectives of key COMPASS personnel regarding factors that shaped the knowledge brokering process, perceived outcomes, and suggestions for change; and,

3. To explore the experiences and perceived outcomes of school and public health stakeholders (knowledge users) regarding the COMPASS School Health Profile (SHP) and knowledge brokering strategies.

Additionally, it will answer the mixed methods research question:

- What results emerge from comparing the perspectives of COMPASS researchers and knowledge users with the quantitative analysis of influential factors and school- and student-level changes?

Findings will be contextualized using the existing literature. Theoretical, substantive, and methodological contributions and practice implications of the research will be discussed. Lastly, limitations and directions for future research will be considered.

6.2 Summary of Key Findings

6.2.1 Factors that Influenced COMPASS Knowledge Exchange

Chapters 3 and 4 examined factors that influenced COMPASS knowledge exchange. The quantitative results (Chapter 3) showed both school-level and COMPASS study factors were associated with a school's level of knowledge brokering engagement. School-level factors included school size, the socioeconomic status of the area surrounding the school, and school characteristics at baseline (e.g., existing health initiatives in the school; relationship with public health). COMPASS study factors included the position of the school contact and the year of study participation. Schools tended to remain at the same engagement level across study years (i.e., schools "involved" in year 1 remained "involved" in years 2 and 3). In all years examined, the knowledge broker assigned to a school was significantly associated with its engagement level; however, a change in knowledge broker between subsequent years had contrasting effects

on engagement level in years 2 and 3. Lastly, a change in school contact or principal between subsequent years had no effect.

Qualitative methods (Chapter 4) provided an opportunity to deepen understanding of not only factors influencing knowledge brokering, but also school and public health unit staff's use of COMPASS findings. Aligning with the quantitative findings, knowledge users indicated that knowledge broker attributes (e.g., approachability, availability, expertise) were facilitators to their participation. The qualitative results indicated limited time and resources as being a challenge to using COMPASS findings and knowledge brokering engagement; this may help explain the quantitative finding that large schools were more likely to be "involved" in knowledge brokering, since they may have had greater resources and a larger staff for delegating tasks. Knowledge users also described the importance of a strong relationship between the school and public health unit in using COMPASS findings, aligning with the finding that schools actively involved with their public health unit at baseline were more likely to be "involved" in knowledge brokering.

However, some of the qualitative and quantitative findings diverged. For example, despite the absence of association in the quantitative results, a change in school administrator was a perceived challenge to using COMPASS findings (knowledge users) and knowledge brokering engagement (researchers). This discrepancy may be explained by local context (e.g., change in administrator may have only affected the knowledge brokering engagement of certain schools in the sample). Additionally, the perceived challenge of limited resources within the school appears to contrast the finding that schools with a lower baseline school health score were more likely to engage in knowledge brokering. Overall, the quantitative results suggest schools with lower capacity (i.e., smaller schools, schools with a lower baseline school health score) engaged in

knowledge brokering, whereas the qualitative results identify facilitators and challenges that schools faced, irrespective of their capacity.

6.2.2 Outcomes of COMPASS Knowledge Exchange

Chapters 3 and 5 examined COMPASS knowledge exchange outcomes. The quantitative results showed that knowledge brokering engagement was associated with school-level changes related to healthy eating, physical activity, and tobacco programming but not changes at the aggregate student level. This aligns with COMPASS researchers' uncertainty regarding whether COMPASS knowledge exchange impacted student health behaviours (Chapter 5). While researchers perceived programming changes as a result of knowledge brokering, knowledge users linked them with their use of COMPASS findings, and the health behaviours mentioned were healthy eating, substance use, and bullying/mental health. The qualitative methods expanded on the quantitative findings by indicating knowledge users valued school-specific results, shared them within their networks, and used them for planning and programming purposes (e.g., integrating into School Improvement Plans). Additional outcomes of using COMPASS findings included an enhanced school culture, identifying health priorities, and collaborating with public health units. The added value of knowledge brokering beyond the SHP was indicated, and researchers discussed the impact of knowledge brokering on the COMPASS study as a whole. Lastly, knowledge exchange could be a mechanism to impact school practice, evidenced by the alignment of outcomes with the components for implementing a health-promoting schools approach (Samdal & Rowling, 2011).

6.3 Discussion

Chapter 4 concluded that factors influencing schools' use of COMPASS findings and knowledge brokering participation align with factors that influence school health interventions.

For example, limited resources within schools present a barrier to using COMPASS findings and knowledge brokering engagement, which have also been identified as a barrier to implementing school health interventions (Deschesnes, Drouin, Tessier, & Couturier, 2014; Hung, Chiang, Dawson, & Lee, 2014; McCuaig & Hay, 2014; Storey, Spitters, Cunningham, Schwartz, & Veugelers, 2011). In contrast, Chapter 5 concluded that outcomes of using COMPASS findings and engaging in knowledge brokering aligned with components that facilitate the implementation of a health-promoting schools approach. These two findings raise a critical question. If the barriers to using COMPASS findings and engaging in knowledge brokering are similar to barriers that schools face implementing health interventions, then is COMPASS knowledge exchange reaching those who need the most support? Or, is COMPASS knowledge exchange reaching the schools that already have capacity to implement health interventions? These findings parallel a study of knowledge brokering with public health units, in which impacts for staff with capacity in evidence-informed decision making did not extend to other staff within the organization (Yousefi-Nooraie, Dobbins, Marin, Hanneman, & Lohfeld, 2015).

While enhancing schools' capacity to implement a health-promoting schools approach is beneficial, we must be mindful as to whether knowledge exchange initiatives increase the gap between schools who have the capacity to implement school health interventions and those that do not. This is particularly interesting because knowledge brokering has been identified as a knowledge translation method that supports health equity (Davison, Ndumbe-Eyoh, & Clement, 2015). However, the quantitative results suggest that schools with lower capacity engaged in knowledge brokering, since those with a lower school health baseline score were more likely to engage. Nonetheless, we should consider how to increase equity in knowledge exchange engagement and reach schools that did not engage, especially since knowledge brokering

benefits organizations with lower capacity to use evidence (Dagenais, Laurendeau, & Briand-Lamarche, 2015; Dobbins, Hanna, et al., 2009). This does not mean researchers should only focus on schools with lower capacity (indeed, some schools may not be interested in addressing health), but simply consider alternative approaches to engagement. Guidance for equity-focused knowledge translation exists (Masuda, Zupancic, Crighton, Muhajarine, & Phipps, 2014). These ideas will be revisited with respect to practice implications and future research directions.

6.4 Contributions

6.4.1 Substantive Contributions

Substantive contributions of this dissertation include the evaluation of a knowledge exchange initiative in school health research, which has been identified as a need in the literature (Murnaghan et al., 2013; Riley, Wong, & Manske, 2014; Short, Weist, Manion, & Evans, 2012). Further, evaluating knowledge brokering has been described as a difficult task considering its complexity and contextual nuances (Langeveld, Stronks, & Harting, 2016). This research indicates that knowledge exchange can have an impact on school-level changes (Sharples & Sheard, 2015) and enhance partnerships between researchers, schools, and public health units to address student health. Further, it shows the value of providing local, school-specific findings to knowledge users, aligning with the health-promoting schools implementation literature (Samdal & Rowling, 2011) and the broader knowledge translation literature (Bowen & Graham, 2013). Facilitators and challenges to schools' use of health evidence and engagement in knowledge brokering were also identified. These findings indicate the value of integrated knowledge translation in school health research and can help researchers understand the factors that influence knowledge uptake in secondary schools. They may also inform knowledge translation initiatives in other school health studies.

Secondly, this dissertation provides an evaluation of a knowledge brokering strategy in public health research. Evidence for knowledge brokering has mainly emerged from health care settings (Salsberg & Macaulay, 2013), so these findings indicate the promise of knowledge brokering in public health research. Further, many studies examining knowledge brokering in public health have focused on policy-makers (Mavoa et al., 2012; Waqa et al., 2013) and public health units (Dagenais et al., 2015; Dobbins, Robeson et al., 2009; Traynor, DeCorby, & Dobbins, 2014); hence, this case study shows that knowledge brokering can be effective in local settings outside of public health. Findings may be transferable to other public health research areas working with organizations outside the health sector. Specifically, the uptake of recommended interventions by schools shows promise that impact (type 2) evidence can be integrated into practice, building on findings that descriptive evidence is mainly used by public health decision makers (Armstrong, Pettman, & Waters, 2014).

6.4.2 Theoretical Contributions

Theoretical contributions are threefold. The integration of social constructionism and social ecological theory addresses the need for theory in evaluating knowledge translation strategies (Salsberg & Macaulay, 2013; Thomas, Menon, Boruff, Rodriguez, & Ahmed, 2014). Using both a social constructionist and social ecological lens allowed for the consideration of individual, relational (researcher-knowledge user), and broader environmental factors. Social constructionism informed the qualitative research design; perspectives from four stakeholder groups (COMPASS team, Co-Investigators, school staff, public health staff) were included to enhance understanding of COMPASS knowledge exchange (Patton, 2015). Social constructionism was highlighted through the importance of relationships (school-knowledge broker and school-public health unit) in the use of COMPASS findings and knowledge brokering

engagement. The role of previous experience in school staff's use of COMPASS findings was evident when they identified the challenge of discrepancies between a perceived change at the local level (e.g., decreased smoking on school property) and the student-level summary (e.g., no change in percent of current smokers). Lastly, the perceived outcomes discussed by knowledge users (clarification of findings, access to additional findings) and researchers (greater understanding of school environment) indicate that knowledge brokering may provide a platform for shared construction of knowledge between researchers and knowledge users (Patton, 2015). This research illustrates the value of using social constructionism to evaluate knowledge translation initiatives (Thomas et al., 2014).

Social ecological theory allowed for the consideration of factors beyond the researcher-knowledge user relationship. Influential factors identified through both the quantitative and qualitative methods spanned the micro-, meso-, exo-, and macrosystem levels. This indicates that not only do we need to consider the specific research and school settings when implementing knowledge exchange, but also larger structures (e.g., structures within the education, health, and research sectors to allocate funding to school health interventions). This aligns with the school health intervention literature (Deschesnes et al., 2014). Lastly, social ecological theory helps to explain findings indicating the influence of knowledge user and knowledge broker characteristics on knowledge use, since intervention effectiveness depends on the fit between individuals and the intervention setting (Green, Richard, & Potvin, 1996; Stokols, 1996).

Second, the knowledge to action (KTA) framework (Graham et al., 2006) provided a useful model to guide this research and conceptualize the COMPASS knowledge exchange components (i.e., SHP as a "knowledge tool"; knowledge brokering as steps from "identify problem" to "select, tailor, implement interventions"). Using the KTA framework to guide the

research allowed for the assessment of factors influencing knowledge use (Chapters 3 and 4), examination of how knowledge users used findings (Chapter 5), evaluation of outcomes (Chapter 3 and 5), and consideration of modifications to enhance knowledge use (Chapter 5). This dissertation provides an example of applying the KTA framework to evaluate a public health knowledge translation initiative, supplementing a review of how the framework has been used in practice (Field, Booth, Ilott, & Gerrish, 2014).

Lastly, a unique theoretical contribution that arose inductively during the qualitative analysis was the alignment between COMPASS knowledge exchange outcomes and the theoretical implementation components of health-promoting schools (Samdal & Rowling, 2011). The outcomes' alignment with Samdal and Rowling's (2011) components strengthens the rationale for implementing knowledge exchange in school health research. By providing the building blocks for schools to implement a health-promoting schools approach, knowledge exchange can lead to change in practice. These components also allowed for the identification of potential changes to enhance the contribution of COMPASS knowledge exchange to the implementation of a health-promoting schools approach.

6.4.3 Methodological Contributions

This research employed a convergent parallel mixed methods approach to examine both implementation and outcomes of knowledge exchange strategies. The use of mixed methods to evaluate knowledge translation initiatives has been advocated in the literature (Bhattacharyya, Hayden, & Zwarenstein, 2013; Bornbaum, Kornas, Peirson, & Rosella, 2015; LaRocca, Yost, Dobbins, Ciliska, & Butt, 2012). Additionally, the convergent parallel design permitted the qualitative and quantitative methods to be implemented with equal priority, and their integration enhanced understanding of the research question. The quantitative methods allowed for breadth

of understanding, identifying influential factors and outcomes for the entire COMPASS school sample, and comparing schools at all knowledge brokering engagement levels. The qualitative methods offered a deeper understanding of researchers' and knowledge users' experiences with COMPASS knowledge exchange, expanding on the quantitative findings in three ways. The interviews captured i) influential factors and outcomes of knowledge brokering that were not measured in the COMPASS data, ii) influential factors and outcomes related to the use of school-specific findings, and iii) outcomes from the public health and researcher perspectives. Overall, the triangulation of the qualitative and quantitative findings enhanced our understanding of the COMPASS knowledge exchange strategies.

6.5 Implications for Practice

Practice implications are twofold: first, for the COMPASS knowledge exchange initiatives, and second, for knowledge translation in school health and public health research. This research identifies suggestions for enhancing the SHP, knowledge brokering practice, and promotion of COMPASS knowledge exchange. School stakeholders were very interested in how their students compared to other schools as well as actions other schools were taking to improve student health behaviours. Based on these findings, the COMPASS team has started to ask whether participating schools would like to be connected with each other, with the goal of creating a community of practice to allow schools to share resources and ideas. Additionally, the team is developing data management and analysis techniques to enable the dissemination of outcomes from program and policy changes within the study to COMPASS schools. Considering the reduced funding for knowledge brokering in the 2017-2021 phase (cut by the funder), integrating comparison data and ideas from other schools into the SHP and encouraging schools to join the

COMPASS community of practice may alleviate some of the challenges, while still achieving outcomes identified in this dissertation.

The impact of knowledge exchange for public health staff raises a question as to whether the COMPASS team should explicitly engage public health units in knowledge brokering (irrespective of corresponding schools' engagement) and whether there may be other groups of interest (e.g., provincial Ministries of Education and Health, Ophea). However, these changes must be considered within the context of reduced funding for knowledge brokering in the 2017-2021 phase.

Further, qualitative results indicating schools' frustration by the absence of student-level changes despite making school-level changes align with quantitative results that knowledge brokering engagement was not associated with changes at the aggregate student level. These findings indicate the importance of helping knowledge users set realistic expectations that student-level changes may take longer than one year.

A final consideration for the COMPASS team is how to increase knowledge users' understanding of the opportunities available through knowledge exchange. Potential strategies include describing the knowledge broker role in study recruitment materials, and sharing case studies of how Phase 1 schools benefitted from participating in knowledge exchange. These techniques would be particularly valuable since findings showed that schools maintained their level of engagement over time, indicating the importance of engaging schools in knowledge brokering in the first year. To address equity and ensure knowledge exchange is reaching schools with lower capacity for addressing student health, the COMPASS team could use the School Policies and Practices (SPP) questionnaire data to identify schools that have fewer school health initiatives and make specific efforts to engage these schools in knowledge exchange.

These findings indicate the value of integrated knowledge translation in school health research; in some ways, participation in the COMPASS study could be considered an intervention. In particular, providing school-specific findings and suggesting evidence-based interventions appears to be a way that school health researchers can help schools identify concerns and take action, aligning with the education literature (Sharples & Sheard, 2015). However, the need for funding to enable schools to implement health interventions is evident. This study suggests that knowledge brokering is particularly useful in retaining schools in longitudinal studies, through developing rapport. The key role of the school principal as a gatekeeper to school change indicates the benefit of developing specific strategies to engage administrators in knowledge brokering (Roberts et al., 2016).

Finally, this study has implications for knowledge translation in public health research, which has been identified as a key area for growth in the literature (McVay, Stamatakis, Jacobs, Tabak, & Brownson, 2016). It would be beneficial to explore whether the low participant attrition seen in this study transfers to other public health research participants. The value of developing systematic recording procedures for knowledge brokering practice (Dobbins, Robeson, et al., 2009) and defining knowledge broker tasks and expectations (Langeveld et al., 2016) at the beginning of an initiative are transferable to other research areas.

6.6 Limitations

In addition to the limitations outlined in the substantive chapters, this research was conducted retrospectively; the quantitative measures were not designed for the research objectives and the qualitative interviews occurred in the final year of the first phase of COMPASS (2016). Nonetheless, these findings can inform changes to the COMPASS knowledge exchange components and strengthen methods for their evaluation in the study's next

phase (2017-2021). For example, based on the findings from this dissertation, a theory of change or logic model could be developed for the 2017-2021 COMPASS knowledge exchange activities and inform a real-time evaluation (Bhattacharyya et al., 2013; Fazey et al., 2014). A similar approach is being considered for the Health Canada expansion of the COMPASS study.

6.7 Directions for Future Research

Five areas are identified for future research. First, the absence of student-level changes in the quantitative findings suggests the need for further investigation. This could include the examination of change in student behaviours over a longer timeframe (i.e., compare knowledge brokering engagement in year 1 to change in student outcomes in years 3 and 4) and the change in individual student behaviours over time (using paired data). Further, a difference-in-difference modelling approach (Abadie, 2005) could be used to compare the difference in school-aggregated student health behaviour changes between schools that engaged in knowledge brokering compared to those that did not. This approach has been used to assess the impact of school interventions in other COMPASS publications related to school-based breakfast and tobacco control programming (Leatherdale & Cole, 2015; Leatherdale, Stefanczyk, & Kirkpatrick, 2016). Additionally, the sustainability of the COMPASS knowledge exchange outcomes should be investigated; this would be possible if schools from the first phase participate in the study's second phase.

Second, we must examine how to engage schools that did not participate in knowledge brokering, by modifying recruitment and considering alternative knowledge translation strategies (Dobbins, Hanna et al., 2009). We must also consider the factors that led certain schools to achieve outcomes through knowledge exchange engagement (Fazey et al., 2014) in order to determine how to enhance outcomes for all participating schools. Since there were school-level

changes associated with both “somewhat involved” and “involved” engagement levels, an investigation regarding the amount of knowledge brokering engagement required for change would be useful (Dobbins, Robeson, et al., 2009).

Lastly, the Co-Investigator interviews added little in response to the objectives of this dissertation; Co-Investigators mentioned few facilitators, barriers, or outcomes of COMPASS knowledge exchange, citing they knew little about the knowledge exchange implementation beyond the initial grant proposal. However, Co-Investigators contributed valuable information beyond the objectives of this dissertation; these findings will be summarized in a future paper. Further, the knowledge to action framework will guide an examination of the process of COMPASS knowledge exchange.

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Chapter 1

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Appendix A. Secondary Quantitative Analysis Variables.

1) Knowledge brokering participation

Variable	Description	Source
Knowledge brokering (KB) participation intensity	• not involved (0): no KB help given • somewhat involved (1): 1 successful phone contact • involved (2): more than 1 successful phone contact or at least 1 in-person meeting	Knowledge brokering records

2) School characteristics

Variable	Description	Source
Baseline School Health Indicator	How "healthy" the school was at baseline; scored from 0 ("less healthy") -5 ("more healthy") Each of the following indicators (i-v) were scored out of 1 and summed for final score out of 5: i) Policy: Each of the following was scored as a 1 (yes) or 0 (no) and averaged to a final policy score out of 1: -whether the school had written policies related to a) healthy eating, b) physical activity, c) tobacco, d) alcohol & drugs, and e) bullying -if the school had made any health policy or program changes in the past year ii) Programs Each of the following was scored out of 1 and averaged to a final program score out of 1: -whether the school had programs related to a) physical activity, b) healthy eating, c) bullying, d) tobacco, and e) alcohol and drug use iii) Partnerships & Services Schools were assigned a 1 (had a partnership with the organization type) or 0 (did not have any partnerships of that type) and then averaged to a final partnerships & services score out of 1: a) non-government organizations b) parks and recreation department c) youth organizations d) health or fitness club e) board/division/district consultant or specialist iv) Professional Development Each of the following was scored out of 1 and averaged	Derived from baseline SPP for each school (corresponding SPP questions noted below) i) Q1, 4, ii) Q18, 20, 27, 32a, 36a, 44a, 45a, 46a, 47a iii) Q7 iv) Q33, 49 v) Q3

	to a final professional development score out of 1: -whether the school had received any professional development related to a) healthy eating, b) promoting positive body image, c) tobacco prevention and/or cessation, d) alcohol prevention and/or cessation, e) drug prevention and/or cessation v) Has school used data from a student health assessment at least once in the past two years: scored as a 1 (yes) or 0 (no)	
Urban/rural	Using the postal code of the school, categorized schools using Statistics Canada's classification of urban and rural areas.[1] • Large Urban (1): populations 100,000 and larger and a population density of at least 400 people per km^2 • Medium Urban (2): populations between 30,000 to 99,999 and a population density of at least 400 people per km^2 • Small Urban (3): populations between 1,000 to 29,999 and a population density of at least 400 people per km^2 • Rural (4): population less than 1,000 or population density less than 400 people per km^2	OSIS (postal code), 2011 Canadian Census data
Socioeconomic Status (SES) of surrounding area	Using the postal code of the school and the Quebec social and material deprivation index[2,3] • Low SES (1): both social & material deprivation scores in quintile 4 and/or 5 • High SES (3): both social & material deprivation scores in quintile 1 and/or 2 • Average SES (2): postal codes that have social & material deprivation scores that don't fit in either of the categories above.	OSIS, Statistics Canada postal code conversion file, Quebec social and material deprivation index[3]

[1] Statistics Canada. (2011). From urban areas to population centres. Retrieved from http://www.statcan.gc.ca/eng/subjects/standard/sgc/notice/sgc-06

[2] Used publically-available data from the Government of Québec, consisting of indices from 2006 Canadian Census data (due to poor data quality [poor response rate] from the 2011 National Household Survey). Retrieved from http://www.msss.gouv.qc.ca/statistiques/atlas/atlas/index.php?id_carte=20061

[3] Used classification from Canadian Institute for Health Information. (2008). Reducing gaps in health: A focus on socio-economic status in urban Canada. Retrieved from https://secure.cihi.ca/free_products/Reducing_Gaps_in_Health_Detailed_Methods_Paper.pdf

Variable	Description	Source
Student enrolment	Classified i) total student enrolment in school (any grade) and ii) grade 9-12 students in school using the Ontario Federation of School Athletic Associations (OFSAA) 2014-2015 guidelines[4] • Small (1): ≤500 students • Medium (2): 501-900 students • Large (3): >900 students	OSIS, school websites, Ontario Ministry of Education website
Grades in school	• All grades in the school were reflected in COMPASS SHP (i.e., Grade 9-12, Grade 10-12) (0) • School had grades that weren't reflected in COMPASS SHP (i.e., grades 8 and younger) (1)	
Year of COMPASS Participation	Whether it was the first (1), second (2), or third year (3) a school participated in the COMPASS study (based on the year the school joined the study)	OSIS
Time of Cq (student) survey	Whether the student survey data were collected within the 2 months before Christmas or the summer. The rationale for this was that School Profile wouldn't arrive until close to or after the break and may be given less of a priority by the school. • Nov, Dec, May, June (1) • Sept, Oct, Jan, Feb, Mar, April (0)	OSIS
Baseline relationship with public health unit (PHU)	School's relationship with the local public health unit based on the baseline SPP. Data from SPP were re-coded into 3 categories: • No contact (0): Responded "no contact with local Public Health Unit regarding health promotion and/or activities" • Passive involvement (1): Responded "provided information/resources/programs (e.g., posters, toolkits)" only • Active involvement (2): Responded "solved problems jointly" and/or "developed/implemented program activities jointly"	Baseline SPP (Q5)
School KB contacts	If the school participated in KB in the respective year, the position(s) listed was/were the individuals who participated in KB. If the school did not participate in KB in the respective year, the position listed was that of the individual who was contacted about KB or if no records, the school contact listed in OSIS • Teacher (1) • Principal (2) • Vice-principal (3) • Other (4) • Multiple contacts (5)	Knowledge brokering records, OSIS

[4] Ontario Federation of School Athletic Associations (OFSAA). (2014). By-Laws. Retrieved from http://www.ofsaa.on.ca/sites/default/files/bylaws_sept_2014_0.pdf

Variable	Description	Source
Change in school contact	Whether there was a change in the school contact (as described above) between the years analyzed • No (0) • Yes (1) • N/A (2)	Knowledge brokering records, OSIS
Change in school principal	Whether there was a change in school principal between the years analyzed • No (0) • Yes (1) • N/A (2)	Knowledge brokering records, OSIS
COMPASS KB	• COMPASS KBs were identified by a number in order to link the schools to the KB they had for that year (1, 2, 3, 4) • Two subject-specific KBs introduced in 2014-2015 were combined into one category (6) as they only had 3 schools individually • Schools that had multiple KBs in a given year were categorized to the KB that worked with the school the most that year	Knowledge brokering records, OSIS
Change in KB	Whether the KB assigned to a particular school changed between the years analyzed • No (0) • Yes (1) • N/A (2) (i.e., school did not participate in one of the years analyzed)	Knowledge brokering records, OSIS

4) **School-level changes**

Variable	Description	Source
Policy Change	Whether there was a policy change (no=0, yes=1) in each of the following health behaviours since the previous study year (as answered by the school contact) a) healthy eating b) physical activity c) tobacco use d) alcohol and drug use e) bullying f) sedentary behaviour	SPP (yr 2-4) Q2, 7, 12, 17, 22, 26
Practice Change	Whether there was a practice change (no=0, yes=1) in each of the following health behaviours since the previous study year (as answered by the school contact) a) healthy eating b) physical activity c) tobacco use d) alcohol and drug use	SPP (yr 2-4) Q3, 8, 13, 18, 23, 27

	e) bullying f) sedentary behaviour	
Any change	Whether there was any change [policy, practice, environment/equipment, or changes in relationships with public health] (no=0, yes=1) in each of the following health behaviours since the previous study year (as answered by the school contact) a) healthy eating b) physical activity c) tobacco use d) alcohol and drug use e) bullying f) sedentary behaviour	SPP (yr 2-4) Q2-5, 7-10, 12-15, 17-20, 22-25, 26-29

5) **School-aggregated student health behaviours**

Variable	**Description**	**Source**
% of students eating at school	% of students in a school who eat at school at least 4 days/week (responded *"eat lunch at school – lunch packed and brought from home"* or "*each lunch at school – lunch purchased in the cafeteria"* a combined frequency of "4 days" or more)	Cq (Q25c, 25d)
% of students meeting Canada's Food Guide recommendations for fruit & vegetable consumption	% of students in a school who meet the Canada's Food Guide recommendations for fruit and vegetable consumption • Meeting guideline (1): males with 8 or more servings, females with 7 or more servings[5,6]	Cq (Q28)
% of students meeting Canada's Food Guide recommendations for all food group	% of students in a school who meet the Canada's Food Guide recommendations: • Meeting guidelines (1): males (3+ meat, 8+ fruit & veg, 3+ milk, 7+ grain); females (2+ meat, 7+ fruit & veg, 3+ milk, 6+ grain) [5,7]	Cq (Q27-30)

[5] Health Canada. (2016). Canada's food guide. Retrieved from http://www.hc-sc.gc.ca/fn-an/foodguide-aliment/order-commander/index-eng.php. Accessed October 26, 2016.
[6] Leatherdale, S. T.; Harvey, A. (2015). Examining communication- and media-based recreational sedentary behaviours among Canadian youth: Results from the COMPASS study. *Preventive Medicine.* 74: 74-80.
[7] Leatherdale, S. T., & Laxer, R. E. (2013). Reliability and validity of the weight status and dietary intake measures in the COMPASS questionnaire: Are the self-reported measures of body mass index (BMI) and Canada's food guide servings robust? *Int J Behav Nutr Phys Act*. 10:42.

Variable	Description	Source
% of students meeting Canadian Physical Activity guidelines	% of students in a school who meet the Canadian Physical Activity guidelines[8]: • Meeting guidelines (1): participant indicated they had taken part in at least 60 minutes of moderate and/or vigorous physical activity on each and every day of the past week	Cq (Q10-11)
% of students that participate in non-competitive school physical activity	% of students that indicated they participated in before school, noon hour, or after-school physical activities organized by their school (e.g., intramurals, non-competitive clubs)	Cq (Q16)
% of students that are current binge drinkers	% of students that are current binge drinkers (5 or more drinks on one occasion once per month or more in the last 12 months)[9,10]	Cq (Q47)
% of students being bullied	% of students that had been bullied in the last 30 days	Cq (Q54)
% of students using marijuana	% of students using marijuana once a month or more in the last 12 months[9,10]	Cq (Q49)
% of students that are current smokers	% of students that reported ever smoking 100 cigarettes AND any smoking in the previous 30 days[11]	Cq (Q38, 40)
% of students <u>not</u> using alternative tobacco	% of students who have not had any alternative tobacco products in the past 30 days • When asked, *"In the last 30 days, did you use any of the following?" (Pipe tobacco, cigarillos/little cigars, cigars, roll-your-own, loose tobacco with marijuana, bidis* (year 1)*, e-cigarettes* (year 2-4)*, smokeless tobacco, nicotine products, hookah, blunt wraps),* student responded *"I have not used any of these products in the past 30 days"*	Cq (Q44)

[8] Canadian Society for Exercise Physiology. (2016). 24-hour movement guidelines for children and youth. Retrieved from http://www.csep.ca/en/guidelines/24-hour-movement-guidelines.

[9] Leatherdale, S. T. (2015). An examination of the co-occurrence of modifiable risk factors associated with chronic disease among youth in the COMPASS study. *Cancer Causes and Control, 26*(4), 519-528. doi:10.1007/s10552-015-0529-0

[10] Leatherdale, S. T., & Rynard, V. (2013). A cross-sectional examination of modifiable risk factors for chronic disease among a nationally representative sample of youth: Are Canadian students graduating high school with a failing grade for health? *BMC Public Health, 13*, 569. doi:10.1186/1471-2458-13-569

[11] Wong, S. L.; Shields, M.; Leatherdale, S.; Malaison, E.; Hammond, D. (2012). Assessment of validity of self-reported smoking status. Health Reports. 23(1).

% of students meeting Canadian Sedentary Behaviour guidelines	% of students meeting Canadian Sedentary Behaviour guidelines [12:] • % of students that reported less than 120 minutes of screen time per day (watching/streaming TV shows or movies, playing video games, talking on the phone, surfing the internet, texting, messaging, emailing)	Cq (Q10)
% of students who are of healthy weight	% of students categorized as healthy weight • BMI was calculated from self-reported height and weight using World Health Organization BMI cut-off points, adjusting for age and sex	Cq (Q8, 9)
% of students who drank energy drinks at least once per week	% of students that reported drinking high-energy drinks (e.g., Red Bull, Monster, Rock Star) 1-5 days in a usual school week (Monday to Friday)	Cq (Q25)

[12] Canadian Society for Exercise Physiology. (2016). 24-hour movement guidelines for children and youth. Retrieved from http://www.csep.ca/en/guidelines/24-hour-movement-guidelines.

Appendix B. Knowledge Broker Interview Guide.

Construct	Question	Probes
Introduction	Tell me about yourself.	-Education -Role on COMPASS team -Research experience -Interest in school health
Knowledge translation and knowledge brokering	What does knowledge brokering mean to you? In your opinion, how does knowledge brokering differ from "knowledge translation"?	
Experience as a knowledge broker	Tell me about your role as a COMPASS knowledge broker. In your opinion, what skills are required to be a knowledge broker?	-How long have you been working as a knowledge broker with COMPASS? -How many schools have you worked with? Can you tell me about your experience working with these schools? -What training did you receive to become a knowledge broker? -Do you have other knowledge brokering experience?
Facilitators and challenges of knowledge brokering	What factors have helped you in your role as a knowledge broker? What challenges have you faced as a knowledge broker?	-Personnel? Resources? Previous experience? -How have you dealt with these challenges? -How could these challenges be mitigated?
Perceived outcomes for research team	How has knowledge brokering (as part of COMPASS) influenced your work and/or research? In your opinion, how has knowledge brokering influenced the COMPASS project/team?	-Positive? Negative? -Current research interests? -Future research interests? -Positive? Negative? -Current research interests? -Future research interests?
Facilitators and barriers to school participation in knowledge brokering	In your opinion, what factors influence schools' participation in knowledge brokering?	-Initial/ongoing participation? -Facilitators? Barriers? -Time? Priority of health?

Perceived outcomes for schools	How has knowledge brokering influenced COMPASS schools in your view? What impacts do you think knowledge brokering has on COMPASS schools?	-Process? Outcomes? -School policy/practice changes? -Linking to resources? Partners? -Increased knowledge? Prioritizing health? -Student health behaviours? Positive? Negative? Changes over time?
	How has the School Health Profile influenced COMPASS schools in your view? What impacts do you think the School Health Profile has on COMPASS schools?	-School policy/practice changes? -Linking to resources? Partners? -Increased knowledge? Prioritizing health? -Student health behaviours? Positive? Negative? Changes over time? -Has this changed over time?
	What health outcomes do you discuss most often with schools?	-What outcomes do you think you should be discussing with schools?
	Do you think knowledge brokering has worked better in some schools than others? Why do you think that is?	-Characteristics of schools that benefit? -Characteristics of schools that benefit less?
Suggestions	If COMPASS was starting again, what would you do differently with respect to knowledge brokering? If you were going to start your own study similar to COMPASS, how would you design the knowledge brokering piece? In your opinion, what would the ideal knowledge brokering system look like for school health research? What advice would you give someone starting as a knowledge broker in school health?	-Current study? Future studies? -Resources? Alternative methods? Data collection/management practices? -Communication of knowledge brokering to schools?
	Five years from now, how would you know the School Health Profile and knowledge brokering were a success? What would failure look like?	-Outcomes? Indicators?

Discussion	Is there anything else you'd like to add that we haven't talked about? Is there anything you'd like to ask schools and public health units about knowledge brokering, the School Health Profile, or their participation in COMPASS? Do you have any questions for me?

Appendix C. COMPASS Staff Interview Guide.

Construct	Question	Probe
Introduction	Tell me about yourself.	-Education, research experience -Interest in school health -Role in COMPASS study
Knowledge translation and knowledge brokering (KB)	What does knowledge brokering mean to you? In your opinion, how does knowledge brokering differ from "knowledge translation"? Do you have any experience with knowledge translation or knowledge brokering?	 -Previous experience working with stakeholders in research process? -If yes, how did you find this experience? Can you tell me about it?
COMPASS knowledge brokering	Tell me about the knowledge brokering component of COMPASS. -Did you have a role in conceptualizing knowledge brokering in COMPASS? What do you perceive the role of knowledge brokering to be in the COMPASS study? In your opinion, what skills are required to be a knowledge broker?	-How does your role relate to the knowledge translation components of COMPASS (KB & SHP)? -Intended role at beginning of study? -Has that role changed over time? -Current role?
Facilitators and challenges of knowledge brokering	From your experience in the COMPASS study, what factors do you think influence knowledge brokering? -What factors have helped the KBs in their roles? From your experience in the COMPASS study, what are the challenges related to knowledge brokering?	-Personnel? Resources? Previous experience? External factors? -Facilitators? Barriers? -All stages of research process -How have you dealt with these challenges? -How could these challenges be mitigated?
Perceived outcomes for research team	What impacts do you think knowledge brokering could have in the COMPASS study? Do you think this has happened? Why or why not? How has knowledge brokering (as part of COMPASS) influenced your work and/or research? In your opinion, how has knowledge	-Positive? Negative? -Positive? Negative? -Current research interests? -Future research interests?

	brokering influenced the COMPASS project/team?	
Facilitators & barriers to school participation in KB	What factors do you think influence schools' participation in knowledge brokering?	-Initial participation? -Ongoing participation? -Facilitators? Barriers?
Perceived outcomes for schools	What impacts do you think the School Health Profile has on COMPASS schools? What impacts do you think knowledge brokering has on COMPASS schools?	-School policy/practice changes? -Linking to resources? Partners? -Increased knowledge? -Prioritizing health? -Student health behaviours? -Positive? Negative? -Any changes over time?
Suggestions	If COMPASS was starting again, what would you do differently with respect to knowledge brokering? If you were going to start your own study similar to COMPASS, how would you design the knowledge brokering piece? In your opinion, what would the ideal knowledge brokering system look like for school health research? What advice would you give someone starting as a knowledge broker in school health? Five years from now, how would you know the School Health Profile and knowledge brokering were a success? What would failure look like?	-Current study? Future studies? -Resources? Alternative methods? Data collection/management practices? -Communication of knowledge brokering to schools? -Outcomes? Indicators?
Discussion	If there anything else you'd like to add that we haven't talked about? Is there anything you'd like to ask schools and public health units about knowledge brokering, the School Health Profile, or their participation in COMPASS? Do you have any questions for me?	

Appendix D. Co-Investigator Interview Guide.

Construct	Question	Probe
Introduction	Tell me about yourself.	-Research experience -Interest in school health
Knowledge translation and knowledge brokering (KB)	What does "knowledge translation" mean to you? In your opinion, how does "knowledge brokering" differ from "knowledge translation"? Do you have any experience with knowledge translation or knowledge brokering?	 -Previous experience working with stakeholders in research process? -If yes: how did you find this experience? Can you tell me about it?
Experience with COMPASS	Tell me about your role in the COMPASS study. What do you know (or remember) about the knowledge translation component of COMPASS? What do you perceive the role of knowledge brokering to be in the COMPASS study?	 -KB? SHP? -How does your role relate to the knowledge translation components of COMPASS (KB & SHP)? -Intended role at beginning of study? Current role? -Has that role changed over time?
Perceived outcomes	What impacts do you think the School Health Profile could have in the COMPASS study? Do you think this has happened? Why or why not? What impacts do you think knowledge brokering could have in the COMPASS study? Do you think this has happened? Why or why not?	-Positive? Negative? -Schools? Researchers? -Positive? Negative? -Schools? Researchers?
Suggestions	If you were going to start your own school health study similar to COMPASS, how would you design the knowledge brokering piece? In your opinion, what would the ideal knowledge brokering system look like for school health research? Five years from now, how would you know the School Health Profile and knowledge brokering were a success? What would failure look like?	
Discussion	Is there anything else you'd like to add that we haven't talked about? Is there anything you'd like to ask schools and public health units about knowledge brokering, the School Health Profile, or their participation in COMPASS? Do you have any questions for me?	

Appendix E. School Staff Interview Guide.

Construct	Question	Probes
Introduction	Tell me about yourself and your experience in education.	-Experience as principal/VP/teacher -Grades within the school (i.e., 7-12, 9-12?) -How many years at current school? -Do you have any training in health and/or physical education? -During which school year did you become involved with the COMPASS study?
Educational context and COMPASS experience	Tell me about your school. For you, where does student health rank among other priorities? Overall, how has your experience been participating in COMPASS?	-What challenges do you face in your school? -For the school? For parents? For your school board? WHY?
School Health Profile	*Each year, you received a COMPASS School Health Profile (SHP), a booklet summarizing your students' health behaviours.*	
	Do you remember receiving your school's SHP? Did you read it?	-Who did you share the SHP with (e.g., staff, parent councils, school board, public health)? -If not, why not?
	Did your school find the information in the SHP helpful? How so?	-What was the most interesting thing/trend you learned from the SHP? -Did it provide any information you didn't know? -If not, why not? -Was there anything you were expecting to see that you didn't see?
	There was a variety of information in the SHP. What specific information in the SHP did you find useful? Why?	-Student health behaviours? School connectedness? Academic outcomes? Prevalence by gender? Recommended interventions? Comparison to previous year's findings? Grade breakdown?
	Did your school use the information from the SHP?	-How did you use it? If not, why not? -Did it inform any changes in your school (e.g., policies, curricular and extracurricular programming)? Provide evidence for funding applications? Examples?
	What other health behaviours do you think should be included in the COMPASS survey and SHP?	

Construct	Question	Probes
School Health Profile (cont.)	What changes would make the SHP more useful for your school? Is there anything else you'd like to share about the SHP?	
Knowledge brokering (KB)	Are you familiar with the term "knowledge broker"? What does "knowledge broker" mean to you in the context of the COMPASS study? Do you remember communicating with a knowledge broker?	After 2nd Q: *As part of the COMPASS study, you were contacted by a COMPASS researcher (knowledge broker) each year. The knowledge broker's role was to answer any questions you had related to the School Health Profile, connect you to public health and community resources, and help you implement health-related changes at your school.*
• *Schools that participated in KB*	Why did you choose to communicate with the knowledge broker? Did you find communicating with the knowledge broker helpful? How so? What outcomes did communicating with the knowledge broker have for your school? →Did it lead to "action" in your school? Would your experience with the COMPASS study have been different if there wasn't a knowledge brokering component? How so? Did you face any challenges communicating with the knowledge broker? What changes would make COMPASS knowledge brokering more useful for your school?	-What were your **expectations** for knowledge brokering? Did the KBs meet those expectations? -Increased understanding? Setting priorities? Accessing resources? -If not, why not? -Positive? Negative? -Policy/program changes in the school? -Research/public health/community partnerships? -If none, why do you think that is? -Availability? Scheduling? Communication method? How could these be mitigated? -What would make the KB process easier? -What's the best way to connect with school contacts? -What would you like the KB role to be? What would you like the KB to do? -What would help you make changes related to student health in your school? -Are there any opportunities we missed? Who should we have been

	Some schools didn't participate in knowledge brokering – why do you think that might be?	talking to that we didn't?
• *Schools that did NOT participate in KB*	Why did you choose not to communicate with the knowledge broker? Is there anything that COMPASS could change so that you would use the knowledge broker as a resource?	-Availability? Scheduling? Communication method? -What would help you make changes related to student health in your school?
COMPASS Participation	What outcomes do you think participating in COMPASS has had for your school? If the COMPASS study was to continue, do you have any suggestions for change?	-Increased priority for health? More health programming? Any negative outcomes? -Do you think anyone noticed a difference in your school because of COMPASS? How/What/Who? Students?
	Is there anything else you would like to share about the COMPASS study, the School Health Profile, or knowledge brokering?	

Appendix F. Public Health Staff Interview Guide.

Construct	Question	Probes
Introduction	Tell me about yourself.	-Experience in public health – what's your position? How many years? -During which school year did you become involved with the COMPASS study?
Educational context	Can you explain to me how your work intersects with schools?	-How many schools do you work with? What's the nature of your work with schools? -In your opinion, where does school & student health rank among other priorities for your health unit?
	Can you tell me about your relationship with <COMPASS school(s)>?	-Did you work with this/these school(s) before they became involved in the COMPASS study?
	Can you tell me about <COMPASS school(s)>?	-In your opinion, what are the main challenges this/these school(s) face(s)? -In this/these school(s), where does health rank among other priorities, in your opinion?
School Health Profile	*Each year, schools participating in the COMPASS study received a School Health Profile (SHP) summarizing their students' health behaviours.*	
	Were you provided with access to the SHP for <COMPASS school(s)>?	-Did you read it? Did you share it with your staff? -If not, did you ask to see it? Would you be interested in seeing this document? *<skip to KB qs>*
	Did your public health unit find the information in the SHP helpful?	-Did it provide any information you didn't know? -If not, why not? -What was the most interesting thing/trend you learned from the SHP? -Was there anything you were expecting to see that you didn't see?
	What specific information in the SHP did you find useful? Why (not)?	-Student health behaviours? School connectedness? Academic outcomes? Prevalence by gender? Recommended interventions? Comparison to previous year's findings?
	Did your health unit use the information from the SHP?	-How? Did it influence your public health unit's support or programming to the corresponding school(s)? -If not, why not?
	In your opinion, what other health behaviours should be included in the COMPASS survey and SHP?	

	What changes would make the SHP more useful for your health unit?	
	Is there anything else you'd like to share about the SHP?	