UNDERSTANDING THE PHENOMENON OF EARLY CHILDHOOD CARIES IN RURAL AND REMOTE CHILDREN IN NORTHERN SASKATCHEWAN: A REALIST SYNTHESIS

A Thesis Submitted to the
College of Graduate and Postdoctoral Studies
In Partial Fulfillment of the Requirements
For the Degree of Master of Science
In the Department of Community Health and Epidemiology
University of Saskatchewan
Saskatoon

By

Maniza Abedin Chowdhury

© Copyright Maniza Abedin Chowdhury, August, 2023. All rights reserved.
Unless otherwise noted, copyright of the material in this thesis belongs to the author
PERMISSION TO USE

In presenting this thesis/dissertation in partial fulfillment of the requirements for a Postgraduate degree from the University of Saskatchewan, I agree that the Libraries of this University may make it freely available for inspection. I further agree that permission for copying of this thesis/dissertation in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis/dissertation work or, in their absence, by the Head of the Department or the Dean of the College in which my thesis work was done. It is understood that any copying or publication or use of this thesis/dissertation or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of Saskatchewan in any scholarly use which may be made of any material in my thesis/dissertation.

Requests for permission to copy or to make other uses of materials in this thesis/dissertation in whole or part should be addressed to:

Head of the Community Health & Epidemiology Department
Health Sciences Building E-Wing, 104 Clinic Place
University of Saskatchewan
Saskatoon, Saskatchewan S7N 2Z4 Canada

OR

Dean
College of Graduate and Postdoctoral Studies
University of Saskatchewan
116 Thorvaldson Building, 110 Science Place
Saskatoon, Saskatchewan S7N 5C9 Canada
ABSTRACT

Early childhood caries in preschool children is a growing public health concern in Canada. Children in Northern Saskatchewan experience poor oral health outcomes compared to those in the southern regions of the province (Inam, 2021; Saskatchewan Health Authority Oral Health Program, n.d.). Despite various efforts by the government and non-governmental organizations to address this problem, the situation is still a major public health concern. This study aims to understand the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan. While initially appearing as a straightforward phenomenon, it is, in fact, a complex systemic phenomenon. Therefore, this study employs a systems approach to realism to understand its complexity. Based on realist philosophy, I used realist synthesis, a theory-driven process that synthesizes evidence and aims to create a generative explanation for causation - that is, an outcome (O) of interest was generated by relevant mechanism(s) (M) being triggered in various contexts (C). This study followed six iterative steps, including 1. initial program theory, 2. search strategy, 3. the selection and appraisal of documents, 4. data extraction, 5. analysis and synthesis of data, and 6. the dissemination of results. Through the iterative process of searching and data analysis, this realist synthesis developed an initial program theory, identified some potential mechanisms (parents’ perceived values, prioritization and beliefs, self-efficacy, stress, depression, trust, anxiety, fear of being judged, and losing their child to social service, perceived food value, effects of colonialism in their beliefs, confidence, and empowerment) at the individual and community levels, and designed a multilayer conceptual map showing a hierarchy of different level mechanisms, and their interactions with each other in influencing the existence of early childhood caries in rural and remote children in Northern Saskatchewan based on available data. The mechanisms identified and hypothesized in this realist synthesis are based on
secondary data that will need to be tested with the community in future research aimed to refine or refute this initial program theory.

*Keywords:* Early childhood caries, rural and remote children, Northern Saskatchewan, realist synthesis.
ACKNOWLEDGEMENTS

I want to begin by expressing my heartfelt gratitude to Allah, the Almighty, for granting me the strength and opportunity to complete this thesis.

I would like to sincerely thank my supervisor, Dr. Gary Groot. I am incredibly thankful to him for his inspiring supervision, encouragement, and constructive feedback throughout my MSc program, which enabled me to make the most of this experience.

My sincere appreciation goes to my thesis committee members, Dr. Valery Chirkov and Dr. Jessica Lieffers, for their expertise, support, insightful comments, and valuable contributions to my thesis. I would also like to acknowledge Dr. Tracey Carr for her enthusiastic mentorship that guided me on this journey. I am grateful to Stephanie Kehrig and all the members of the Community Health and Epidemiology department for their continuous support throughout my program.

I am forever grateful to my beloved parents, Md. Khoirul Abedin Chowdhury and Rasheda Akther Khanom, for their unwavering support, prayers, and love. Their belief in me and constant presence in every step of my life have been fundamental to my achievements. Without their blessings, I would not have reached this milestone. I would also like to thank Irtiza, Muntakim, and my father-in-law for their love and support.

A heartfelt acknowledgement goes to my husband, T. M. Rezwanul Islam, for being my constant support and pillar of strength throughout my research journey. His unwavering faith in my abilities has been a driving force, helping me overcome hurdles and self-doubt. His support has lifted me to reach beyond my limits.
DEDICATION

To my lovely daughter Rose and my dear mother Rosie
# TABLE OF CONTENTS

ABSTRACT ................................................................................................................................. ii  
ACKNOWLEDGEMENTS ........................................................................................................ iv  
LIST OF FIGURES .................................................................................................................. ix  
LIST OF TABLES ..................................................................................................................... x  
CHAPTER ONE ......................................................................................................................... 1  
  1.1: Background .................................................................................................................. 1  
  1.2: Rationale for this Research ......................................................................................... 3  
  1.3: Systems Thinking in My Current Project ................................................................. 5  
  1.4: Purpose of the Study ................................................................................................. 9  
  1.5: Research Questions .................................................................................................. 9  
  1.6: Approach .................................................................................................................. 10  
  1.7: Introduction to the Researcher .................................................................................. 10  
  1.8: Understanding Rural and Remote Areas in Northern Saskatchewan including the Importance of the Indigenous Context ......................................................................................................................... 11  
    1.8.1: Definition of Rural and Remote Area .............................................................. 11  
    1.8.2: Geographic and Demographic Features of Northern Saskatchewan .......... 12  
    1.8.3: Plan for Engaging with Indigenous Communities Following this Initial Work ........................................................................................................................................................................... 13  
  1.9: Definition of Terms .................................................................................................... 14  
  1.10: Chapter Summary .................................................................................................... 18  
CHAPTER TWO ........................................................................................................................ 19  
  2.1: Literature Review ....................................................................................................... 19  
    2.1.1: Biological Level ................................................................................................. 19  
    2.1.2: Family/Individual Level .................................................................................. 24  
    2.1.3: Community Level ............................................................................................. 28
2.1.4: Policy Level.................................................................33
2.1.5: Societal Level...............................................................37
2.2: Chapter Summary.............................................................40

CHAPTER THREE........................................................................42
3.1: Philosophical Framework..................................................42
  3.1.1: Realism........................................................................42
    3.1.1a: Realist ontology....................................................42
    3.1.1b: Realist epistemology.............................................43
    3.1.1c: Mechanism............................................................45
  3.1.2: History of Realism......................................................48
  3.1.3: Critical Realism and Scientific Realism..........................49
  3.1.4: Systems Thinking......................................................51
  3.2: Chapter Summary.............................................................56

CHAPTER FOUR..........................................................................57
4.1: Analytical Framework......................................................57
  4.1.1: Realist Synthesis.........................................................58
    4.1.1a: Context..................................................................59
    4.1.1b: Mechanism............................................................60
    4.1.1c: Outcome...............................................................60
  4.1.2: Realist Synthesis Steps................................................64
  4.2: Chapter Summary.............................................................69

CHAPTER FIVE............................................................................70
5.1: Methods.............................................................................70
  5.1.1: Initial Program Theory (Step 1)....................................70
  5.1.2: Search Strategy (Step 2).............................................71
  5.1.3: Selection and Appraisal of Documents (Step 3)................79
  5.1.4: Data Extraction (Step 4).............................................80
5.1.5: Analysis and Synthesis of Data (Step 5) .................................................. 81

5.2: Ethical Consideration ..................................................................................... 82

5.3: Chapter Summary .......................................................................................... 82

CHAPTER SIX ........................................................................................................ 83

6.1: Results ............................................................................................................. 83

6.1.1: Initial Program Theory Development ....................................................... 83

6.1.2: Search Results, Selection, Data Extraction and Analysis and Synthesis of Data ......................................................................................................................... 83

6.1.3: Findings ........................................................................................................ 86

6.1.3a: Oral hygiene ............................................................................................... 87

6.1.3b: Diet ............................................................................................................. 113

6.1.3c: Colonization of bacteria ........................................................................... 122

6.1.4: Identification of Substantive Theory ........................................................ 136

6.2: Chapter Summary .......................................................................................... 140

CHAPTER SEVEN ................................................................................................... 142

7.1: Discussion ....................................................................................................... 142

7.1.1: Significance ................................................................................................. 147

7.1.2: Limitations .................................................................................................. 150

7.1.3: Future Directions ......................................................................................... 151

7.1.4: Comparisons with Current Literature ..................................................... 152

7.2: Chapter Summary .......................................................................................... 154

REFERENCES ....................................................................................................... 155

APPENDIX A ......................................................................................................... 196

APPENDIX B ......................................................................................................... 200
LIST OF FIGURES

Figure 1.1: Systemic nature of the phenomenon of early childhood caries.................................08
Figure 2.1: Key triads of dental caries .....................................................................................20
Figure 4.1: Six steps process of conducting a realist synthesis .........................................................68
Figure 6.1: Documents screening flowchart..................................................................................85
Figure 6.2: CMO configurations for early childhood caries ..............................................................86
Figure 6.3: Key mechanisms identified for regular teeth brushing...................................................89
Figure 6.4: Key mechanisms identified for a regular dental visit......................................................99
Figure 6.5: Key mechanisms identified for the community water fluoridation .........................109
Figure 6.6: Key mechanisms identified for parents' decision to buy non-perishable processed foods, sugary drinks, and snacks .................................................................114
Figure 6.7: Key mechanisms identified for parents' low breastfeeding tendency ....................119
Figure 6.8: Key mechanisms identified for the early colonization of bacteria .........................124
Figure 6.9: Key mechanisms related to developmental dental defects .......................................134
Figure 7.1: Connection of mechanisms for regular teeth brushing.............................................144
Figure 7.2: Connection of mechanisms for a regular prenatal dental visit ......................................146
Figure A.1: Initial program theory...............................................................................................200
**LIST OF TABLES**

Table 4.1: Realist review, Systematic review, and Meta-narrative review comparison .......... 62
Table 4.2: List of publication standards for realist reviews by RAMESES. .................. 65
Table 5.1: Individual level search terms and queries for academic literature, theses and dissertations. ................................................................. 72
Table 5.2: Individual level search terms and queries for grey literature .................. 72
Table 5.3: Individual level hand search terms and queries for grey literature ........... 73
Table 5.4: Community level search terms and queries for academic literature, theses and dissertations. .................................................................................. 74
Table 5.5: Community level search terms and queries for grey literature .............. 75
Table 5.6: Community level hand search terms and queries for grey literature ....... 75
Table 5.7: Policy and societal level search terms and queries for academic literature, theses, and dissertations. ...................................................... 76
Table 5.8: Policy and societal level search terms and queries for grey literature ..... 77
Table 5.9: Policy and societal level hand search terms and queries for grey literature .. 78
Table 6.1: Key mechanisms and detailed CMO related to oral health knowledge and instructions. ......................................................................................... 90
Table 6.2: Key mechanisms and detailed CMO related to regular teeth brushing ....... 92
Table 6.3: Key mechanisms and detailed CMO related to regular dental visit .......... 99
Table 6.4: Key mechanisms and detailed CMO related to the availability of dental professionals in a remote area ................................................................. 104
Table 6.5: Key mechanisms and detailed CMO related to run water fluoridation in the community ......................................................................................... 110
Table 6.6: Key mechanisms and detailed CMO related to parents' decision to buy non-perishable processed foods, sugary drinks and snacks ......................... 115
Table 6.7: Key mechanisms and detailed CMO related to parents' low breastfeeding tendency. .................................................................................................. 120
Table 6.8: Key mechanisms and detailed CMO related to regular prenatal dental visit ...... 124
Table 6.9: Key mechanisms and detailed CMO related to the early colonization of bacteria. .. 132
Table 6.10: Key mechanisms and detailed CMO related to developmental dental defects. ...... 134
Table 6.11: Identified substantive theories................................................................. 138
Table A.1: Final Included Documents................................................................. 196
CHAPTER ONE

1.1: Background

Dental caries – the most common chronic disease in children worldwide – is a significant public health concern that affects children’s oral and general health (Çolak, Dülgergil, Dalli, & Hamidi, 2013; World Health Organization, 2019). The presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a preschool-age child, (i.e., between birth and 71 months of age) is called early childhood caries (Department of Scientific Information, Evidence Synthesis & Translation Research, ADA Science & Research Institute, LLC, 2021). The worldwide prevalence of early childhood caries stands at approximately 48% (Uribe, Innes, & Maldupa, 2021). Unaddressed early childhood caries that are associated with infection can cause pain and discomfort, affecting children’s quality of life and food intake, and it can sometimes cause a life-threatening condition (“Early childhood caries”, n.d.; Hibberd & Nguyen, 2012; Kleiss, 2015; Owings, 2007).

A severe dental infection that went untreated caused a nine-year-old girl from Alberta, Canada, to experience malnutrition, respiratory failure, congestive heart failure, and septic shock (Kleiss, 2015). Before facing these health issues, this child and her family endured constant hardship because of their severe poverty, with most of their meals coming from food banks. The young child complained to her parents about her dental pain. In response, her parents provided her with painkillers rather than taking her to the dentist. Unfortunately, within a month, the girl was taken to the Emergency Room with life-threatening conditions. She underwent emergency
surgery at the Alberta Children’s Hospital and spent the next two months recovering. The girl survived but needed plastic surgery (Kleiss, 2015). There is a concern that she may experience physical and mental health issues in the long run (Stanzel & Sierau, 2022).

Early childhood caries accounts for around one-third of all-day surgeries performed on Canadian children aged 1 to 5 years. In addition, it is the most common reason for day surgery in this age group (Canadian Dental Association, 2017). Addressing oral health issues is particularly relevant in Saskatchewan, where early childhood caries-related day surgery among children aged 1 to younger than 5 years was 35 per 1,000 children between 2010 and 2012. In Northern Saskatchewan, the rate was far higher (132.9 per 1,000 children in the Mamawetan Churchill River Health Region and 227.4 per 1,000 children in the Athabasca Health Region) (Canadian Institute for Health Information, 2013). Also, children living in Northern Saskatchewan experience significantly worse oral health outcomes compared to their counterparts in the southern regions of the province (Inam, 2021; Saskatchewan Health Authority Oral Health Program, n.d.)

In Saskatchewan, $3.4 million is spent annually to treat early childhood caries (Jafari, 2015). This is simply the hospital-related cost, which is just the tip of the iceberg because data on the expenses of care providers like dental surgeons and anesthesiologists are not readily available (Schroth, Quiñonez, Shwart, & Wagar, 2016). Moreover, children from rural and remote areas need to travel long distances to a more central location, often by airplane, to have these dental surgeries performed, which adds additional costs (Indigenous Services Canada, n.d.; Schroth et al., 2016). Children undergoing dental surgery under general anesthesia in a hospital setting may endure anxiety, and their families may also suffer financial and emotional strain (Baghdadi, Jbara, & Muhajarine, 2021).
Several Canadian researchers have identified the risk factors related to early childhood caries in Canada. These risk factors include age, sex, race, urban vs. rural settings, socioeconomic status, parental attitudes, parental level of education, family characteristics, maternal dental health, and infant feeding patterns (Pierce et al., 2019; Tiberia et al., 2007). With consideration of these risk factors, there are associated mechanisms related to the geographic location and diverse population in Northern Saskatchewan that may have a connection to the existence of early childhood caries in that region. These mechanisms need to be understood and explored. In the rest of this paper, I work to understand, explore and hypothesize some potential mechanisms of the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan, based on the available data.

1.2: Rationale for this Research

There is an old proverb that states, “Prevention is better than cure.” This proverb emphasizes the importance of taking preventive measures to avoid illnesses before they develop (“Prevention is better than cure”, n.d.). Prevention of early childhood caries can help reduce the burden of this disease on children, families and the healthcare system (“Early childhood caries”, n.d.). There is a significant association between early childhood caries and the development of caries in permanent dentition (Lam, Chua, Ekambararam, Lo, & Yiu, 2022). Therefore, focusing on the prevention and treatment of early childhood caries in young children is crucial to reducing the risk of oral health problems later in life. Poor oral health can affect their overall health and quality of life, as well as their ability to learn, grow, and thrive (“Early childhood caries”, n.d.; “FDI’s definition of oral health”, n.d.; Petersen, 2003). By focusing on preventing early childhood caries, we can help promote long-term good oral health and well-being for children.
The Ministry of Health and the Saskatchewan Health Authority (SHA) have established three public dental care programs in Saskatchewan that target early childhood caries. These programs include the Enhanced Preventive Dental Services program, additional dental programs offered by the Saskatchewan Health Authority, and the Children's Oral Health Initiative (COHI) (Farmer et al., 2022; “Oral health program”, n.d.; Saskatchewan Oral Health Coalition, 2016). The Enhanced Preventive Dental Services program run by the Ministry of Health offers coverage to children aged 5 and under, as well as children in grades 1, 2, 7, and 8 who have been identified as high risk. This program is designed to provide various dental services, including oral health assessments, referrals and follow-up care, fluoride varnish, dental sealants, and dental health consultations for pre-and post-natal mothers who are considered high-risk (Farmer et al., 2022; Saskatchewan Oral Health Coalition, 2016). The Saskatchewan Health Authority also operates several dental programs targeting different groups, including children aged 0-16 years, pregnant women, vulnerable adults, and long-term care residents. These programs provide dental health education, diagnostic, preventive, and restorative dental services, as well as referral services. They also offer treatments such as silver diamine fluoride and atraumatic restorative treatment (Farmer et al., 2022; “Oral health program”, n.d.). In 2017, the merging of 12 regional health authorities of Saskatchewan led to the creation of the Saskatchewan Health Authority (SHA), while the Athabasca Health Authority remains separate (Farmer et al., 2022). Athabasca Health Authority runs another dental program named Children’s Oral Health Initiative (COHI). This program is administered across many Indigenous communities, involves a community member serving as an aide selected and hired by the community to support dental service providers (dentists, dental hygienists, and dental therapists). The program focuses on providing dental care to children aged 0 to 7 years, their caregivers, and pregnant women who live on-reserve or access
on-reserve resources. In addition, the program covers all school-aged children between the ages of 4 to 16 years old (grades Pre-K to 7). Dental services offered to school-aged children include a brushing program, a fluoride varnish program, one-on-one oral health education, and basic dental treatments (Farmer et al., 2022; “Children's Oral Health Initiative”, n.d.). In 2004, only six Indigenous communities in Saskatchewan participated in the Children’s Oral Health Initiative (COHI) program. However, by 2014, the number of Indigenous communities in Saskatchewan participating in the program had significantly increased to 42 (Mathu-Muju, McLeod, Walker, Chartier, & Harrison, 2016). Despite the implementation of the above-mentioned initiatives to prevent early childhood caries, according to The Children’s Oral Health in Saskatchewan Report for 2018-19 (Saskatchewan Health Authority Oral Health Program, n.d.), grade one students in the northern region of the province continue to experience poor oral health outcomes. This raises the question of why the phenomenon of early childhood caries that exists in rural and remote children in Northern Saskatchewan is so hard to address. This motivated me to dig deeper into this issue and explore the underlying mechanisms of this phenomenon from a system-thinking perspective which emphasizes the importance of understanding the system as a whole rather than just individual parts of it. It involves analyzing how the interactions and dynamics among different components of the system impact the overall behaviour of the system (Mingers & White, 2010).

1.3: Systems Thinking in My Current Project

To understand the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan, I started with the biological level. The biological mechanisms related to early childhood caries are bacteria, diet, and poor oral hygiene (Keyes & Jordan, 1963). Then it
came into my mind to question what causes those biological mechanisms to be activated (or triggered)? I focused on diet first and found how poor diet can cause dental caries. Then I tried to uncover the mechanism linked to the problem of poor diet in children residing in the rural and remote areas in Northern Saskatchewan. Also, what is the context that triggers this mechanism? Initially, I found some potential answers in different pieces of literature, such as the high cost of living expenses in remote areas, the lack of availability of healthy food, and food insecurity. These issues force parents to choose less healthy options (store-bought processed foods, a high proportion of sugar-containing snacks and cariogenic liquids) because those foods are far more affordable than healthier options (“Household food insecurity in Canada: Overview”, n.d.; Socha, Zahaf, Chambers, Abraham, & Fiddler, 2012). Then, why is food so expensive in Northern Saskatchewan? I found that there are issues related to transportation and the government’s food policy (policy level). For example, there is a low budget allocated for the maintenance and construction of Northern Saskatchewan roads, and fewer benefits received from the Nutrition North program (a Government of Canada program that helps make nutritious food and some essential items more affordable and more accessible) in Northern Saskatchewan than other Northern Canadian communities (“Position on the future of liquor retailing in Saskatchewan”, 2015). Access to healthy food is a huge problem for people residing in remote communities, regardless of whether one is Indigenous or not. It's important to note that Indigenous Peoples are the original inhabitants of Canada, comprises all First Nations, Inuit, and Métis people of Canada, each with distinct histories, cultures, languages, and spiritual beliefs (“Indigenous peoples and communities”, n.d.; Parrott, 2023). While remoteness is the primary issue, it's essential to acknowledge that in Northern Saskatchewan, where around 85% of the population are Indigenous Peoples, being an Indigenous child can add another layer of
complexity due to the impact of colonization (Irvine & Quinn, 2016; Statistics Canada, 2017; Tait, Butt, Henry, & Bland, 2017). As a non-Indigenous person, I recognize that it is not within my capacity to understand and fully comprehend the unique challenges faced by Indigenous Peoples. However, in my efforts to understand the complexity of the problem, I tried to explore why many Indigenous Peoples live in remote communities in the first place, and from the literature, I found the potential answer at the next level (societal level). From the literature, I found colonization forced Indigenous Peoples to live on reserves located in remote areas. The colonizers restrict them from farming and traditional hunting by limiting access to the land and hunting territories (Gilmore, 2016). Literature suggests that having their traditional diet disrupted and the belief brought by colonization that their traditional food was not good enough could have driven some Indigenous parents to rely on store-bought highly processed foods, which, in turn, may contribute to the development of dental caries.

Due to the COVID-19 pandemic and the resulting travel restrictions, I was unable to visit Northern Saskatchewan and directly engage with the communities living there. As a non-Indigenous individual, I am fully aware that, I cannot speak for the complexity of important mechanisms that only Indigenous Peoples know. The Indigenous-specific mechanisms that I hypothesized related to early childhood caries came from my understanding of what I found in the literature. These mechanisms need to be further developed with community consultation. However, the available existing data from the literature helped me to understand that the problem of early childhood caries in Northern Saskatchewan as a complex phenomenon.
In summary, I started exploring from the biological level, where I found one of the biological mechanisms of dental caries is poor diet. Then I tried to unpack the mechanism of why rural and remote children in Northern Saskatchewan have a poor diet and what is the context that triggers this mechanism. While trying to unpack the mechanisms of early childhood caries in rural and remote children in Northern Saskatchewan, I found that different mechanisms exist at different levels (individual, community, policy and societal). Those mechanisms interact with each other. In addition, the outcome of the higher level (for example, the societal level) can act as a context and trigger mechanism in the lower level (for example, the individual level) to
shape the phenomenon of early childhood caries. Mingers (2014) described the hierarchical nature of these mechanisms as: “nesting of systems within systems” (p. 31) (Mingers, 2014). To effectively tackle a complex system issue such as the phenomenon of early childhood caries and, in turn, to develop successful interventions in the future, we must first have a comprehensive understanding of the hierarchical structure of systems within systems, as well as the interconnections and interdependencies among the various levels of the system. In recognition of the systemic nature of the phenomenon of early childhood caries, I aimed to identify and hypothesize the potential mechanisms at the individual and community levels that influence early childhood caries in rural and remote children in Northern Saskatchewan.

1.4: Purpose of the Study

This study’s purpose is to understand the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan. By developing a multilayer conceptual map that presents a hierarchy of different-level mechanisms and their interactions with each other that influence early childhood caries in rural and remote children in Northern Saskatchewan, this study aims to present the complexity of the problem.

1.5: Research Questions

The following research questions guide this study:

1. What are the contexts and mechanisms at the individual and community levels that influence early childhood caries in rural and remote children in Northern Saskatchewan?
2. What causal initial mid-range theories can be developed?

1.6: Approach

To understand the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan, in this realist synthesis, I applied a systemic realist approach. Details about realism and systems thinking are discussed in chapter three.

1.7: Introduction to the Researcher

As a dentist from Bangladesh, my clinical experience working with children suffering from early childhood caries has left a lasting impression on me. Witnessing the pain and suffering these young children endure has instilled in me a deep commitment to prevent this issue rather than just treating it. This personal dedication is what motivates me to focus on early childhood caries.

When I moved to Canada, I learned from various literature and news sources that many rural children in this vast and diverse country face significant problems with dental caries. Living in Saskatchewan, I came across literature that highlighted the poor oral health conditions of rural and remote children in Northern Saskatchewan, igniting an even stronger passion for conducting research in the realm of early childhood caries.

Growing up, I had the opportunity to interact with people from diverse backgrounds. Also, when I started working as an intern doctor in a government hospital, I had the chance to interact with socioeconomically diverse patients and monitor their health status. This experience
has developed a profound appreciation in me for different traditions and perspectives. This serves as a driving force behind my research endeavours, motivating me to address the issue of early childhood caries within the diverse communities of rural and remote areas in Northern Saskatchewan.

What interests me most about this research is the opportunity to make a positive impact on the oral health of children, particularly those residing in rural and remote areas. By doing so, I can contribute to the long-term well-being and oral health of these children, so that they can enjoy brighter, healthier smiles for years to come.

1.8: Understanding Rural and Remote Areas in Northern Saskatchewan including the Importance of the Indigenous Context

1.8.1: Definition of Rural and Remote Area

Rural areas encompass all regions located outside of population centres (a population centre is an area with population of at least 1,000 residents and a population density of 400 individuals or greater per square kilometer) (Statistics Canada, 2022). Rural areas exhibit significant variations in population densities and living conditions. They encompass: 1. small towns, villages, and similar inhabited areas with fewer than 1,000 residents based on the most recent census, 2. rural sections within census metropolitan areas and census agglomerations, which may include estate lots, agricultural lands, undeveloped spaces, and areas that cannot be developed and 3. remote and wilderness areas, including agricultural lands (Statistics Canada, 2022).
Remote area refers to a geographical area where a community is situated more than 350 kilometers away from the nearest service center, and this community has consistent year-round accessibility (may be by ground, water or air) (Public Health Agency of Canada, 2009). On the other hand, "isolated" characterizes a geographical area with regular flight services and reliable telephone communication, but it lacks year-round road access. It's important to note that not all households in such a community have telephones, and flights can be cancelled due to adverse weather conditions (Public Health Agency of Canada, 2009).

1.8.2: Geographic and Demographic Features of Northern Saskatchewan

Northern Saskatchewan, which encompasses about half of Saskatchewan's total land area, has a significantly sparse population, comprising merely 3% (35,986) of the entire provincial population (“Northern Saskatchewan Administration District”, n.d.). The Northern Saskatchewan Administration District, referred as Northern Saskatchewan, consists of various types of areas, including incorporated municipalities like towns (Creighton, La Ronge), northern villages (Air Ronge, Beauval, Buffalo Narrows, Cumberland House, Denare Beach, Green Lake, Île-à-la-Crosse, La Loche, Pelican Narrows, Pinehouse, Sandy Bay), and northern hamlets (Black Point, Cole Bay, Dore Lake, Jans Bay, Michel Village, Patuanak, St. George's Hill, Stony Rapids, Timber Bay, Turnor Lake, Weyakwin), as well as the District, which encompasses Northern settlements, Northern subdivisions and resort subdivisions (“Northern Saskatchewan Administration District”, n.d.; “The Northern Saskatchewan Administration District (NSAD)”, n.d.).

In Northern Saskatchewan, around 85% of the population are Indigenous Peoples – all First Nations, Inuit, and Métis people of Canada, each with distinct histories, cultures, languages, and spiritual beliefs (“Indigenous peoples and communities”, n.d.; Irvine & Quinn, 2016; Parrott,
In this expansive region, there are more than 70 communities, and as of the 2021 census, approximately 51% of the population within Northern Saskatchewan reside on reserves, with 69% identifying as Registered or Treaty Indians (“Northern Saskatchewan Administration District”, n.d.).

1.8.3: Plan for Engaging with Indigenous Communities Following this Initial Work

During my initial literature review, I came to understand that the issue of early childhood caries in rural and remote children in Northern Saskatchewan is not a straightforward phenomenon. Instead, it appears to be a complex systemic phenomenon. As I dig deeper into the issue, I began to hypothesize some mechanisms at the individual and community levels that influence early childhood caries in rural and remote children in Northern Saskatchewan based on my readings of the literature. It's crucial to note that while remoteness is a primary issue, I also recognized that in Northern Saskatchewan, where approximately 85% of the population consists of Indigenous Peoples, some of the hypothesized mechanisms are related to Indigenous Peoples, while most are not. What became increasingly clear to me is the significance of engaging with Indigenous communities at that time, because as a non-Indigenous individual, I cannot speak for the complexity of important mechanisms that only Indigenous Peoples know. Unfortunately, due to the COVID-19 pandemic and the resulting travel restrictions, I was unable to visit Northern Saskatchewan and directly engage with the communities. The Indigenous-specific mechanisms that I hypothesized are based on my readings of the literature and may not be applicable to all Indigenous Peoples living in Northern Saskatchewan. Historical political relationships, differing government policies and assimilation strategies have played a crucial role in shaping distinct social experiences among Indigenous Peoples (Reading & Wien, 2009; Tri-Council Panel on Research Ethics, 2023b; Voyageur & Calliou, 2000). Also, it is important to note that Indigenous
Peoples experience with research almost certainly limits the findings in academic literature. Moreover, published literature often presents findings in a ‘pan-Indigenous’ fashion that fails to recognize the richness found in the various Indigenous groups (Reading & Wien, 2009). Despite these limitations, I have done my best to hypothesize mechanisms based on available secondary data in order to capture the complexity and systemic nature of this phenomenon fully acknowledging that these will need to be tested with the various communities living in Northern Saskatchewan in future research to refine or refute this initial program theory. This initial work sets the stage for proper engagement with Indigenous Peoples and communities.

1.9: Definition of Terms

Accessibility in the context of food insecurity refers to the ability of individuals to physically and financially access food that is sufficient to meet their dietary requirements (Carson & Boege, 2020).

Affordability in the context of food insecurity means that individuals have the financial resources to buy an adequate amount of food that meets their nutritional requirements (Carson & Boege, 2020).

Availability in the context of food insecurity refers to the presence and variety of food options in a specific area, as well as the quality of those options (Carson & Boege, 2020).

Constructivism mainly talks about how individual create the image of reality in their mind based on their own intelligence, experiences, and interactions with the world (“What is constructivism?”, 2020).
Context refers to the collection of situations and conditions that accompany an event (Pawson, 2013). Context-Mechanism-Outcome (CMO) configuration refers to a representation, either in the form of a statement, diagram, or drawing, that outlines how specific elements of the context, mechanisms, and outcomes in a particular program are related. CMO configuration serves as a fundamental tool for developing and refining the theory that becomes the review’s final product (Jagosh et al., 2012; Wong, Westhorp, Pawson, & Greenhalgh, 2013).

Early childhood caries is characterized as one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a preschool-age child, i.e., between birth and 71 months of age (Department of Scientific Information, Evidence Synthesis & Translation Research, ADA Science & Research Institute, LLC, 2021).

Food insecurity refers to inability of an individual or household to obtain or consume an adequate amount of nutritious food that meets social standards for a healthy diet (“Household food insecurity in Canada: Overview”, n.d.).

Indigenous Peoples are the original inhabitants of Canada, comprises all First Nations, Inuit, and Métis people of Canada, each with distinct histories, cultures, languages, and spiritual beliefs (“Indigenous peoples and communities”, n.d.; Parrott, 2023).

Initial program theory helps to refine the scope of realist synthesis by “sketching the terrain” (Flynn, Schick-Makaroff, Levay, & Greenhalgh, 2020).

Mechanisms are the underlying elements, processes, or structures that act in certain contexts to produce an outcome (Astbury & Leeuw, 2010).
Middle-range theory refers to a theory that contains enough data to generate testable hypotheses while being abstract enough to apply to other circumstances as well (Wong, Westhorp, et al., 2013).

Oral health refers to the condition of the tissues of the mouth and the oral structures that contribute to physical, mental, and social well-being, welfare, and enjoyment of life (“CDA position statements”, n.d.).

Outcome refers to something that follows as a result or consequence.

Positivism as a philosophical doctrine, believes that scientific knowledge is the best way to understand reality. This knowledge comes from the positive affirmation of ideas via a precise scientific method (investigating phenomena based on gathering observable, empirical and measurable evidence) (“Positivism”, n.d.).

Program theory explains how a program or phenomenon is hypothesized to work. Realist program theory includes descriptions of contexts, mechanisms, and outcomes (Wong, Westhorp, et al., 2013).

Realist evaluation is a theory driven evaluation approach (Pawson & Tilley, 1997; Wong, 2018). It starts with a program theory which explains how, why, for whom, in what settings, and to what extent an intervention is intended to 'work.' Before starting the evaluation, programme theories need to be middle-range in nature—that is, articulated at a degree of abstraction close enough to the observable data to allow empirical testing (Wong, 2018).

Realist synthesis is a theory-driven evidence synthesis process. In this process, the researcher works with secondary data such as policy documents, grey literature, editorials,
published studies etc., in order to confirm, refute and refine realist theory or theories about the phenomenon of interest (Pawson, 2006).

Refined theory is the outcome of realist synthesis. During the realist synthesis, some components of the initial program theory may have been proven incorrect, and some may have been backed up with solid evidence. Getting a better grasp of the contexts, creating a more sophisticated understanding of how certain mechanisms work, and getting a better understanding of outcomes are all means to refine a theory (Wong, Westhorp, et al., 2013).

Severe early childhood caries refers to the progressive or acute type of dental caries. For children below the age of three, the presence of any smooth-surface tooth decay indicates severe early childhood caries. It can also be diagnosed in children aged three to five if they have one or more decayed, missing (caused by cavities), or filled smooth surfaces on their primary anterior maxillary teeth. Alternatively, it can be diagnosed if their teeth have a decayed, missing, or filled score of four or more at age 3, five or more at age 4, or six or more at age 5 (Department of Scientific Information, Evidence Synthesis & Translation Research, ADA Science & Research Institute, LLC, 2021).

Substantive theories refer to existing theories within particular disciplines such as constructivist learning theory in education, attachment theory in human development etc. They help to understand CMO patterns and provide structure to the program theory (Wong, Westhorp, et al., 2013).

System thinking emphasizes the importance of understanding the system as a whole rather than just individual parts of it; it considers how the relationships and dynamics among its parts influence the behaviour of the system (Mingers & White, 2010).
1.10: Chapter Summary

This chapter focuses on an introduction and a brief discussion of the early childhood caries in rural and remote children in Northern Saskatchewan. It also communicates the purpose of the study and puts forth the research questions. This chapter introduces the researcher and discusses the importance of considering the Indigenous context when exploring the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan. The following chapters present reviews of research on the studied phenomenon, philosophical, analytical framework, study method, results, and a discussion of the findings of this realist synthesis.
CHAPTER TWO

2.1: Literature Review

Although there is an absolute necessity to improve the oral health of children in Canada, data on this topic are scarce in the published literature. Moreover, very little is known about early childhood caries in Northern Saskatchewan. To understand the early childhood caries in rural and remote areas in Northern Saskatchewan, at the very beginning of this realist synthesis, I explored literature related to this topic. I found most of the Canadian studies on this topic were conducted in Ontario, Manitoba and British Columbia. I have categorized those studies as being at the biological, individual, community, policy and societal levels to better understand the concept.

2.1.1: Biological Level

It is well established that childhood dental caries are caused by bacteria acting on susceptible tooth surfaces and that diet provides the substrate (i.e., fermentable carbohydrates) for the bacteria to flourish and cause caries (Keyes & Jordan, 1963; Tinanoff, Lowe, Holt, & Goodman, 2010). First, Streptococcus mutans (S. mutans) (a bacterium that causes dental caries) adheres to the tooth surface. Then, S. mutans replicates and colonizes on the tooth surface to form dental plaque (a soft, thin layer of bacteria, mucin, dead epithelial cells, and food debris) (Zayed, Aboulwafa, Hashem, & Saleh, 2021). After people eat food containing sugars and other fermentable carbohydrates, food becomes hydrolyzed by salivary amylase and provides a
substrate for *S. mutans*. Next, *S. mutans* metabolizes carbohydrates in the diet (particularly sugar), generates lactic and other acids within the plaque, and reduces oral plaque and salivary pH (Keyes & Jordan, 1963; Touger-Decker & Van Loveren, 2003; Zayed et al., 2021). When pH level in the mouth drops below the critical point of 5.5, the tooth surface loses minerals such as calcium, phosphorus and others, that compose teeth. This results in dental caries (Keyes & Jordan, 1963; Touger-Decker & Van Loveren, 2003; Zayed et al., 2021). This is the biological mechanism of dental caries.

![Figure 2.1. Key triads of dental caries (Keyes & Jordan, 1963; Tinanoff et al., 2010).](image)

*S. mutans* usually does not colonize in the mouths of infants before tooth eruption (Douglass, Douglass, & Silk, 2004). Salivary transfer from one person to another is required to spread *S. mutans*. This may happen through food and spoon-sharing with mother and family members. In the primary dentition, the sooner *S. mutans* colonizes the teeth, the higher the caries
risk (Aaltonen & Tenovuo, 1994; Damle et al., 2016). According to studies, mothers who have high levels of salivary *S. mutans* are more likely to transfer the infection to their children compared with mothers who have low levels (da Silva Bastos et al., 2015; Köhler & Bratthall, 1978; Nisar, 2015). Moreover, the children in the former group are more likely to have dental caries at an early age in the primary dentition than are children in the later group (da Silva Bastos et al., 2015; Köhler & Bratthall, 1978; Nisar, 2015).

Diet plays a crucial role in the development of dental caries. Diet has a significant impact on tooth integrity, pH levels, saliva production, and the composition of dental plaque as well as the overall health of the oral cavity, including the teeth, periodontium, oral mucosa, and alveolar bone (Touger-Decker & Van Loveren, 2003). Regular consumption of a poor diet (not eating enough of the nutritious foods that are required each day or eating too much of low-fibre, high-fat, salt, high sugar meals and beverages) can affect a person systematically and locally, ultimately affecting general and dental health (“The risks of poor nutrition”, n.d.). A study conducted on 800 children as part of the "MINA study: Maternal and child health in Acre: birth cohort in the Western Brazilian Amazon" has identified the inclusion of sugar in children’s diets and early discontinuation of breastfeeding as the primary factors contributing to the development of dental caries by the age of two (Abanto et al., 2022; Henderson, 2023). A diet containing sugars and fermentable carbohydrates interferes with the balance of tooth demineralization (resulting in a loss of minerals such as calcium and phosphate ions from the tooth surface) and remineralization (which reunites of minerals in the tooth surface) processes (Touger-Decker & Van Loveren, 2003; Zayed et al., 2021). Fermentable carbohydrates, especially sucrose, provide the substrate for the cariogenic microorganisms (*S. mutans*) in the dental plaque to form organic acids. When the mouth level pH often drops below the critical point of 5.5, the demineralization
(the tooth surface loses minerals or dissolves) process starts (Touger-Decker & Van Loveren, 2003; Zayed et al., 2021). In turn, remineralization starts when minerals like fluoride, calcium, and phosphate reunite with the tooth surface through consuming cariostatic foods (milk, cheese, meats, and high-fibre vegetables) and foods lower in added sugars, and fermentable carbohydrates (Moynihan, 2007; Touger-Decker & Van Loveren, 2003). The demineralization process creates a white spot lesion on the tooth surface, which is the first indicator of dental caries (Roberts & Wright, 2009; Touger-Decker & Van Loveren, 2003). When demineralization happens more as a result of poor diet than the remineralization process, and it is accompanied by the irregular cleaning of dental plaque, white spot lesion proceeds into cavitation, which leads to dental caries (Roberts & Wright, 2009; Touger-Decker & Van Loveren, 2003). Also, children may suffer from malnutrition through the regular consumption of a poor diet, which can cause salivary glandular hypofunction and the alternation of the salivary function, leading to early childhood caries (Aluckal et al., 2016; Carmen Llena-Puy, 2006).

Children's snacking or grazing habits throughout the day can have a significant impact on the development of dental caries. Consumption of refined carbohydrates and highly processed foods such as soda, candy, cookies, cake, fruit juice, potato chips, pasta, and crackers throughout the day, can lead to a continuous acidic attack on the teeth surface (Department of Scientific Information, Evidence Synthesis & Translation Research, ADA Science & Research Institute, LLC, 2023; Touger-Decker & Van Loveren, 2003; van Loveren, 2019). Frequent snacking can cause a constant acid attack, as the mouth's pH level remains low or acidic for up to 30 minutes after eating sugary foods (Department of Scientific Information, Evidence Synthesis & Translation Research, ADA Science & Research Institute, LLC, 2023; Stephan & Miller, 1943). This activity makes the teeth’s surface susceptible to mineral loss, without allowing enough time
for the teeth to remineralize (Touger-Decker & Van Loveren, 2003; van Loveren, 2019). A study was conducted on American preschool children to investigate the association between snacking and caries in a population at high risk of dental caries (Johansson, Holgerson, Kressin, Nunn, & Tanner, 2010). The study found that consuming chips was associated with caries in young children, along with traditional risk indicators such as sugar intake, the presence of plaque, and socioeconomic status (Johansson et al., 2010). The study also identified other factors that were linked to an increased risk of caries such as tooth exposure time, cariogenic challenge (the consumption of sugar-containing snacks together with chips/crisps and sugar-containing drinks), and low income (Johansson et al., 2010).

Another mechanism in the progression of dental caries is the presence of developmental dental defects (anomalies that occur during the tooth formation stage). These defects affect the mineralization of the hard tissues of primary teeth (enamel and dentin). Developmental dental defects may result in hypoplasia (present as pits, grooves, and thin enamel), hypomineralization (present as soft enamel), hypomaturation (present as opaque tooth) of enamel and as well as the dentinogenesis imperfecta (teeth being more prone to wear and tear) of dentin (Seow, 2014). A defective enamel surface provides a suitable area for adhesion and colonization of cariogenic bacteria (S. mutans) which metabolize carbohydrates in the diet (particularly sugar) and generate lactic and other acids (Hong, Levy, Warren, & Broffitt, 2009; Li, Navia, & Bian, 1996). Since the acid solubility of defective enamel is greater than that of normal enamel, it is more vulnerable to dental caries (Hong et al., 2009; Zheng, Deng, & Gao, 1998). Several interacting causes, ranging from genetic to environmental, play roles in the development of dental defects. These factors include hereditary ectodermal dysplasia (genetic), hereditary epidermolysis bullosa (genetic), maternal smoking, maternal gestational diabetes mellitus, vitamin D deficiency during
pregnancy, and postnatal nutritional deficiencies (Seow, 2014). A prospective cohort study conducted in Winnipeg, Canada, investigated the association between prenatal 25-hydroxyvitamin D (25OHD) concentrations in expectant mothers and dental caries in their infants during the first year of life (Schroth et al., 2014). A total of 207 women from an economically disadvantaged urban area participated in the study. The results indicated that mothers of children with early childhood caries had significantly lower levels of 25OHD compared to mothers whose children remained caries-free (Schroth et al., 2014). The result suggests that inadequate maternal vitamin D levels during pregnancy may contribute to enamel hypoplasia and the development of early childhood caries in infants' primary dentition (Schroth et al., 2014). Moreover, the early transmission of bacteria from the mother or caregiver to the child's mouth, poor feeding and eating practices (the frequent consumption of sugary and unhealthy foods), and the presence of a vulnerable tooth surface due to developmental dental defects can speed up the caries process (Tinanoff et al., 2010).

The biological mechanisms of dental caries have been presented. This literature review explains how S. mutans establishes itself in the oral cavity and how consuming fermentable carbohydrates plays a role in developing dental caries. The review also explores the relationship between the complexity of a child’s diet and dental caries. Finally, it addresses how developmental dental defects can make teeth more vulnerable to dental caries.

2.1.2: Family/Individual Level

The attitudes and beliefs of parents toward oral health behavior play a significant role in their children's oral hygiene because young children rely on their parents to satisfy their needs (Finlayson, Siefert, Ismail, & Sohn, 2007). A study conducted in four communities in Manitoba,
Canada revealed that parents with positive oral health behaviors and who were mindful of the impact of early childhood caries on overall health had children with less dental caries than their counterparts (Schroth, Brothwell, & Moffatt, 2007). These researchers also found that some parents did not feel baby teeth were important, so they were not very worried about a diagnosis of tooth decay (Schroth et al., 2007). Schroth et al. (2015) reached a similar conclusion in a subsequent study in Manitoba, Canada that examined changes in caregiver awareness, attitudes and activities linked to early childhood caries following the implementation of a programme called the Healthy Smile Happy Child (HSHC) project (Schroth et al., 2015). The programme aimed to deliver oral health promotion and activities focused on preventing early childhood caries in a broad range of ways (Schroth et al., 2015). The research enrolled 319 children under the age of 71 months and interviewed their primary caregivers who lived in four Manitoba communities (Schroth et al., 2015). The findings of this study were compared with those of their earlier one (Schroth et al., 2007). The result showed a significant improvement in caregivers' attitudes, knowledge and beliefs after the programme implementation with a reduction in dmfs (the mean, decayed, missing and filled surface) score (Schroth et al., 2015).

The ability of parents to monitor or maintain their children's oral hygiene also depends on the attitudes and cooperation of the children, the parents' working hours, their time constraints, their financial ability to purchase oral hygiene supplies (toothpaste and toothbrushes), other competing demands, and the support of family members (Prowse et al., 2014; Trubey, Moore, & Chestnutt, 2014). A qualitative descriptive study was conducted in Manitoba, Canada, where parents and caregivers from four cultural groups (Indigenous, Hutterite, refugee and newcomer immigrants) participated (Prowse et al., 2014). The participants from the Indigenous group stated that the uncooperativeness of their children makes it difficult for them to maintain good oral
hygiene (Prowse et al., 2014). Some participants also mentioned that their children do not want to visit the dentist because of their fears, previous unpleasant dental experiences, and needle phobias (Prowse et al., 2014). Family members other than parents also play an important role in maintaining children’s good oral hygiene because children spend time with them. However, if these individuals do not share the same values and attitudes towards preventing this disease (for example, offering sugary foods to children despite their parents' disapproval, different viewpoints towards oral hygiene), it may create difficulties for parents trying to implement good oral hygiene practices (Kyun-Achan et al., 2021; Prowse et al., 2014). On the other hand, if family members such as grandparents share their knowledge and practice for safeguarding a child's dental health (such as using facecloths and infant toothbrushes to clean babies’ teeth and gums), it can help parents adopt preventative measures early in the children’s lives (Prowse et al., 2014).

According to several Canadian studies, parents’ income and social status are strongly associated with early childhood caries (Pierce et al., 2019). Poverty may force parents to purchase less nutrient-dense foods, and it may limit their ability to afford and access dental care. This situation can put their children at a greater risk of developing early childhood caries (Çolak, Dülgergil, Dalli, & Hamidi, 2013). On average, 47% of off and on-reserve First Nations children live in poverty; unfortunately, Saskatchewan and Manitoba have a 65% poverty rate for status First Nations children living on reserve (Beedie, Macdonald, & Wilson, 2019). A cohort study enrolled 5171 preschool children in Arizona between February 1994 and September 1995 to measure the associations of ethnicity/race and socioeconomic status with early childhood caries patterns (Psoter, Pendrys, Morse, Zhang, & Mayne, 2006). Five examiners examined the children's teeth surface status and collected demographic information (self-reported), including
family income, caregiver education level, and ethnicity/race (Psoter et al., 2006). The study found that there was an association of increased risk of early childhood caries with low socioeconomic and minority ethnicity/race status (Psoter et al., 2006). Later, Schroth, Halchuk, and Star, (2013) drew a similar conclusion in a cross-sectional study; this research, included interviews with caregivers in Manitoba First Nation communities who participated in the RHS (First Nations Regional Longitudinal Health Survey) Phase 2 (2008-10). They found correlations between severe early childhood caries with the level of parenteral schooling, employment status, and maternal smoking during pregnancy (Schroth, Halchuk, & Star, 2013).

Parenteral behaviors such as providing children with sugary beverages in bottles or training cups and with a high level of sugary snacks each day are associated with early childhood caries (Lawrence et al., 2004). Parents sometimes have false beliefs that some sugary drinks, such as fruit beverages with added sugar, sports drinks, and flavoured waters containing vitamins or ingredients for boosting energy, are healthy. This belief can lead them to purchase those products for their children (Munsell, Harris, Sarda, & Schwartz, 2016). A study was conducted in Garden Hill First Nation, Manitoba, included a cross-sectional dental examination of children, an interview with mothers and a maternal chart review (Schroth, Smith, Whalen, Lekic, & Moffatt, 2005). The study revealed that many mothers give their young children bottles with formula, canned milk, whole milk, tea, juice, Kool-Aid and soft drinks, especially at night or during naptime (Schroth et al., 2005). In turn, the study showed that the rates of caries in children who had sugar added to their feeding bottles were considerably higher (Schroth et al., 2005).

In this section, the literature review considers the attitudes and beliefs of parents, their knowledge, perceptions, income, social status, time constraints, and the support of family
members, and it examines the role they play in maintaining children’s oral hygiene practices. It also highlights some of the obstacles that parents encounter in implementing good oral hygiene practices, including children's protests and resistance, fear of dental visits, and parents’ misconceptions about sugary drinks. In addition, the review emphasizes the need for oral health promotion programs that can improve parents' attitudes, knowledge, and beliefs and help them adopt preventative measures early in the lives of their children.

### 2.1.3: Community Level

In remote area, the cost of healthy and nutritious foods is higher than is the cost of processed foods (Socha, Zahaf, Chambers, Abraham, & Fiddler, 2012). Accessibility, availability, and affordability are the three main factors that lead to food insecurity (inability to obtain or consume a proper diet quality or sufficient amount of food in a socially acceptable manner) in Northern Saskatchewan (Socha et al., 2012; “Household food insecurity in Canada: Overview”, n.d.). Some other issues also contribute to the food insecurity in that region, such as colonization, the introduction of provincial trespass laws (e.g., the Saskatchewan trespass law) and more (Lampow, 2022; Morrison, 2011; Socha et al., 2012). These issues restrict traditional hunting, and fishing activities and threaten Indigenous food sovereignty (the policy that permits and supports a community’s ability to continue traditional hunting, fishing, gathering, and farming) (Lampow, 2022; Morrison, 2011; Socha et al., 2012). In 2015, the average weekly food expenditure for a family of four in Northern Saskatchewan was over $315 compared to about $229 per week in the more densely-populated southern Saskatchewan (Saskatchewan Food Costing Task Group, 2017). With rising inflation, Canada’s Food Price Report 2023, predicts a sharp rise in grocery prices for 2023 (University of Guelph; Dalhousie University; University of
In Northern Saskatchewan, there is a lack of local grocery stores with healthy foods such as fresh vegetables and fruits as well as transportation difficulties (Saskatchewan Food Costing Task Group, 2017; Sterritt, 2016). As a result, people in this area may need to rely on the food available at convenience stores or general stores. One out of every five northern and rural Saskatchewan stores lacked over 30% of the standard available foods such as vegetables, fruits, meats and meat alternatives that are essential to a healthy diet (Saskatchewan Food Costing Task Group, 2017; Sterritt, 2016). Due to the high cost of nutritious, healthy food and northern communities’ limited access to them, parents have little choice but to purchase foods that are economical, non-perishable, stomach-filling snacks, and sugary-starchy foods that are heavy in calories rather than nutrients (Haman et al., 2010; Rall & La Fortune, 2020).

Remote geographical locations may pose challenges to people in accessing oral health care throughout Canada (Canadian Dental Association, 2017). In most cases, visiting dental providers provide treatment in remote communities (Lemchuk-Favel, 2010). However, this service may become unavailable in winter due to transportation difficulties (Lemchuk-Favel, 2010). Moreover, there is a lack of dentists, dental hygienists and dental therapists in remote areas (Inam, 2021). As well, travel costs, prolonged waiting times for treatment, and off-reserve-on-reserve dental benefit-claiming issues can limit access to preventive care (Lawrence et al., 2009). In some cases, early childhood caries requires treatment under general anesthesia (Lawrence et al., 2009). This treatment can impose challenges for parents living in remote areas because they may need to travel long distances, by car or plane, from their community to city hospitals or surgical centers to receive treatment (First Nations Information Governance Centre, 2018). In addition, many surgeries were cancelled in Saskatchewan during the COVID-19
pandemic as resources were redirected to deal with the pandemic (Djuric, 2021). At the beginning of the COVID-19 pandemic, some treatment services were shut down to stop the spread of the virus, and this created a long waiting list for elective surgery (Djuric, 2021; Vescera, 2020). This unfortunate event (COVID-19) has further affected children with early childhood caries who now require surgery under general anesthesia.

Health promotion programmes that work for one community might not be successful for others. The preconditions for running an effective community health promotion programme are to recognize people’s needs and concerns and seek ways in which to involve them in every step of the programme (Harrison, 2003; Zakus & Lysack, 1998). A study was conducted to observe the efficacy of community-based and culturally responsive health promotion programmes in reducing the prevalence of early childhood caries in a Northern British Columbia First Nations community (Harrison & White, 1997). It mainly focused on traditional child-rearing practices, such as using the willow cradle, to pacify fussy infants (Harrison & White, 1997). Through the supervision of health workers and a committee of mothers from the community, the programme's popularity grew due to the local theme-based poster and leaflet distribution as well as the counselling of the mothers of toddlers and babies (Harrison & White, 1997). At the end of the project, it was reported that more children dropped the bottle-feeding habit, and fewer children slept with a bottle (Harrison & White, 1997). Though the findings were not statistically significant, the mean decayed, extracted or filled surfaces (defs) of children 18–38 months of age had decreased. This program is an example of a community-based approach having a positive impact (Harrison & White, 1997; Lawrence, 2010).

In Canada, fluoride has been used to prevent tooth decay since 1940 (“Fluoride and oral health”, n.d.). It is supplied through various forms such as water fluoridation, toothpaste, fluoride
varnish, and fluoride supplements ("Fluoride and oral health", n.d.). The World Health Organization, Health Canada, the American Academy of Pediatric Dentistry, the Canadian Dental Association, the Canadian Academy of Paediatric Dentistry, the American Academy of Pediatrics and the Canadian Paediatric Society all strongly support the use of fluoride for caries prevention and control ("ADA policy on fluoridation", n.d.; American Academy of Pediatrics, Committee on Native American Child Health, Canadian Paediatric Society, First Nations, Inuit and Métis Committee, 2011; “CDA position on fluoride”, 2021; Petersen & Ogawa, 2016). Fluoride efficacy relies on its regular implementation, such as through regular toothbrushing with fluoridated toothpaste, and exposure to dental treatment or publicly-funded programmes (water fluoridation, topical fluoride application) (Baghdadi Z. D., 2016; Irvine, Holve, Krol, & Schroth, 2011). Community water fluoridation is the most cost-effective and fair way of supplying fluoride to the community. It leads to equity in oral health because it overcomes the social determinants of health (Canadian Electronic Library & Public Health Agency of Canada, 2018). In Saskatchewan, 39.6% of the overall population benefits from the fluoridation of their water system (Canadian Electronic Library & Public Health Agency of Canada, 2018).

The variation in the extent of community water fluoridation within different communities can be attributed to factors such as their geographic location, municipal transfer agreements, and other issues (Canadian Electronic Library & Public Health Agency of Canada, 2018). For example, in some areas multiple wells may supply water at different times during the year, which means that some communities receive only intermittent fluoridated water (Canadian Electronic Library & Public Health Agency of Canada, 2018). There is also controversy over community water fluoridation, emerging from political, ethical, economic, and health considerations, which caused several municipalities to end community water fluoridation, contributing to its decline.
Indigenous communities in Canada can access community water fluoridation if they have a Municipal Transfer Agreement, that allows them to obtain drinking water from a municipal source (Canadian Electronic Library & Public Health Agency of Canada, 2018). According to The state of community water fluoridation across Canada 2017 Report (Canadian Electronic Library & Public Health Agency of Canada, 2018), only 2.4% of Indigenous communities in Saskatchewan (Muskoday First Nation with a population of 695 and One Arrow First Nation with a population of 675) received fluoridated water. The report also highlighted that there were occasional disruptions in the supply of fluoridated water in some communities (Canadian Electronic Library & Public Health Agency of Canada, 2018).

One way to address this obstacle may be to use fluoride varnish. To evaluate the effectiveness of fluoride varnish Lawrence et al. (2008) conducted a 2-year cluster randomized controlled trial (Lawrence et al., 2008). The study enrolled 1275 Indigenous children (6 months to 5 years old) from twenty First Nations communities located in the Sioux Lookout Zone (SLZ), Northwest Ontario, Canada; the participants were randomly divided into a control group and a fluoride varnish study group (Lawrence et al., 2008). The study also included 150 primarily non-Indigenous children of the same age group from Thunder Bay District (Lawrence et al., 2008). The result indicated an 18% decline in mean ‘net’ dmfs (the decayed, missing and filled surfaces) increment in the Indigenous children who received fluoride varnish compared to the control group and a 25% reduction for all the children who participated in that study (Lawrence et al., 2008).

The literature review in this section presented information about the difficulties that parents who are living in remote and rural areas in Canada encounter while trying to provide a
healthy diet to their children, and, in turn, how a poor diet affects the development of early childhood caries. It also explained the challenges that children living in remote and rural areas in Canada face in accessing oral healthcare services. Finally, it discussed several fluoride application initiatives that have been implemented in different communities to reduce the prevalence of early childhood caries.

2.1.4: Policy Level

To ensure that all Canadian children, regardless of their background or circumstances, can access quality dental care and maintain good oral health, all three levels of government (Federal, Provincial and Municipal) should prioritize developing and implementing oral health care policies, regulations, and initiatives at the governmental or organizational level. To achieve this goal, the government must give equal importance to oral healthcare as it does to other healthcare services provided to the public (Rowan-Legg, Canadian Paediatric Society, & Community Paediatrics Committee, 2013). One effective way to improve oral healthcare access for children from remote and deprived areas is by implementing school-based oral health programs (Kwan, Petersen, Pine, & Borutta, 2005). Saskatchewan's Health Dental Plan (SHDP) was an outstanding example of such a program that received worldwide recognition (Ewart, 2010; Mathu-Muju, Friedman, & Nash, 2017). The programme was launched in 1974 to cover dental care for children from 3-12 years of age (Ewart, 2010). It aimed to provide diagnostic, preventive, restorative, emergency treatment, and oral surgery. A dental therapist supervised by a dentist provided the first point of care, and complicated cases were referred to the dentist (Mathu-Muju, Friedman, et al., 2017). The service allowed all children living in the rural and remote areas of Saskatchewan access to dental care. It has also made a ground-breaking effort in
the province to eradicate inequalities in dental healthcare access for children (Swanson, 1976). Before the programme was implemented, a survey conducted by the Saskatchewan Department of Health in Regina and Saskatoon in 1968 found that children in those cities had poor oral health (Saskatchewan Department of Health, n.d.). In addition, at that time, Saskatchewan had the third-lowest dentist-to-population ratio in the country (Ewart, 2010). In 1979, a survey result was released from Saskatchewan Health (as cited in Ewart, 2010) to understand the mindset of families participating in the Saskatchewan Dental Plan and to determine whether there were variations in attitudes between treatment locations, such as comparing rural and urban areas. Among 600 participants, almost 90% of participants were satisfied with the treatment provided by the dental therapists (Saskatchewan Health, 1979, as cited in Ewart, 2010). A similar conclusion was also found by Dr. D. W. Lewis (1981), who evaluated the Saskatchewan Health Dental Plan from 1974 to 1980. He identified that 90% of children in Saskatchewan had accessed dental care, 89% of participants were pleased with the program, 94% of rural participants were satisfied with their therapists, and 89% of urban residents were happy with the therapists’ service. The evaluation also found that the treatment cost per patient dropped from $163 to $68 across that time (Ewart, 2010; Lewis, 1981).

Unfortunately, the programme was discontinued in 1987 due to the opposition of the newly elected provincial Government (Ewart, 2010; Mathu-Muju, Friedman, et al., 2017). Furthermore, private dentistry played a significant role in deliberately pushing for its discontinuation (Marchildon, 2011). This action shattered the careers of all 420 SHDP employees who engaged with this programme. Today, most dental therapists work in the private sector, which makes it difficult for the government to fill the few remaining government-funded opportunities in remote regions (Marchildon, 2011). The cessation of this service created
difficulties in finding oral health providers for children living in rural and remote communities and for low-income households that could not afford the treatment costs (Marchildon, 2011).

Inevitably, the termination of this programme has had an obvious and persistent impact on oral health in these regions. After the termination of this programme the Saskatchewan Health Dental Health Education Program implemented dental health screenings every five years. These screenings revealed a rising trend in dental decay among grade one children (Pilly, 2010). In 1993-94, 20% of grade one children in Saskatchewan had dental caries. This figure increased to 24.9% in the 1998-1999 screening, slightly to 25.5% in the 2003-2004 screening, and further to 27.5% in the 2008-2009 screening (Pilly, 2010). The 2008-2009 screening result also identified dental health discrepancies between students attending urban and rural schools; in total, 43.8% of children in rural communities were caries-free, while 55.4% of children attending schools in urban communities were caries-free (Pilly, 2010). Although dental therapists can play an important role by providing basic oral health services, including prevention, fillings and extractions in rural and remote communities in Canada, unfortunately, all the remaining dental therapy program was completely shut down in November 2011 (Leck & Randall, 2017).

Recently, the Northern Inter-Tribal Health Authority (NITHA), the University of Saskatchewan’s (USask) College of Dentistry, Saskatchewan Polytechnic, and Northlands College have developed a dental therapist training program which is set to begin in fall 2023. The program is likely to have a significant positive impact on the oral health workforce that works with rural and remote communities, and it has the potential to address the oral health needs of rural and remote communities (“USask collaboration establishes first dental therapy degree program in Canada”, 2022).
In rural and remote areas, dental hygienists can also play an important role by providing scaling, filling, screening and promoting oral health. Children in rural and remote areas can avoid complicated dental surgeries by receiving preventive treatment from dental hygienists. Seven provinces in Canada – Saskatchewan, Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia, and Ontario – have dental hygiene legislation that enables dental hygienists to establish private practices (Lemchuk-Favel, 2010). Nearly 94% of NIHB clients reside in those provinces where private dental hygiene practice offers a possibility to enhance access to dental care in remote and northern communities (First Nations and Inuit Health Branch, Health Canada, 2008; The Canadian Dental Hygienists Association, 2009). Previously dentists, orthodontists, oral surgeons, and denturists were allowed to bill through the NIHB programme, while dental hygienists in private practice were not (Lemchuk-Favel, 2010). In addition, dental hygienists were required to have a contract/employer relationship with a dentist; in turn, this acted as a barrier for those interested in working in rural and remote areas (Cowan, 2017). Nowadays, the NIHB programme allows dental hygienists to submit claims to the program as independent service providers (“Dental benefits guide for First Nations and Inuit: Non-Insured Health Benefits program”, 2023).

This section of the literature review provides information about different governmental policies, regulations, and initiatives aimed at improving oral healthcare access for children residing in rural and remote areas. The review discussed the significance of the Saskatchewan Health Dental Plan as well as the negative impact that discontinuing this program has had on the oral health of all children, but especially the children living in the rural and remote parts of Saskatchewan. Moreover, the literature review discusses the current challenges faced by dental therapists and hygienists in providing oral healthcare services in rural and remote areas due to
bureaucratic barriers, and it provides information about the recent efforts that have been made to tackle the oral health disparities in these areas.

2.1.5: Societal Level

The existence of Indigenous inequity in Canada attributed to historical and ongoing colonization, as well as the subsequent trauma, have led to a deterioration in the health of Indigenous Peoples (Reading & Wien, 2009). In the Saskatchewan Health Authority’s (SHA) Dental Health Screening Program Report, a comparative analysis between Indigenous and non-Indigenous children in Saskatchewan determined that Indigenous children were significantly more likely to have severe early childhood caries; moreover, these children performed significantly poorer on twelve of the thirteen oral health indicators (Gill, 2014). Previous traumatic historical events due to colonization and the history of medical experiments being conducted on Indigenous children (a government-run food experiment on Indigenous children in the 1940s, a tuberculosis vaccine trial in Saskatchewan, the illegal special flour experiment, etc.) without their consent has created fear of accessing healthcare among some Indigenous parents (Malone, 2020). In Manitoba, a community-based participatory research project was undertaken with four First Nations and Métis communities in urban and rural areas of the province (Kyyoon-Achan et al., 2021). The aim of the study was to report on the obstacles and problems experienced by First Nations and Métis parents in fulfilling their children's early oral health needs (Kyyoon-Achan et al., 2021). The study results revealed that certain parents expressed concerns about dentists not providing sufficient emotional support, having limited engagement with parents, employing overly rigid approaches, and inadequately communicating treatment
Colonization introduced racism into the Canadian health system and has created difficulty in accessing healthcare for Indigenous Peoples. Existing race-based legislation in Canada creates an unequal distribution of health funding, resources, and services based on state-created Indigenous identities (Allan & Smylie, 2015; Reading & Wien, 2009). The Non-Insured Health Benefits (NIHB) programme is an example of this race-based legislation. NIHB benefits First Nations and Inuit peoples while leaving Métis and non-status First Nations people out of dental care and other health care (Allan & Smylie, 2015; Indigenous Services Canada, n.d.; Reading & Wien, 2009). In Canada, dental treatments are expensive, so it is hard for caregivers to meet children's dental needs without dental coverage. Moreover, for people living in remote communities, accessing dental care adds an additional challenge due to the unavailability of nearby dental services (Lemchuk-Favel, 2010). In Phase-3 RHS (First Nations Regional Longitudinal Health Survey), 18.4% of First Nations children caregivers reported that they had travelled more than 90 km to meet a professional dentist for their children's dental treatment (First Nations Information Governance Centre, 2018). In addition, there are various reasons why the NIHB programme is unattractive to dentists who have a large Indigenous patient practice. These reasons include the lengthy process of claiming benefits, auditing dentists’ treatment by the programme, administrative issues, and the NIHB programme refusing to pay for certain recommended treatments for patients (Health Canada and Public Health Agency of Canada, 2017; Lemchuk-Favel, 2010). In turn, some dentists have turned away from the NIHB programme (Health Canada and Public Health Agency of Canada, 2017). Rather than seeking compensation from the NIHB programme, dentists prefer to ask patients to pay for their
treatments first and then seek reimbursement later from the programme (Health Canada and Public Health Agency of Canada, 2017; Lemchuk-Favel, 2010). Due to the high cost of dental treatment, needing to pay upfront for treatment reduces patient interest and causes treatment avoidance (Lemchuk-Favel, 2010).

Many of the dental services covered by the NIHB programme require predetermination before beginning care (Lemchuk-Favel, 2010). Usually, other insurers will review online records to decide whether the treatment will be covered. During the predetermination phase, the NIHB programme compares the dental services requested against its defined Dental Policy Structure and the NIHB Dental Benefits Guide, and it also considers the oral health condition and needs of the patients (Health Canada and Public Health Agency of Canada, 2017; Lemchuk-Favel, 2010). Unfortunately, the waiting time for this approval is lengthy, as it may take up to one month. The entire process leads to a waiting period for most Indigenous patients, and this is especially difficult in those who may have pain and are traveling long distances for care (Lemchuk-Favel, 2010).

On December 1, 2022, the Government of Canada implemented the Canada Dental Benefit program, which has the potential to provide protection for all children, including Indigenous children, who currently do not have any coverage under any federal, provincial, or territorial government program (“Canada dental benefit”, n.d.). This program aims to improve their access to dental care. This program provides an upfront payment to qualified Canadians who have an adjusted family net income of less than $90,000 and who have children under 12 years old that do not have private dental care coverage (“Canada dental benefit”, n.d.). The amount of coverage provided under this federal government dental plan depends on the family's adjusted net income. For instance, eligible children from families with an adjusted net income of
less than $70,000 will receive $650 of benefits, families with an income between $70,000 and $79,999 will receive $390, and those with an income between $80,000 and $89,999 will receive $260. Moreover, children already covered under other government dental care programs, such as Non-Insured Health Benefit (NIHB) and the Interim Federal Health Program (IFHP), can also benefit from this program if all their dental care expenses are not covered by that program (“Canada dental benefit”, n.d.; “Canada dental benefit promotional toolkit: Infographic”, n.d.)

The literature review in this section discusses the challenges faced by Indigenous parents in accessing oral healthcare for their children in Canada, and it examines how colonization and historical trauma have created distance between Indigenous parents and oral healthcare providers. It also explores Canada's race-based legislation, specifically the Non-Insured Health Benefit program, which provides dental coverage for some Indigenous children while leaving others without coverage. In addition, the review highlights the recent efforts made by the Government of Canada to provide dental care for all children (including Indigenous children) who currently lack coverage under any federal, provincial, or territorial government program.

2.2: Chapter Summary

This chapter reviews publications on my studied phenomenon. To gain a thorough understanding of the concept, I explored early childhood caries from different perspectives: biological, individual, community, policy and societal. The literature on the biological level discusses mechanisms, and it focuses on the role of bacteria, diet, and developmental defects. The research on the individual level examines the relationship between oral health behaviors and factors such as parental attitudes, education, family income, and child resistance. At the
community level, studies investigate the impact that culture, beliefs, and access to healthy food and dental care play on early childhood caries. In turn, the research on the policy level analyzes government initiatives and regulations to improve oral healthcare access for children living in rural and remote areas. Finally, the research on the societal level looks at how colonization, traumatic events, and discrimination affect oral healthcare access for Indigenous children.

I did this initial literature review at the very beginning of this realist synthesis which helped me to develop the first sketch of the Initial program theory. It is clear from the literature review that the phenomenon of early childhood caries is a problem that involves multiple factors at different levels of analysis. Each level of analysis helps us to understand the development and existence of early childhood caries and how the interactions among these levels make the problem more difficult to overcome. To address this issue, a system thinking approach is particularly useful as it allows us to understand how these factors from different levels fit together and influence each other. Based on the understanding from this initial literature review, later I did subsequent searches to develop and design a multilayer conceptual map showing a hierarchy of different level mechanisms, and their interactions with each other in influencing the existence of early childhood caries in rural and remote children in Northern Saskatchewan.
CHAPTER THREE

3.1: Philosophical Framework

3.1.1: Realism

Realism is a philosophical viewpoint that asserts that the external world exists independently of our perceptions and knowledge about it (Sayer, 2000). Realism sits between the positivist and constructivist accounts of science (Maxwell, 2012).

3.1.1a: Realist ontology. Ontology refers to the nature of reality. It contributes to realizing the nature and character of reality and the essence of the social phenomena under study (Kivunja & Kuyini, 2017). Realist ontology is based on the belief that reality exists and works independently of our consciousness or knowledge of it (Bhaskar, 2008). According to the critical realist Ray Bhaskar, reality is stratified into three domains: empirical – involves actual events-effects that can be, or have been, observed or experienced; actual – involves events and their effects that happen whether we experience them or not; and real – involves mechanisms that generate events, whether observable or not (Archer, Bhaskar, Collier, Lawson, & Norrie, 1998; Bhaskar, 2008). For example, when people look at a rainbow, they can only see the visible spectrum of colours (red, orange, yellow, green, blue, indigo, and violet). Infrared radiation exists just beyond the red colour in the rainbow and ultraviolet exist just beyond the violet colour; however, people cannot see them with the naked eye (“Rainbow”, n.d.). Our perception of the rainbow's visible spectrum of colours represents the empirical domain, while the full spectrum of colours (including infrared and ultraviolet) represents the actual reality. In addition,
there are also some factors and rules that cause colours to exist in the first place (Da, 2019). Different mechanisms have evolved over time to understand what causes the rainbow to exist such as Judeo-Christian myth (a rainbow occurs from God as a reminder of the covenant), the Mayan myth (a rainbow occurs from God as a symbol of pleasure), and the classical physics (a rainbow occurs due to reflection and refraction of light (Alyssa, 2011; “Color theory”, n.d.; Da, 2019). All these understandings were derived from different mechanisms. Whether they are observable or not, the underlying mechanisms that make a rainbow possible are part of the real domain. Realism mainly focuses on the real domain. Realist ontology recognizes the view that there is a gap between what we see and comprehend, what actually happens, and – most importantly – the deep dimension where the mechanisms that cause the events to exist (real domain) (Bergin, Wells, & Owen, 2008; Danermark, Ekström, Jakobsen, & Karlsson, 2002). By giving the opportunity of exploring the generative mechanisms, realist ontology helps researchers better comprehend the nature of the phenomenon they study (Bergin et al., 2008).

3.1.1b: Realist epistemology. The term epistemology refers to how we come to know something or the nature of knowledge. It is concerned with the nature of human knowledge and comprehension that researchers may be able to gain to widen, deepen, and extend the grasp of their field of study (Kivunja & Kuyini, 2017). Realist epistemology mainly focuses on what and how we can know about a subject that exists independently of our mind (Smith, 2010). From a positivist perspective, only knowledge that is gained through observation and measurement is trustworthy (Wainwright & Forbes, 2000). This viewpoint may limit the researcher’s ability to develop sophisticated understandings and causal explanations for the phenomena under investigation. In contrast, realist researchers seek truth beyond empiricism (the theory that all knowledge is derived from sense experience or experimental science) by examining the
underlying mechanisms (Wainwright & Forbes, 2000). Again, from the constructivist perspective, knowledge about reality is incomplete and never certain since reality is socially constructed, where people's interpretations of a phenomenon may differ due to language and cultural differences (Danermark, 2002). Although realists believe this as well, they argue that some knowledge is less fallible than others. As a result, it is possible to develop reliable knowledge about the external world (Danermark, 2002). They also think that mechanistic explanations can be examined despite knowledge fallibility (Sayer, 2000).

Science, according to Bhaskar (2008), has two dimensions: intransitive and transitive, which he refers to as the "central paradox of science" (p.11) (Bhaskar, 2008; Danermark et al., 2002). The intransitive dimension refers to the real entities or objects of scientific knowledge that constitute the natural and social worlds (Outhwaite, 1987; Bergin et al., 2008). In scientific philosophy, the intransitive dimension refers to ontology (Danermark et al., 2002). On the other hand, the transitive dimension refers to established facts and theories (Bergin et al., 2008). Scientific facts and theories are hypothetical, and they can fluctuate with new evidence and knowledge. So, transitive knowledge can be fallible (change with time, new evidence and knowledge) and corresponds to epistemology (Smith, 2010). The main goal of science is to help us to gain a deeper knowledge of reality (“Understanding science”, n.d.). From a positivist perspective, reality can only be pursued through observation. Positivists suggest that science only involves the empirical domain, and they only accept perceivable reality, and reject unobservable part of reality (Passmore, 1967). They believe that unobservable is all about speculation. But realists do not reject unobservable entities because they think that real is not only about empirical or what we see, but also about what exists beyond what we see (Smith, 2010). According to positivist the main goal of science is to investigate the regularities of empirical events (events
that are observable, perceivable, measurable, and statistically analyzable) (Bergin et al., 2008; Potter & López, 2001). However, realists think that the regularity of these empirical events generates because of some latent or unobservable mechanisms. That’s why realists think that the main goal of science is to hypothesize and investigate the mechanisms that generate events that are either observable or unobservable (Danermark et al., 2002).

Again, from a constructivist perspective, people cannot gain any reliable knowledge about the reality that exists independently of us since access to reality is controlled by social circumstances (Danermark, 2002). In addition, it is impossible to develop reliable knowledge about the external world (Danermark, 2002). However, realist philosophy combines both the transitive and intransitive aspects of science. Realists assert that there is no final source of knowledge; instead, we can only continue to expand our understanding of various world views (Waldron, 2018). Thus, realists use data obtain from both positivists and constructivists to explore the hidden mechanisms of a phenomenon to understand the phenomenon more precisely.

3.1.1c: Mechanism. Mechanism is the central concept of the realist paradigm (Wong, Westhorp, et al., 2013). Before discussing the mechanism, I would like to discuss causality first. In order to understand why any events or phenomena are happening around us, we need to find out what causes them to happen. Causality is the connection between cause and effect (the result or consequence) (Merriam-Webster, n.d.). According to the empiricist understanding of causality, if event A (an evening walking) is regularly followed by event B (decreased blood sugar level), people can say that event A causes event B, and that they have a causal relationship (C. M. Lorkowski, n.d.). However, this type of interpretation of causality does not answer why evening walking reduces blood sugar levels in humans (Maxwell, 2004). On the other hand, the
realist understanding of causality focuses on the causal factors that produce the event. By looking at the conjunction of events, realists try to find the answers to the questions why, what are the components, structures involved, and what are the causal mechanisms that reduce blood sugar when people go on evening walks. To understand why things are happening around us, realists do not focus only on the regularities of events; rather, they focus on the mechanisms that consist of entities and activities organized in such a way that they generate the events (Illari & Williamson, 2012; Maxwell, 2012).

Mechanisms exist in the physical, chemical, biological, psychological, and social realms. For example, *Streptococcus mutans* causes dental caries, adheres to teeth and forms plaque, metabolizes carbohydrates in one’s diet (particularly sugar), and generates acid within the plaque. This acid dissolves the calcium and phosphorus that composes teeth, and this results in dental caries. This is the biological mechanism of early childhood caries (Seow, 1998). In turn, social mechanisms are similar to biological mechanisms, but they are much more complex because they are related to human behavior. They can be studied on various levels in the real domain. As mentioned above, reality is stratified, and composed of hierarchically ordered layers, each of which sets the stage for the next. Each stratum is different and may interact with the layers above and below it to create new mechanisms, objects, and events (Bhaskar, 1998; Danermark, 2002; Eastwood, Jalaludin, & Kemp, 2014). The existence of such level-specific mechanisms defines each level. It is easier to identify mechanisms in a closed system (i.e., experimental designs) by keeping other mechanisms under control. In an open system, such as in the social sciences, it is difficult to identify the mechanisms at play as they tend to be in higher-level strata (Sayer, 2000). The identification of mechanisms in higher-level strata indicates that there may be more mechanisms, or more combinations of mechanisms may exist, that can
explain a phenomenon. For example, people with bad breath (halitosis) may experience stigmatization in society. Sometimes people avoid talking with other people because they have bad breath; in turn, this reduces their social communication skills. We can understand the pathophysiology of this disease by looking at its biological mechanisms. Again, psychological mechanisms can help us understand how different people experience the effects of bad breath and how they address this issue. Suppose we want to understand the stigmatization of bad breath (the phenomenon of interest). The obvious mechanism would be self-esteem. But there are some other potential mechanisms that exist at a different level than just self-esteem, such as why someone would have bad breath (the biological level), which might be the result of dental caries and/or gingivitis or it could be a Zenker’s diverticulum or reflux. In turn, these issues might be exacerbated by one’s socioeconomic status and one’s sense of self-efficacy to address the associated illnesses. Thus, there may be a chance that combinations of mechanisms at different levels, such as biological, psychological etc., can help explain this phenomenon (Danermark, 2002). So, understanding and exploring the mechanism of any phenomenon is important because it may help in its analysis as well as the elicitation, modification, or avoidance of that phenomenon (Chirkov, 2016).

The way we can explore and hypothesize a mechanism is by thinking backwards to determine what causes this event or phenomenon; this is called retroduction (Blaikie, 2007). Through retroduction, realists try to infer something based on the knowledge that is available to them at that time, as well as their intuition and rationality (Chirkov, 2016). For example, by looking at the regular empirical events (Children living in rural and remote areas in Canada having poor dental health conditions than children living in urban areas in Canada) from the existing documents (literature, grey literature etc.), I may first try to conceptualize what might be
behind the regularity of this phenomenon. Then using the existing knowledge about this phenomenon, along with my intuition and rationality, I may hypothesize the mechanism that generates this phenomenon.

3.1.2: History of Realism

In the 17th century, Francis Bacon introduced the concept of realist philosophy (Klein & Giglioni, 2020). He challenged (then) modern Aristotelian philosophy throughout his life and stood in the same relation to realism that Descartes, Leibnitz, and Kant did to idealism, the enlightenment, and modern philosophy, respectively (“Francis Bacon. The philosopher of science. Modern philosophy”, n.d.). He opposed Aristotle's logic, which was based on deductive reasoning. In deductive reasoning, an individual can start reasoning based on premises, and these premises can lead that individual to a certain conclusion (Klein & Giglioni, 2020). For example, all men are mortal (premise); Socrates is a man (premise); therefore, Socrates is mortal (conclusion). Bacon introduced the concept of inductive reasoning, a new method of philosophical inquiry in which conclusions are drawn from multiple observations (Knachel, 2017). The main goal of inductive reasoning is probability rather than certainty (Klein & Giglioni, 2020; Knachel, 2017). For example, most humans are right-handed; Maya is a human; so it is probable that Maya may be right-handed. In addition, Bacon proposed two modes of inferences 1. Enumerative induction (the conclusion is based on the number of occurrences), and 2. Ampliative induction (the conclusion is based on the explanation of the nature of the phenomenon). Ampliative induction, also called retroduction, refers to the mode of inference in which phenomena are explained by finding the mechanisms capable of producing those events (Chirkov, 2016). English philosopher William Whewell further developed the realist paradigm with the concept and definition of mechanism, which is the key construct of the realist paradigm.
(Chirkov, 2016). In the 20th century, the concept of the mechanism was popularised more broadly in the philosophy of science and in the philosophy of the social sciences, more specifically (Maxwell, 2012). Ray Pawson, in his "Realist Memorabilia” also mentioned some other philosophers who made important contributions toward the development of realist philosophy, such as Popper, Bhaskar, Campbell, Archer, Bunge and Cartwright (Pawson, 2018).

3.1.3: Critical Realism and Scientific Realism

Before moving into the next section, it behooves me to clarify my philosophical position. A research paradigm is a lens through which a researcher views the world and evaluates the methodological components of their research endeavour to decide the research techniques they will utilize and determine how the data will be processed (Kivunja & Kuyini, 2017). Epistemology, ontology, methodology and axiology are the four elements of a research paradigm (Kivunja & Kuyini, 2017). In the previous paragraphs, I have discussed ontology and epistemology. Methodology refers to the procedures used to locate, select, process, and evaluate information on a topic. In turn, axiology is related to the study of values, particularly the impact of the values on knowledge acquisition and how it is gained (Haigh, Kemp, Bazeley, & Haigh, 2019). All four of these elements help researchers to determine their particular paradigm position. In my research, I concentrated on ontology and epistemology because different ontological and epistemological viewpoints have significance in terms of the questions researchers aim to answer, the techniques they use, the data they collect, and how this data is collected, analyzed and interpreted (Haigh et al., 2019; Kivunja & Kuyini, 2017).

Among different forms of realism, critical realism and scientific realism are the most discussed. To understand the differences between them, we need a clear understanding of their
ontological and epistemological stances, as they have different approaches to trying to discover the truth. Critical realism was popularized by the philosopher Roy Bhaskar. It is a meta-theoretical stance that aims to give a philosophically informed explanation of science and social science, which can then be used to influence our empirical investigations (Archer et al., 2016). Critical realism focuses on inquiring about the nature of reality (ontology), and it suggests that researchers should begin their research by making decisions about their ontological beliefs (Archer et al., 2016; Kemp, 2005). Critical realists start with the assumption that there are social power structures that explain the outcome being explored. In contrast, scientific realists would not start with that assumption but rather want to explore whether that was the case. Before conducting any successful research in the social domain, critical realists attempt to identify essential characteristics of that area. They also try to build an appropriate framework or specific assumption for social scientific thinking before conducting actual research (Kemp, 2005).

Our universe not only exists independently of our understanding, but it also has unseen internal structures and forces that are the topics of scientific hypotheses. The aim of all sciences, including the social and human sciences, is to discover these capabilities and the dynamics of their operation (Chirkov, 2016). Even though, there is an absolute reality, human brains are incapable of gaining complete awareness of it. As a result, our construct of reality might be fallible. Although scientific objectivism claims that there is only one correct way to discover reality or truth, scientific realism believes that there can be more than one scientifically correct way of understanding reality (Maxwell, 2012). Thus, observation and testing may help us gain a better understanding of the nature of reality (Flynn, 2018). For example, many assumptions may exist to explain the development of dental caries in children, such as 1. breastfeeding and dental caries, 2. maternal health and dental caries, 3. family income and dental caries etc. Instead of
believing in one absolute assumption, scientific realism encourages us to explore all these assumptions and others with the help of empirical examination (observation and testing). This strategy may help us to get closer to the truth, or it may lead us to discover the real mechanism of the phenomenon.

I was interested in exploring the mechanisms at play at the individual and community levels to understand the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan. Because mechanism is a fundamental concept in realist paradigm and realist researchers aim to discover the underlying mechanisms that generate a given phenomenon and to grasp how they interact to shape the outcome, it makes sense that I took a realist philosophical stance in my research (Danermark et al., 2002). It would not be wrong to choose critical realism as my philosophical position, but I preferred to choose the scientific realism posture. Critical realists may start with the certain assumption that colonization is the real issue for early childhood caries in rural and remote children in Northern Saskatchewan. Rather than starting with that assumption, I preferred to explore the issue with an open mind to examine all the assumptions related to the existence of this phenomenon. It is indeed possible that I might come to the same conclusions as would a critical realist. However, I preferred to explore first to understand the phenomenon.

3.1.4: Systems Thinking

The concept of system thinking has been widely studied, and it has been applied in various fields, including engineering, management, health, manufacturing, and ecology to understand complex systems (Cabrera & Cabrera, 2019; Senge, 1990; “Systems thinking”, n.d.). It emphasizes the importance of understanding the system as a whole rather than just individual
parts of it; it considers how the relationships and dynamics among its parts influence the behaviour of the system (Mingers & White, 2010). Some important properties of system thinking are holism, the interconnectedness and interdependence of various parts of a system, feedback loops, boundaries, emergence, and nonlinearity (Meadows, 2008; Mingers, 2014). We can understand the system thinking approach by considering the example of the human body system. For example,

- **Interconnectedness**: The human body is comprised of several interconnected systems, including the cardiovascular system, respiratory system, nervous system, endocrine system, and immune system. These systems work together and influence each other to sustain a person’s overall health and wellness. The respiratory system is nested within the larger cardiovascular system, which is nested within the overall body system (Mingers, 2014).

- **Emergent properties**: A system can have emergent properties that arise from the interactions and relationships between the individual parts or the components of the system but that are not present in any individual part or component by itself (Pines, 2014). For example, our immune system has different immune cells with specific functions. When they work together, they can defend the body against a wide range of pathogens (“Overview of the immune system”, 2013).

- **Feedback loops**: Systems thinking highlights the significance of feedback loops in sustaining equilibrium within a system by continuously monitoring and adjusting the system outputs based on the inputs (Meadows, 2008). An example of this can be seen in the body's response to dehydration, where the hypothalamus in the brain detects changes in blood volume and osmolality; in response, it triggers the
release of antidiuretic hormone (ADH). ADH then acts on the kidneys to promote water reabsorption, reduce urine volume and conserve water to prevent further dehydration. This feedback mechanism helps to maintain fluid balance and prevent dehydration (Hall, 2016).

- Non-linear relationships: Systems thinking recognizes that the relationships between the different parts of a system are non-linear. This non-linear relationship means that small changes in one part of the system can have a disproportionate impact on the whole (Meadows, 2008; Willy, Neugebauer, & Gerngroß, 2003). Focusing only on individual parts of the system does not allow us to fully comprehend the behavior of the system as a whole. For example, stress has a notable influence on the immune system, because it can affect the production and distribution of hormones and cytokines. However, the correlation between stress and immune function is not always direct since moderate stress can boost immune function, while prolonged or chronic stress can suppress it (Glaser & Kiecolt-Glaser, 2005).

- Boundary: Boundaries are an important concept in systems thinking, as they refer to the separation of a system and its components from external environments or other systems. In the human body, numerous subsystems collaborate to maintain overall health, and each has its own distinctive boundary. For example, the skin acts as a boundary for the physical system by separating the body from the external environment, while the circulatory system is bounded by veins and arteries that transport blood throughout the body (Mingers, 2014).
• Holism: As stated above, system thinking emphasizes the importance of considering the system as a whole rather than just focusing on individual parts (Meadows, 2008). In the human body, this perspective is evident through the interconnectedness and interdependence of different systems, which work together to maintain the body's overall functioning and stability. The human body can be seen as a nested system, where smaller systems are contained within larger ones. Each system contributes to the maintenance of homeostasis, and their interactions are crucial for the proper functioning of the body. The nervous system facilitates communication and coordination between the different parts of our body systems, while feedback loops involving multiple systems help regulate important bodily processes like body temperature (Hall, 2016; Mingers, 2014). Any changes or issues in one part of the body can affect the entire system.

Systems thinking acknowledges that systems are comprised of hierarchical levels, where each level consists of subsystems or components that interact with one another to produce the behavior of the system as a whole. By examining the relationships among these hierarchical levels, we can gain insights into solving complex issues (Mingers, 2014). Planning any interventions without analyzing the interconnections and interdependencies among the different components of a system may lead to short-term solutions that do not address the root cause of the problem (Lee et al., 2017).

Upon learning of the story of 9-year girl from Alberta, Canada (mentioned in the chapter one, background section of this thesis) who suffered greatly as a result of early childhood caries, people might be tempted to blame her parents for not taking her to the dentist in the first place.
However, before placing judgment, one should consider other factors. The girl and her siblings were in foster care, and after reuniting with their family, the child welfare officials again contacted their mother to take them back into foster care, which their parents refused (Kleiss, 2015). This situation may have factored in on why her mother did not take her to the dentist in the first place. Thus, we must consider what may have been going through in her mother's mind. The potential mechanism may have been the fear of losing her child to social service, or the parents' ability to pay the dental treatment fees or there may have been some other mechanisms. Imagine, if the girl was living in a remote area of Northern Saskatchewan, this could have added new and unique challenges for her parents. The context of remoteness could trigger some different mechanisms that might influence her parents’ decision for not taking her to the dentist. And these mechanisms can be triggered for people residing in remote communities, regardless of whether one is Indigenous or not. However, the literature helped me to understand that being an Indigenous can add another layer of complexity to the problem because of colonization. In that case the potential mechanisms might also have had a connection with colonization, Indigenous inequity, and the history of residential schools.

From the above discussion, we can understand that eradication of early childhood caries in rural and remote children in Northern Saskatchewan relates not only to the acid reduction in the children’s mouths. It may also relate to geographic location, economic conditions, individual beliefs, community cultures, colonization, politics, environment, and more. Due to the systemic nature of this phenomenon, addressing this problem from a system thinking perspective is the appropriate way to understand the complexity of the phenomenon at multiple system levels. System thinking approach can help us to understand the hierarchical structure of this
phenomenon and how different level mechanisms fit together, influence each other and finally shape the outcome.

3.2: Chapter Summary

This chapter summarizes the philosophical background of this study. It discusses a brief history of realism, the ontological and epistemological stances of critical and scientific realism. It also discusses the concept of systems thinking and its importance in understanding the complex phenomenon of early childhood caries. The next chapter will discuss how the analytical framework of this study is framed based on this theoretical framework.
CHAPTER FOUR

4.1: Analytical Framework

The realist philosophy underpins realist research. In turn, realist evaluation and realist synthesis are the two forms of realist research (Greenhalgh et al., 2017). Realist evaluation is a theory-driven evaluation process in which the researcher needs to venture into the field to collect primary data to confirm, refute and refine realist theory or theories about the phenomenon of interest (Pawson & Tilley, 1997; Wong, 2018). Realist evaluation starts with a program theory which explains how, why, for whom, in what settings, and to what extent an intervention is intended to 'work.' Before starting an evaluation, program theories need to be middle-range in nature—that is, they must be articulated at a degree of abstraction close enough to the observable data to allow for empirical testing (Wong, 2018). In contrast, realist synthesis is a theory-driven evidence synthesis process. In this process, the researcher works with secondary data such as policy documents, grey literature, editorials, and published studies, to confirm, refute and refine the realist theory or theories about the phenomenon of interest (Pawson; 2006). Realist synthesis starts with an initial understanding of theory and tries to develop a program theory composed of testable hypotheses (Wong, 2018). Most researchers choose one category (i.e., synthesis or evaluation) as part of their broader research program due to time and other limitations (Jagosh et al., 2015; Pearson et al., 2015; Waldron, 2018). I used realist synthesis in this study because there was no intervention yet regarding the phenomenon of interest that I wanted to evaluate. The rationale for using realist synthesis in this study is described in the next section.
4.1.1: **Realist Synthesis**

The goal of realist synthesis is to articulate an underlying program theory (hypothesizes how, why and what circumstances the phenomenon of interest is thought to happen or work) and then to analyze the existing data to see whether and where that theory is relevant and effective (Pawson; 2006). It employs interpretive cross-case comparison to comprehend and explain how and why observed outcomes in the research included in a review happened (Wong, Greenhalgh, Westhorp, & Pawson, 2012). In this realist synthesis, program theory is about phenomenon not about any program or intervention. Based on realist philosophy, realist synthesis aims to create a generative explanation for causation - that is, an outcome (O) of interest was generated by relevant mechanism(s) (M) being triggered in various contexts (C). Using realist concepts to analyze data helps to distinguish realist synthesis from other types of reviews (Wong, Westhorp, et al., 2013). This study aimed to explore the mechanisms at the individual and community levels to understand the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan in all of its complexity. To do this, I conducted multiple realist syntheses at the various levels of the phenomenon being studied and as identified in an initial program theory. This is both the novelty and challenge of this work, which resulted in the development of a multilayer map showing reasons for early childhood caries in rural and remote children in Northern Saskatchewan. This research will allow future researchers to further test and refine its hypotheses based on the program theory.

As mentioned, realist reviews use a context-mechanism-outcome (CMO) configuration, which was developed by Pawson and Tilly, to explain the outcomes (either intended or unintended) observed within any phenomenon (Pawson & Tilley, 1997). This CMO
configuration is a statement, diagram, or graphic that describes the links between certain features of context, mechanisms, and outcomes (Wong, Westhorp, et al., 2013). In any phenomenon, outcomes may be caused by a mechanism or a series of mechanisms that are only activated when a specific context is present (Wong, 2018). The features of context, mechanisms and outcomes, as well as the relationships between them, are discussed in the following paragraphs.

4.1.1a: Context. The collection of situations and conditions that accompany an event is referred to as context (Pawson, 2013). For the realist researcher, dealing with the complexity of context is a challenge (Pawson, 2013). Contexts include not only physical and social factors, but also psychological, organizational, economic, and technological factors. Context is also related to social rules, customs, and norms as well as the social, cultural and economic infrastructure surrounding a phenomenon (Greenhalgh et al., 2017). Context triggers a mechanism, and this results in an outcome. For example, a lack of maternal oral healthcare during pregnancy (context) increases the mother's salivary S. mutans. Since mothers have close contact with their infants, there is a significant risk of the vertical transmission of S. mutans from mother to child where saliva is the primary vehicle of transmission (mechanism) (Damle et al., 2016). As a result, a lack of maternal oral health care may raise the risk of early childhood caries in children (outcome). Due to the complexity of my program theory at multiple levels, there are situations where an outcome at one level can be a context at another. For example, literature suggests that colonization (context) led to the erosion of a traditional diet among Indigenous Peoples (outcome), as they lack access to their hunting territories and land (Skinner, Hanning, Desjardins, & Tsuji, 2013). Here the outcome (a lack of a traditional diet) at the societal level can act as a context at the Individual level. Because of the unavailability of traditional diets (context), parents may prioritize consuming store-bought highly processed foods or sugar-
containing snacks and beverages that are cariogenic, which can trigger early childhood caries (outcome).

4.1.1b: Mechanism. Mechanisms are the underlying elements, processes, or structures that act in certain contexts to produce outcomes (Astbury & Leeuw, 2010). Mechanisms are hidden; they exist whether or not they are activated (Bhaskar, 2008; Wong et al., 2012). For example, in remote geographic locations (context), most of the visiting dentists who provide treatment are unavailable in winter (context). As a consequence, during the winter, parents need to drive or fly long distances from their communities to receive dental care, which is often provided in environments where no one speaks their language or understands them culturally (Lemchuk-Favel, 2010). Thus, anxiety (mechanism) may influence parents to wait until care can be provided in their home environment. This leads them to defer dental care, which results in early childhood caries (outcome).

4.1.1c: Outcome. An occurrence that follows as a result or consequence is called an outcome. Together, context and mechanisms generate outcomes. The direction of the outcome (intended or unintended, positive or negative) depends on the mechanism triggered by the context within any phenomenon. By putting together context, mechanism and outcome in a configuration of CMO (C + M = O), a realist review aims to explain the outcomes (intended and unintended) observed within a phenomenon (Wong, 2018). Constructing the CMO configuration serves as a foundation for developing and/or refining the theory that will be the review's final product (Wong, Westhorp, et al., 2013).

In realist research, CMO configurations should be expressed in a middle-range of abstraction. They must contain enough data to generate testable hypotheses while being abstract
enough to be applied to other circumstances as well (Wong, Westhorp, et al., 2013). Identifying an underlying middle-range theory at the beginning of a realist synthesis can help the data collection process. This approach can help reviewers strengthen their reasoning and inference, which can make it easier to understand complex results (Flynn, Schick-Makaroff, Levay, & Greenhalgh, 2020; Pawson, Greenhalgh, Harvey, & Walshe, 2005). Well-defined constructs related to the phenomenon at the center of the synthesis can be included or utilized as a reference throughout the process. However, if the constructs are unknown or not well defined, it might be wiser to refer to wider substantive theories (Melville, 2019).

A realist synthesis is different from systematic review and meta-narrative review. The differences between realist synthesis, systematic review, and meta-narrative review are given in the Table 4.1.

Table 4.1

*Table 4.1*  
*Realist review, Systematic review, and Meta-narrative review comparison*

<table>
<thead>
<tr>
<th>Realist Synthesis</th>
<th>Systematic Review</th>
<th>Meta-narrative Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Realist synthesis is a narrative summary based on the interpretive theory that uses realist philosophy to synthesize data from</td>
<td>1. A systematic review aims to find, evaluate, and synthesize all empirical data that fit pre-determined qualifying criteria in order</td>
<td>1. A meta-narrative review seeks to clarify a broad topic area by highlighting the many and complementary</td>
</tr>
<tr>
<td>2. Focuses on causation, attempting to put together the links between contexts, mechanisms, and outcomes, and translating them into explanations of why, how, and for whom an outcome occurs (Pawson &amp; Tilley, 1997; Pawson, 2013).</td>
<td>2. Focuses on finding all primary research related to the review question, critically evaluating that research, and synthesizing the results (Gough, Oliver, &amp; Thomas, 2017).</td>
<td>2. Focuses on bringing clarity to the conception of complex topics where fundamental conceptions are unclear or disagreed upon (Otte-Trojel &amp; Wong, 2016).</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>3. Realist synthesis provides policymakers and practitioners advice and practical recommendations on modifying organizational methodologies that researchers have used to examine the same or a related issue (Greenhalgh, Wong, Westhorp, &amp; Pawson, 2011).</td>
<td>3. It is mainly used as a reliable source of evidence to guide clinical practice (Tacconelli, 2010).</td>
<td>3. A meta-narrative review might be another option for policymakers to better understand and interpret a large body of conflicting evidence.</td>
</tr>
</tbody>
</table>
structures or procedures to most effectively activate relevant mechanisms (Rycroft-Malone et al., 2012).

<table>
<thead>
<tr>
<th>Realist synthesis</th>
<th>Systematic reviews</th>
<th>Meta-narrative review</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Realist synthesis does not seek a definitive decision on any phenomenon of interest because it will be changed or rejected as new data becomes available (Berg &amp; Nanavati, 2016).</td>
<td>4. Systematic reviews seek a definitive answer to whether an intervention is successful or not (Nilsson, Baxter, Butler, &amp; McAlpine, 2016).</td>
<td>4. Instead of focusing on the theories that explain intervention behavior in various contexts, a meta-narrative review examines the researchers' implicit and explicit assumptions, value systems, world views, and other aspects (Greenhalgh et al., 2011; Otte-Trojel &amp; Wong, 2016).</td>
</tr>
</tbody>
</table>

5. Realist synthesis is suited for the deep understanding of complex social interaction. Realist synthesis data to guide decisions (Otte-Trojel & Wong, 2016).

5. Systematic review is well suited to therapeutic interventions where processes and results are

5. Meta-narrative review is well suited to themes where there is disagreement on the nature of the subject being
4.1.2: Realist Synthesis Steps

Realist synthesis is increasingly becoming a common research approach. However, researchers are still working to establish detailed guidelines on the methods for realist synthesis. During the initial introduction of realist synthesis, Pawson suggested five stages to conduct the realist synthesis: 1. clarify the purpose of the realist synthesis, identifying the question, and developing initial program theory, 2. searching for primary studies, 3. quality appraisal, 4. extracting the data, and 5. synthesizing the data (Pawson et al., 2005). After these stages were described the RAMESES (Realist and MEta-narrative Evidence Syntheses: Evolving Standards) project began developing initial publication standards for a realist synthesis. Their goal was to provide relevant and essential information to realist reviewers and users so that they could judge...
the quality and rigor of a realist synthesis (Wong, Greenhalgh, Westhorp, Buckingham, & Pawson, 2013; Wong, Westhorp, et al., 2013). Below (Table 4.2) there is a list of publication standards for a realist synthesis by RAMESES (Wong, Greenhalgh, et al., 2013).

Table 4.2

*List of Publication Standards for a Realist Synthesis by RAMESES*

<table>
<thead>
<tr>
<th>Item</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Title</td>
<td>✓ Name the document as a realist review or synthesis.</td>
</tr>
<tr>
<td>2. Abstract</td>
<td>✓ Brief details of the study's background, review questions or objectives; search strategy; methods of selection, appraisal, analysis and synthesis of sources; main results; and implications for practice.</td>
</tr>
</tbody>
</table>
| Introduction    | A. Rationale for review
<p>|                 | ✓ Why is the review necessary?                                          |
|                 | ✓ What is expected to add to current knowledge of the subject?          |
|                 | B. Objectives                                                          |
|                 | ✓ Describe the review's objective(s).                                    |</p>
<table>
<thead>
<tr>
<th>3. Method</th>
<th>A. Changes in the review process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>✓ Describe the reason for modification of the original plan and justification.</td>
</tr>
<tr>
<td></td>
<td>✓ Rationale for using realist synthesis.</td>
</tr>
<tr>
<td></td>
<td>B. Scoping the literature</td>
</tr>
<tr>
<td></td>
<td>✓ Discuss the initial literature review process.</td>
</tr>
<tr>
<td></td>
<td>C. Searching process</td>
</tr>
<tr>
<td></td>
<td>✓ Discuss the details of the searching process as well as the reasoning for iterative searching.</td>
</tr>
<tr>
<td></td>
<td>D. Selection and appraisal of documents.</td>
</tr>
<tr>
<td></td>
<td>✓ Discuss the details of the data selection process.</td>
</tr>
<tr>
<td></td>
<td>✓ Discuss how the relevance and rigor were maintained.</td>
</tr>
<tr>
<td></td>
<td>E. Data extraction</td>
</tr>
<tr>
<td></td>
<td>✓ Discuss and justify the data that was retrieved from the included documents.</td>
</tr>
<tr>
<td></td>
<td>F. Analysis and synthesis processes</td>
</tr>
<tr>
<td></td>
<td>✓ Detailed description of the analysis and synthesis processes.</td>
</tr>
</tbody>
</table>

| 4. Results                                    | A. Document flow diagram        |
Although there is a publication standard for realist synthesis, there are no specific or clear directions for producing a high-quality realist synthesis product. Thus, I adopted a realist synthesis protocol by combining the original outline developed by Pawson and the publication standards outlined by RAMESES (Pawson et al., 2005; Wong, Greenhalgh, et al., 2013). Molner et al. (2015) utilized the RAMESES guidelines and Pawson’s realist synthesis steps to develop a six-step process; subsequently, he conducted the realist synthesis of unemployment insurance policies, which is outlined below (Molnar et al., 2015).
Figure 4.1. Six steps process of conducting a realist synthesis (Molnar et al., 2015).

This paper outlined the whole process and provided essential details to help researchers work efficiently with their resulting program theory (Molnar et al., 2015). I followed that six steps template to create a realist synthesis protocol for the topic at hand.
4.2: Chapter Summary

This chapter outlines the study's analytical framework. It discusses and addresses the similarities and differences between realist synthesis, realist evaluations, systematic reviews, and meta-narrative reviews. This chapter also explains the publication standards set by RAMESES for any realist synthesis, as well as the steps involved in conducting a realist synthesis according to Pawson. The following chapter covers the detailed steps of this realist synthesis.
CHAPTER FIVE

5.1: Methods

This realist synthesis followed the six-step template used by Molner et al. (2015), which was based on amalgamating the list of publication standards for realist synthesis by RAMESES and the original outline created by Pawson (Molnar et al., 2015; Pawson, Greenhalgh, Harvey, & Walshe, 2005; Wong, Greenhalgh, et al., 2013). These steps I undertook are as follows 1. initial program theory, 2. search strategy, 3. selection and appraisal of documents, 4. data extraction, and 5. analysis and synthesis of data, and 6. dissemination of results.

5.1.1: Initial Program Theory (Step 1)

The first step of realist synthesis is to develop an initial program theory that will help to refine the scope by providing a preliminary map (Flynn et al., 2020). An initial program theory offers the preliminary hypothesis of the potential mechanisms of the phenomenon being studied. As the study goes forward, this hypothesis becomes more refined (Pawson et al., 2005). There are several ways to develop an initial program theory for realist synthesis, such as holding workshops with stakeholders, analyzing secondary documents (policy documents, grey literature, editorials, published studies etc.), or studying literature regarding the phenomenon of interest (Flynn et al., 2020; Wong, Westhorp, et al., 2013). In this study, I developed the initial program theory based on my previous knowledge and expertise and by conducting a
preliminary literature review. The initial program theory presented a brief idea that the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan was operating at multiple levels, including the individual, community, policy, and societal levels. Later, I discussed the initial program theory with my academic supervisor Dr. Gary Groot who has expertise in realist methodology.

5.1.2: Search Strategy (Step 2)

Based on the idea from the initial program theory (step 1), I consulted with a Health Sciences Librarian from the University of Saskatchewan multiple times to develop and refine the search strategy to find out the potential mechanisms at the individual and community levels that result in early childhood caries in rural and remote children in Northern Saskatchewan. I carried out searches using different search engines, databases, and websites to identify academic and grey records. For academic records, I searched MEDLINE, Embase, First Nations Periodical Index, Native Health Database, National Indigenous Studies with Portal (I-Portal), Dentistry and Oral Sciences Source (DOSS), CINAHL database, and Health Star databases. I used MeSH (Medical Subject Heading) terms for search in MEDLINE. I set no publication date restriction while searching for the documents. For academic records, I also searched Google Scholar until I obtained 40-50 sources based on my experience. After this amount, I stopped because the sources were either duplicative or irrelevant to the study. I also searched ProQuest Dissertations and Theses for theses and dissertations; in this case, I restricted the search to Canada. For grey records, the searches were conducted through Google (restricting the search to Canada), provincial health-related resource websites (such as Saskatchewan Oral Health Coalition), and different Indigenous health resources websites (such as First Nations Health Authority website). A document search was also carried out at the policy and societal levels based on the initial
program theory. With so many documents, this was a challenging endeavour. However, the broad search strategy was beneficial in helping me to obtain a complete understanding of the topic and to identify the mechanisms at the individual and community levels. The search terms are given below.

5.1.2a: Individual level search terms and sources searched for academic literature, theses, and dissertations.

Table 5.1

<table>
<thead>
<tr>
<th>Search engines</th>
<th>Search terms and queries</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEDLINE, Embase, CINAHL, I-Portal, Google Scholar, ProQuest Theses and Dissertations</td>
<td>(Early Childhood Caries OR Dental Caries, Dental Decay OR Cavities, Cavit, Caries) [MeSH Term] OR Oral Health OR Dental Health AND (Children OR Preschool Children OR Baby, Babies OR Infants) AND (Indigenous Children OR Indigenous Communities OR First Nations, Inuit, And Métis) AND (Remote OR Rural OR Remote Geographical Location OR Northern Saskatchewan) AND (Canada) AND (Parent-Child Relations OR Parents Oral Health Knowledge, Attitudes, Practice OR Occupations OR Income OR Socioeconomic Factors OR Family OR Family Relations OR Housing OR Parents Educational Status OR Parents OR Mothers OR Fathers)</td>
</tr>
</tbody>
</table>

5.1.2b: Individual level search terms and sources searched for grey literature.

Table 5.2
Individual Level Search Terms and Queries for Grey Literature

<table>
<thead>
<tr>
<th>Search engine</th>
<th>Search terms and queries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Early Childhood Caries OR Dental Caries, Dental Decay AND Remote/Rural Children AND Canada</td>
</tr>
<tr>
<td></td>
<td>2. Early Childhood Caries OR Dental Caries, Dental Decay AND Indigenous Children OR Indigenous Community OR First Nations, Inuit, And Métis AND Saskatchewan, Canada AND Indigenous Parents.</td>
</tr>
<tr>
<td></td>
<td>3. Early Childhood Caries OR Dental Caries, Dental Decay AND Rural/Remote Children OR Rural/Remote Community AND Saskatchewan, Canada.</td>
</tr>
</tbody>
</table>

5.1.2c: Individual level hand search terms and sources searched for grey literature.

Table 5.3

Individual Level Hand Search Terms and Query for Grey Literature

<table>
<thead>
<tr>
<th>Websites</th>
<th>Search approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. National Collaborating Center for Indigenous Health</td>
<td>• Search for children dental caries in rural and remote areas in Canada.</td>
</tr>
<tr>
<td>3. First Nations Information Governance Centre</td>
<td>• Search for early childhood caries in Northern Saskatchewan.</td>
</tr>
<tr>
<td>5. Saskatchewan First Nations, Métis and Northern Affairs Directory</td>
<td></td>
</tr>
<tr>
<td>6. First Nations Health Authority</td>
<td></td>
</tr>
<tr>
<td>7. Indigenous Health: Oral Health - Research Guides USASK library</td>
<td></td>
</tr>
<tr>
<td>8. Canadian Dental Association</td>
<td></td>
</tr>
<tr>
<td>9. Oral health - Canada.ca</td>
<td></td>
</tr>
<tr>
<td>10. Canadian Paediatric Society</td>
<td></td>
</tr>
<tr>
<td>11. <a href="http://www.oralhealthroundtable.ca/oral-health-reports">http://www.oralhealthroundtable.ca/oral-health-reports</a></td>
<td></td>
</tr>
</tbody>
</table>
5.1.2d: Community level search terms and sources searched for academic literature, theses and dissertations

Table 5.4

*Community Level Search Terms and Queries for Academic Literature, Theses and Dissertations*

<table>
<thead>
<tr>
<th>Search engines</th>
<th>Search terms and queries</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEDLINE</td>
<td>(Early Childhood Caries OR Dental Caries, Dental Decay OR Cavities, Cavit, Caries) [MeSH Term] OR Oral Health OR Dental Health</td>
</tr>
<tr>
<td>Embase</td>
<td>AND (Children OR Preschool Children OR Baby, Babies OR Infants) AND (Indigenous Children OR Indigenous Community OR First Nations, Inuit, And Métis) AND (Canada) AND (Remote OR Rural OR Remote Geographical Location OR Northern Saskatchewan) AND (Community Based OR Community Level OR Community Involvement OR Community Participation)</td>
</tr>
<tr>
<td>CINAHL</td>
<td></td>
</tr>
<tr>
<td>I-Portal</td>
<td></td>
</tr>
<tr>
<td>Google Scholar</td>
<td></td>
</tr>
<tr>
<td>ProQuest Theses and Dissertations</td>
<td></td>
</tr>
</tbody>
</table>

5.1.2e: Community level search terms and sources searched for grey literature.
Table 5.5

*Community Level Search Terms and Queries for Grey Literature*

<table>
<thead>
<tr>
<th>Search engine</th>
<th>Search terms and queries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google</td>
<td>1. Early Childhood Caries OR Dental Caries, Dental Decay AND Remote/Rural Children OR Remote/Rural Community OR First Nations, Inuit, And Métis AND Canada.</td>
</tr>
<tr>
<td></td>
<td>2. Early Childhood Caries OR Dental Caries, Dental Decay AND Indigenous Children OR Remote Indigenous Community OR Rural/Remote Community OR First Nations, Inuit, And Métis AND Northern Saskatchewan, Canada AND Fluoride OR Community Fluoridation.</td>
</tr>
<tr>
<td></td>
<td>4. Early Childhood Caries OR Dental Caries, Dental Decay AND Indigenous Children OR Remote Indigenous Community OR First Nations, Inuit, And Métis AND Canada AND Community Involvement OR Culturally Competent Community Dental Health Initiatives/Programs.</td>
</tr>
</tbody>
</table>

5.1.2f: Community level hand search terms and sources searched for grey literature.

Table 5.6

*Community Level Hand Search Terms and Queries for Grey Literature*

| Websites | Search approach |
1. National Collaborating Center for Indigenous Health
2. Saskatchewan Oral Health Coalition
3. First Nations Information Governance Centre
4. Métis Nation - Library and Archives Canada
5. Saskatchewan First Nations, Métis and Northern Affairs Directory
6. First Nations Health Authority
7. Indigenous Health: Oral Health - Research Guides USASK library
8. Canadian Dental Association
9. Oral health - Canada.ca
10. Canadian Paediatric Society
11. http://www.oralhealthroundtable.ca/oral-health-reports
12. Canadian Association of Public Health Dentistry
https://www.caphd.ca/programs-and-resources/members-publications#y2008

- Search for dental caries in remote/rural areas and community level access barriers.
- Search for early childhood caries in rural/remote or Northern Saskatchewan or First Nations, Inuit and Métis children.
- Search for Indigenous children’s dental caries and community level access barriers.

5.1.2g: Policy and societal level search terms and sources searched for academic literature, theses and dissertations.

Table 5.7

Policy and Societal Level Search Terms and Queries for Academic Literature, Theses, and Dissertations

<table>
<thead>
<tr>
<th>Search engines</th>
<th>Search terms and queries</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEDLINE Embase CINAHL I-Portal</td>
<td>(Early Childhood Caries OR Dental Caries, Dental Decay OR Cavities, Cavit, Caries) [MeSH Term] OR Oral Health OR Dental Health AND (Children OR Preschool Children OR Baby, Babies OR Infants) AND</td>
</tr>
<tr>
<td>Google Scholar ProQuest Theses</td>
<td></td>
</tr>
<tr>
<td>Dissertations</td>
<td></td>
</tr>
</tbody>
</table>
(Remote OR Rural OR Remote Geographical Location OR Northern Saskatchewan)
AND
(Indigenous Children OR Indigenous Community OR First Nations, Inuit, and Métis)
AND
(Canada)
AND
(Policy OR Government Dental Health Policy)
AND
(Indigenous Dental Health Benefits OR Administrative OR Bureaucratic Barriers in Accessing Benefits OR Barriers in Accessing NIHB)
AND
(Colonization OR Racism OR Historic Trauma)

5.1.2h: Policy and societal level search terms and sources searched for grey literature.

Table 5.8

*Policy and Societal Level Search Terms and Queries for Grey Literature*

<table>
<thead>
<tr>
<th>Search engine</th>
<th>Search terms and queries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Early Childhood Caries OR Dental Caries, Dental Decay AND Indigenous Children OR Indigenous Community OR First Nations, Inuit, and Métis AND Northern Saskatchewan, Canada AND Indigenous Dental Health Benefits OR Administrative and Bureaucratic Barriers in Accessing Benefits.</td>
</tr>
<tr>
<td></td>
<td>3. Early Childhood Caries OR Dental Caries, Dental Decay AND Remote/Rural Community OR Northern Saskatchewan, Canada AND Colonization OR Racism OR Historical Trauma.</td>
</tr>
</tbody>
</table>
5.1.2i: Policy and societal level hand search terms and sources searched for grey literature.

Table 5.9

*Policy and Societal Level Hand Search Terms and Queries for Grey Literature*

<table>
<thead>
<tr>
<th>Websites</th>
<th>Search approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. National Collaborating Center for Indigenous Health</td>
<td>• Search for remote/rural children's dental caries and dental policy.</td>
</tr>
<tr>
<td>2. Saskatchewan Oral Health Coalition</td>
<td>• Search for colonization and children dental caries in remote/rural areas or dental caries in</td>
</tr>
<tr>
<td>4. Métis Nation - Library and Archives Canada</td>
<td></td>
</tr>
<tr>
<td>5. Saskatchewan First Nations, Métis and Northern Affairs Directory</td>
<td></td>
</tr>
<tr>
<td>6. First Nations Health Authority</td>
<td></td>
</tr>
<tr>
<td>7. Indigenous Health: Oral Health - Research Guides USASK library</td>
<td></td>
</tr>
<tr>
<td>8. Canadian Dental Association</td>
<td></td>
</tr>
<tr>
<td>9. Oral health - Canada.ca</td>
<td></td>
</tr>
<tr>
<td>10. Canadian Paediatric Society</td>
<td></td>
</tr>
<tr>
<td>11. <a href="http://www.oralhealthroundtable.ca/oral-health-reports">http://www.oralhealthroundtable.ca/oral-health-reports</a></td>
<td></td>
</tr>
<tr>
<td>12. Canadian Association of Public Health Dentistry</td>
<td></td>
</tr>
<tr>
<td><a href="https://www.caphd.ca/programs-and-resources/members-publications#y2008">https://www.caphd.ca/programs-and-resources/members-publications#y2008</a></td>
<td></td>
</tr>
</tbody>
</table>

The search continued through an iterative process. The "pearl growing" strategy was utilized to find more materials or studies on the same topic by exploring the reference lists of the included studies (Hadfield, 2020). The search stopped when there were no new documents found. All the searched documents (only in the English language) were transferred to Covidence.
This software was used to identify duplicate documents and screen documents for data selection, appraisal and data extraction (“Covidence”, n.d.).

5.1.3: Selection and Appraisal of Documents (Step 3).

This step of realist synthesis involves document review. In a realist synthesis, the searching of documents, their selection, and their appraisal are purposive and iterative to refine the initial program theory (Rycroft-Malone et al., 2012). Any document – such as research, reports, news articles, conference presentations, case studies, and more – can be useful if it has the information to refine or build theory/CMO configurations. Initially, in the first stage (first screening), all the documents were reviewed by their titles and abstracts while grey document files were reviewed in full (as there were no abstracts to review). I tried to find whether the document discussed early childhood caries and, rural and remote areas in Canada or Indigenous communities in Canada, was written in the English language and ensured that it did not only discuss proposed future research plans. In the second stage (second screening), the selected documents were further screened at the full-text level because, in a realist synthesis, data can be found in any part of the article, not only in the result section (Jagosh, 2019). Subsequently, the documents were included if they contained enough information that could help build or refine theory/CMO configurations and if they had relevance to the initial program theory (Wong, Westhorp, et al., 2013). Another important inclusion criterion for selecting documents is rigour – whether the data was good enough to be included (Hunter, Gorely, Beattie, & Harris, 2022; Rycroft-Malone et al., 2012). In this realist synthesis, information was drawn from different parts of the articles or documents (research, reports, news articles, conference presentations, case studies, and more); as such, they were screened to see whether they could support the CMO
configurations or had data that were rich enough to construct them. In traditional systematic reviews, the quality appraisal of studies is done to eliminate unreliable evidence (Tacconelli, 2010). However, in a realist synthesis, evidence is appraised to determine its significance to refine the program theory. This sets a realist synthesis apart from a traditional systematic review (Hunter et al., 2022; Tacconelli, 2010).

5.1.4: Data Extraction (Step 4)

After reading the selected documents, I extracted the important information from the texts. All the extracted information was organized in a Microsoft Excel document in contexts, mechanisms and outcomes columns, and it was further assembled into explanatory account statements (Pearson et al., 2015). Important information (possible context) was also extracted and kept, even if it was not possible to express it through explanatory accounts. Explanatory account statements were written as “if and then” statements; they sometimes contained all three aspects of a CMO configuration and sometimes did not (Pearson et al., 2015; Waldron, 2018). For example,

<table>
<thead>
<tr>
<th>Extracted text from a study (Kyoon-Achan et al., 2021)</th>
<th>Explanatory account statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>“When you’re First Nations, you’re budgeted. Then who is going to drive all the way to [town] and go buy a little toothbrush and toothpaste, you know …”</td>
<td>If parents need to drive into town from a remote area (context) only to buy dental hygiene products (toothpaste and toothbrushes), then they may not give priority to buying these items; this may...</td>
</tr>
</tbody>
</table>
result in their children skipping teeth brushing (outcome).

5.1.5: Analysis and Synthesis of Data (Step 5).

This step was also completed through an iterative approach. All the extracted data and explanatory account statements were analyzed and organized into themes. The research team (which was comprised of Dr. Gary Groot, Dr. Tracey Carr, and me) met together twice to discuss and identify demi-regularities (recurrent patterns of contexts and outcomes) within the data. On some occasions, I got clues about context and outcome from the same article, either quantitative or qualitative; however, none of the articles had precise or clear mechanisms. To determine the mechanisms that may be activated through different contexts, I used retroduction. For example, the literature mentioned that in remote areas, the unavailability of grocery stores with healthy food and the high food costs of such items might have a connection with dental caries in the children living in Northern Saskatchewan (Ogenchuk et al., 2022). To try to understand the mechanism or the hidden thoughts that these parents had in their minds as they were buying groceries, I read and explored around 15-20 peer-reviewed articles, news articles, and documentaries regarding people's food-buying tendencies and priorities that were not included in the original screened documents. These reading materials did not directly mention early childhood caries; nonetheless, they gave me the basis for creative thinking and for inferring possible mechanisms. Again, as a non-Indigenous person, I may not have accurately reflected the thinking of Indigenous parents based on my analysis of secondary data. However, the reason I hypothesized some Indigenous-specific mechanisms, is to highlight the complexity of the
phenomenon and acknowledge that these mechanisms need to be verified through engagement with the communities involved.

5.2: Ethical Consideration

This realist synthesis utilized documents that were already published and publicly accessible to develop the multilayer map showing a hierarchy of different-level mechanisms, illustrating how they interact with each other to influence the existence of early childhood caries in rural and remote children in Northern Saskatchewan. The study followed the ethical standards of utility, practicality, accuracy and accountability (Durham & Bains, 2015). Studies that solely utilize publicly available information protected by law are exempt from requiring review by the Research Ethics Board (Tri-Council Panel on Research Ethics, 2023a). However, the mechanisms that I hypothesized related to Indigenous Peoples in Northern Saskatchewan, based on secondary data, only serve to highlight the complexity of the phenomenon to be further developed with community consultation.

5.3: Chapter Summary

This chapter summarizes the specific steps undertaken in this realist synthesis. Based on available secondary data, I hypothesized the potential mechanisms that influence the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan. The findings of this realist synthesis are presented and thoroughly explained in the following chapter
CHAPTER SIX

6.1: Results

6.1.1: Initial Program Theory Development

The initial program theory may not always be constructed in realist terms but still it helps
the reviewer to guide the realist synthesis process (Wong, Westhorp, et al., 2013). By conducting
an initial review of the relevant literature and using my knowledge and background as a dentist, I
formulated the initial program theory. This theory outlined the concept that the phenomenon of
early childhood caries in rural and remote children in Northern Saskatchewan was operating at
multiple levels, including the individual, community, policy, and societal levels. A figure of the
initial program theory can be found in appendix B.

6.1.2: Search Results, Selection, Data Extraction and Analysis and Synthesis of Data

First, a total of 327 records were identified through searching databases. 43 documents
were removed as duplicates. Then, all the documents were reviewed in the first stage (first
screening) at the title, and abstract levels. In turn, grey document files were reviewed in full
since there were no abstracts to review. 112 documents were selected for the full-text level
screening (second screening). After the full-text level screening, 64 of these documents were
excluded as they had no relevance and rigour in terms of constructing or supporting the program
theory. In the end, 48 documents were included in this review.
All the included documents’ references are given in the appendix A. From the included documents, important data were extracted and arranged as explanatory account statements. Predominantly, the records discussed context and outcome; as such, mechanisms were identified through performing retrodiction based on the available data. Through analysis and synthesis of the data, I developed the multilayer conceptual map that presents a hierarchy of different-level mechanisms and their interactions with each other that influence early childhood caries in rural and remote children in Northern Saskatchewan. The following Figure 6.1 shows the documents screening flowchart.
Figure 6.1. Documents screening flowchart.
6.1.3: Findings

Figure 6.2. CMO configurations for early childhood caries (biological level).

From Figure 6.2, we can see that the key pathophysiologic mechanisms responsible for early childhood caries are dental plaque accumulation in the mouth, acid production and the demineralization of the tooth surface. These key mechanisms can be influenced by oral hygiene, diet, and the colonization of bacteria. However, in the case of a child living in remote area in Northern Saskatchewan who may have good oral hygiene or a poor diet, the specific mechanisms
that impact them can be triggered through certain contexts. In this realist synthesis, I have hypothesized those potential mechanisms based on available secondary data. Among these mechanisms, some are Indigenous-specific while most are not. I've hypothesized those Indigenous-specific mechanisms based on my analysis of secondary data. As a non-Indigenous individual, I am fully aware that, I can't speak for the complexity of important mechanisms that only Indigenous Peoples know. Again, these Indigenous-specific mechanisms might not be applicable for all Indigenous Peoples living in Northern Saskatchewan. This is because historical political relationships, differing government policies and assimilation strategies have played a crucial role in shaping distinct social experiences among Indigenous Peoples (Reading & Wien, 2009; Tri-Council Panel on Research Ethics, 2023b; Voyageur & Calliou, 2000). Also, it is important to note that literature might not always address each Indigenous group separately while presenting the findings (Reading & Wien, 2009). However, the Indigenous-specific mechanisms that I hypothesized based on secondary data, serve to highlight the complexity of the phenomenon to be further developed with community consultation. All the hypothesized potential mechanisms related to oral hygiene are presented in the next paragraph through figures and tables with detailed CMO configurations (for better clarity and identification, Indigenous-specific mechanisms are marked within tables). Subsequently, I used the same approach to present the other potential key mechanisms related to diet and the colonization of bacteria.

6.1.3a: Oral hygiene. Oral hygiene is the act of ensuring the cleanliness and well-being of one's mouth and teeth in order to avoid tooth decay and gum disease. At the individual level, this can be maintained by visiting the dentist and brushing and flossing teeth regularly (Oral hygiene, n.d.). In the community, oral hygiene can be improved through community water fluoridation (Murchio & White, 2022; “Oral health tips”, n.d.). While developing a program
theory, I hypothesized some potential key mechanisms based on available secondary data that would be triggered by some context, resulting in good or bad oral hygiene in rural and remote children in Northern Saskatchewan (intermediate outcome). These key mechanisms, along with explanations, are given in the figures (6.3 - 6.5) and tables (Table 6.1-6.5) below.
**Figure 6.3.** Key mechanisms identified for regular teeth brushing.

The first step for parents to maintain or monitor their children's regular teeth brushing is having oral health knowledge and instructions. From figure 6.3 we can see that parents’ education, language barriers, availability of educational materials in their language, availability of educational materials in a remote area, colonization, and Indigenous community involvement—all these contexts triggered three different potential mechanisms. Those mechanisms influence the outcome of having oral health knowledge and instructions among parents. The detailed explanation of the key mechanisms related to oral health knowledge and instructions are given in table 6.1

**Table 6.1**

*Key Mechanisms and Detailed CMO Related to Oral Health Knowledge and Instructions*

<table>
<thead>
<tr>
<th>Key mechanisms related to oral health knowledge and instructions</th>
<th>Detailed CMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeling of being able to access, understand and utilize the information (Schroth et al., 2007; Schroth et al., 2013; Mathu-Muju, McLeod, Donnelly, Harrison, &amp; MacEntee, 2017).</td>
<td>Parent’s education (C), language barrier (C), availability of educational materials in their language (C), availability of educational materials in a remote area (C), + feeling of being able to access, understand and utilize the information (M)</td>
</tr>
</tbody>
</table>
If parents have education (C), or the educational materials are available in their language (C), or the educational materials are available in a remote area (C), parents may feel that they are being able to access and understand the information (M), which may increase their confidence to use the oral health knowledge and instructions (O).

2. Trust toward the source (Malone, 2020)

Availability of educational materials in their language (C), availability of educational materials in a remote area (C), colonization (C), + trust toward the source (M) = oral health knowledge and instructions (O).

If parents do not trust the source (M), it may be due to the history of colonization (C), then they may not want to learn or use the oral health knowledge and instructions (O).
3. Feeling of being empowered or valued (Indigenous-specific) (Cidro et al., 2015; Lawrence, 2010; Mathu-Muju, McLeod, et al., 2017; Smylie et al., 2016)  

Indigenous community involvement (C) + feeling of being empowered (M) = \( \uparrow \downarrow \) oral health knowledge and instructions (O).  

If there is Indigenous community involvement (using their beliefs and techniques) (C) to educate Indigenous parents, then it can make them feel empowered or valued (M), which can increase their curiosity to use the oral health knowledge and instructions (O).

<table>
<thead>
<tr>
<th>Key mechanisms identified for regular teeth brushing.</th>
<th>Detailed CMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Parents perceived value, prioritization, and belief about tooth</td>
<td>Parent’s education (C), parents' and family members' dental experiences (C),</td>
</tr>
</tbody>
</table>
decay (Bharadwaj & Bradford, 2018; Kyyoon-Achan et al., 2021; Prowse et al., 2014; Schroth et al., 2007) | community tradition and culture (C), parents' oral health knowledge and instructions (C), availability of toothbrush, tooth paste and clean water in a remote area (C), child protest (C), + parents perceived value, prioritization and belief about tooth decay. (M) = regular teeth brushing and flossing (O).

If parents have knowledge about the importance of maintaining regular teeth brushing or have a fear of the consequences of dental cavities and pain (M), it may encourage them to have their children's teeth brushed twice per day (O).

If parents have certain beliefs (M), such as most children developing caries despite precautions or baby teeth are not that important as they will be replaced by permanent teeth, then it may discourage parents from having their children's teeth brushed twice per day (O).

If there is difficulty in accessing dental hygiene products (toothpaste and brush) in
remote areas (C), and parents need to drive into town from a remote area only to buy dental hygiene products, then they may not give priority to buying (M) which can make their children skip teeth brushing (O).

If there is poor drinking water quality and quantity in remote areas (C), parents may not feel like giving priority (M) to maintaining children's personal hygiene or brushing their teeth every day (O).

| 2. Parents perceived self-efficacy (individual beliefs in his or her ability to perform certain behaviors or activities) (Bandura, 1977; Pierce et al., 2019; Prowse et al., 2014; Tiberia et al., 2007). | Child protest (C), parents' busy schedule (C), parents' socioeconomic status (C), + parents perceived self-efficacy (M) = regular teeth brushing and flossing (O). If child protest (C) does not trigger the parent's perception of not being able to monitor or maintain their children's regular teeth brushing (M), then they may want to maintain or monitor children's personal hygiene or brush their teeth every day (O). |
| 3. Stress, depression and demotivation (Assembly of First Nations Environmental Stewardship Unit, 2008; “Oral Health Effects of Stress in Children”, 2023; Tiberia et al., 2007). | If the child's protest (C), or the parent's busy schedule (C), triggers the parent's perception of not being able to monitor or maintain their children's regular teeth brushing (M), then they may not want to maintain or monitor children's personal hygiene or to brush their teeth every day (O).

Child protest (C), parents' busy schedule(C), parents' socioeconomic status (C), + stress, depression and demotivation (M) = regular teeth brushing (O).

If the child's protest (C), or parent's busy schedule (C), triggers stress and depression among parents (M), then they may not want to engage in maintaining or monitoring children's personal hygiene or brushing their teeth every day (O).

If children's families have low socioeconomic status (C), children may feel stress or depression (M), which can reduce their interest in their daily activities. |
4. Trust in authority (Kyon-Achan et al., 2021; Sterritt & Woodward, 2019)  

Parent’s education (C), parents' and family members' dental experiences (C), community tradition and culture (C), parents’ oral health knowledge and instructions (C), + trust in authority (M) = regular teeth brushing (O).

If parents do not have trust in authority (M), although they have oral health knowledge and instructions (C), then they may not follow the guidelines given by the providers for monitoring children's personal hygiene or brushing their teeth every day (O).

If parents do not have trust in authority (M), may be due to their poor dental experiences or poor relationship with the providers (C), then they may not follow the guidelines given by the providers for monitoring children's personal hygiene or brushing their teeth every day (O).
5. Empowerment (Indigenous-specific) (Smylie et al., 2016; Viscogliosi et al., 2020)

| Indigenous Elder support (C) + feeling of being empowered or valued (M) = regular teeth brushing (O). |
| If educating parents includes Indigenous community involvement and Indigenous Elder support (using their beliefs and techniques) (C), then parents may feel empowered or valued (M), which can motivate them to monitor children's personal hygiene or brush their teeth every day (O). |

Another step to maintain children's good oral hygiene is visiting the dentist regularly. I hypothesized 5 key mechanisms related to regular dental visits of children living in rural and remote areas in Northern Saskatchewan based on available data. Contexts related to those 5 key mechanisms are parent’s education, parents and family members' dental experiences, community tradition and culture, parents' oral health knowledge and instructions, Indigenous inequity through colonization, availability of dental professionals in a remote area, geographic isolation, difficulty travelling in city hospitals or surgical centers etc. Key mechanisms influencing parents' decision to take their children to dental clinics are shown in the figure 6.4 and described in the table 6.3.
Oral Hygiene

- Choice of health care
- Health dental plan
- Transportation difficulty
- Heavy workload
- Availability of resources
- Resources in remote area
- Availability of support
- Support for partners in remote area
- Availability of education
- Education for children in remote area
- Remote location
- Government incentives

Political legacy

Motivation and encouragement

Feeling of being professionally challenged

Availability of dental professionals

Parent education

Parental health knowledge

Parent and family

Community tradition

Fear of being judged

Indigenous identity

Fear of dental treatment

Fear of cost

Anxiety and frustration

Confidence and encouragement

Regular dental visit

Parent perceived value

Parental and cultural beliefs about normalization of dental care in the community

Trust and support

Fear of dental treatment

Fear of cost

Anxiety and frustration

Confidence and encouragement

Child resistance to visit dentist

Parental ability to pay dental treatment fees

Availability of culturally competent dental care

Detail explanation in previous figure
Figure 6.4. Key mechanisms identified for a regular dental visit.

Table 6.3

**Key Mechanisms and Detailed CMO Related to Regular Dental Visit**

<table>
<thead>
<tr>
<th>Key mechanisms identified for a regular dental visit.</th>
<th>Detailed CMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Parents perceived value, prioritization and belief about the normalization of dental caries in the community (Inam, 2021; Kyoon-Achan et al., 2021; Lawrence et al., 2009; “Nishtam Niwiipitan (my first teeth): an Indigenous learning circle”, 2018)</td>
<td>Parent’s education (C), parents and family members' dental experiences (C), community tradition and culture (C), parents’ oral health knowledge and instructions (C), + parents perceived value, prioritization and belief about the normalization of dental caries in the community (M) = regular dental visit (O). If parents/caregivers have a belief about the inevitability of childhood dental caries or belief that dental caries in children is ingrained in the culture and is just something that all children have to experience (M), then they may show less</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>2. Trust and rapport (Inam, 2021; Kyoon-Achan et al., 2021; Malone, 2020; Phillips-Beck et al., 2020)</td>
<td>Parents and family members' dental experiences (C), community tradition and culture (C), parents' oral health knowledge and instructions (C), power imbalance between dental care practitioners and parents (C), Indigenous inequity through colonization (C), + trust and rapport (M) $\rightarrow$ regular dental visit (O). If there is a power imbalance between dental care practitioners and parents (C), it may hinder trust and rapport (M) between dental care practitioners and parents, thus creating an unfavourable atmosphere that leads to delayed children's dental treatment (O). If Indigenous parents feel mistrust (M) toward dentists, may be due to historical traumatic experiences (C), or power imbalance between dentists and parents</td>
</tr>
</tbody>
</table>
| 3. Fear of being judged, isolated and fear of losing their child to social service (Lemchuk-Favel, 2010; Sterritt & Woodward, 2019) | Indigenous inequity through colonization (C), availability of dental professionals in a remote area (C), geographic isolation (C), difficulty travelling in city hospitals or surgical centers (C), + fear of being judged, isolated and fear of losing their child to social service (M) = regular dental visit (O).

If there is a lack of dental professionals in a remote area (C), then parents need to travel to city hospitals or surgical centers (C) for their children's dental treatments, where they may have the feeling of being isolated and separated from their family (M), which can influence parents’ decision to disregard and defer dental care (O). |
If the generational trauma of residential school and colonization (C) triggers Indigenous parents' fear of losing their child to social service (M), then they may want to protect their children and avoid visiting dental care (O).

If parents need to travel to city hospitals (C) for their children's dental treatments, then they may have a fear of being judged (M) by healthcare professionals or fear of being treated differently, which can influence parents' decisions to wait until care can be provided in their home environment resulting in deferred dental care (O).

| 4. Anxiety and frustration (Canadian Academy of Health Sciences, 2014; Desmarais, 2021; Indigenous Services Canada, n.d.; Lemchuk-Favel, 2010; Prowse et al., 2014) | Availability of dental professionals in a remote area (C), geographic isolation (C), difficulty travelling in city hospitals or surgical centers (C), child resistance (C), parents' ability to pay dental treatment fees (C), + anxiety and frustration M) = regular dental visit (O). |
If there is a lack of dental professionals in a remote area (C), and parents need to travel to city hospitals or surgical centers (C) for their children's dental treatments, then parents may feel anxiety (M), which can influence their decision to disregard and defer dental care (O).

If there is a shortage of dentists in remote areas (C), and a long waiting list for a dentist appointment, then parents may become frustrated (M), resulting in avoiding dental care (O).

If parents don't have the ability to pay dental treatment fees, they may become frustrated (M), which can demotivate them from visiting dental care (O).

If a child has previous poor dental experience (C), needle phobia (C), and hearing another child or adult describe a painful dental operation, then it may trigger anxiety in children (M), leading to avoiding dental appointments (O).
If a child's resistance to visiting a dentist triggers parents' anxiety and frustration (M), then parents can be demotivated to visit dental care with their children (O).

| 5. Confidence and empowerment (Indigenous-specific) (Ashworth, 2018) | Availability of culturally competent dental care (C), + confidence and empowerment (M) = ↑↓ regular dental visit (O). If Indigenous parents find culturally competent dental care available, they may have a sense of being respected (validation of traditional culture that was lost previously), empowered and confident (M), which ultimately can motivate parents to seek dental treatment for their children (O). |

Figure 6.4 shows that one of the contexts, the availability of dental professionals in remote areas, can also act as an intermediate outcome. When I explored more, I found different mechanisms influencing the availability of dental professionals in rural and remote areas in Northern Saskatchewan. The table 6.4 provides a thorough description of those mechanisms relating to the availability of dental professionals in remote areas.

Table 6.4
**Key Mechanisms and Detailed CMO Related to the Availability of Dental Professionals in a Remote Area**

<table>
<thead>
<tr>
<th>Key mechanisms identified for the availability of dental professionals in a remote area</th>
<th>Detailed CMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Feeling of being professionally challenged and frustrated (Forcese, 2019; Inam, 2021; Jolicoeur, DeMiglio, Kin, &amp; Orrantia, 2022; Sharifian et al., 2015).</td>
<td>Transportation difficulty and heavy workload (C), availability of manpower and resources in a remote area (C), availability of educational opportunities and modern amenities for children in a remote area (C), availability of career opportunities for partners in a remote area (C), + feeling of being professionally challenged and frustrated (M) = availability of dental professionals in a remote area (O). If there is transportation difficulty and heavy workload (C), low manpower and resources in a remote area (C), or lack of educational opportunities and modern</td>
</tr>
</tbody>
</table>
2. Political legacy (Marchildon, 2011; Mathu-Muju, Friedman, et al., 2017)

<table>
<thead>
<tr>
<th>Amenities for children in a remote area (C), or few career opportunities for partners in a remote area (C), then health professionals (dentist, hygienist, dental therapist, nurses, registered dietitians, etc.) may feel frustration, or professionally challenged (M), which may actually force healthcare professionals to leave (O). Again, if some health professionals face challenges (M), they may sometimes get motivated to work more and continue working in a remote area (O).</th>
</tr>
</thead>
</table>
| Closure of Saskatchewan health dental plan (C), + political legacy (M) = \[
\begin{align*}
\text{availability of dental professionals in a remote area (O).}
\end{align*}
\] When there was the closure of a publicly funded Saskatchewan school-based oral health programme (1974-1987) (C) might be due to divergent political ideologies and resistance from private dentists (M), which might cause a declining number of dental
Another important element of maintaining good oral hygiene in the community is drinking fluoridated water. However, starting water fluoridation in any community needs community approvals. In this realist synthesis, I hypothesized some potential key mechanisms

| 3. Motivation and encouragement (Sharifian et al., 2015). | Government incentives (C) + motivation and encouragement (M) = availability of dental professionals in a remote area (O). If government provides some incentives (it can be financial, educational, social, or cultural etc.) and take some initiatives (it can be by creating career opportunities for partners, building educational opportunities and modern amenities for children, training people from remote communities etc.) then dental professionals may feel encouraged and motivated (M) to work in a remote area, which may help to overcome the lack of availability of dentists or dental professionals in a remote area (O). |
based on available data that may influence community members and the government to initiate and run water fluoridation in rural and remote areas in Northern Saskatchewan. Key mechanisms are given in the figure 6.5, along with explanations in the table 6.5.
Figure 6.5. Key mechanisms identified for the community water fluoridation.
### Key Mechanisms and Detailed CMO Related to Run Water Fluoridation in the Community

<table>
<thead>
<tr>
<th>Key mechanisms identified for running community water fluoridation in the community.</th>
<th>Detailed CMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Community belief of being able to get benefitted (Canadian Agency for Drugs and Technologies in Health (CADTH), 2019a, 2019b).</td>
<td>Education (C), oral health knowledge and instructions (C), community myth and confusion (C), availability of resources to run water fluoridation program in a remote area (C), the total amount of population in a remote area (C), geographic isolation and weather condition (C), environmental risk (C), availability of other sources of fluoride in a remote community (school fluoride varnish program etc.) (C), + community belief of being able to get benefitted (M) = $\uparrow\downarrow$ community water fluoridation (O). If community members have the belief that water fluoridation could potentially benefit</td>
</tr>
</tbody>
</table>
them (M), then they may give permission to run water fluoridation in the community (O).

If there are low resources to run water fluoridation in a remote community (C), or a small number population living in that community (C), then community members may believe that they may not be benefitted, which could influence them not to give permission to run water fluoridation in the community (O).

| 2. Perception of the feasibility of running community water fluoridation (Canadian Agency for Drugs and Technologies in Health (CADTH), 2018). | Availability of resources to run water fluoridation in a remote area (C), geographic isolation and weather condition (C), environmental risk (C), availability of other sources of fluoride in a remote community (school fluoride varnish program etc.) (C), + perception of feasibility of running community water fluoridation (M) = $\nabla$ community water fluoridation (O). |
If there is any environmental risk (C) or if any community does not get municipal water supply for the whole year and they have to rely on well water, then community members may have the perception of feasibility of running community water fluoridation in their community which could influence them not to give permission to run water fluoridation in the community (O).

If there are low resources (C) or a small population living in that community, then community members may have the perception of the feasibility of running community water fluoridation in that community which could influence them not to give permission (O).

| 3. Trust in authority (Canadian Agency for Drugs and Technologies in Health (CADTH), 2019b) | Education (C), oral health knowledge and instructions (C), community myth and confusion (C), + trust in authority (M) = community water fluoridation (O). |
If community members do not have trust in authority (M), although they have oral health knowledge and instructions (C), they may not give permission to run water fluoridation in the community (O).

**6.1.3b: Diet.** One of the important elements related to early childhood caries is diet. A diet high in fermentable carbohydrates interferes with the balance of the tooth demineralization (loss of minerals such as calcium and phosphate ions from the tooth surface) and remineralization (reuniting of minerals in the tooth surface) process (Fejerskov, Nyvad, & Kidd, 2015; Touger-Decker & Van Loveren, 2003). In this realist synthesis, I hypothesized some potential key mechanisms based on available data that can influence parents’ decision to buy non-perishable highly processed foods and sugary drinks and their decision to breastfeed their children. Those key mechanisms are given in the figure 6.6 and 6.7, and their explanations in the table 6.6 and 6.7.
**Figure 6.6.** Key mechanisms identified for parents' decision to buy non-perishable highly processed foods, sugary drinks, and snacks.

**Table 6.6**

*Key Mechanisms and Detailed CMO Related to Parents' Decision to Buy Non-Perishable Highly Processed Foods, Sugary Drinks and Snacks*

<table>
<thead>
<tr>
<th>Key mechanisms identified for parents' decision to buy non-perishable highly processed foods, sugary drinks and snacks.</th>
<th>Detailed CMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Perceived food value (Dhuria et al., 2021; Exner-Pirot, Norbye, &amp; Butler(eds.), 2018; Kristin, Kelly, Travis, Joseph, &amp; Lori, 2017)</td>
<td>Parents' education and nutrition knowledge (C), oral health knowledge and instructions (C), availability of grocery stores with healthy food in a remote area (C), cost of healthy food in a remote area (C), children's preferences for sugary drinks and snacks (C), poor water quality in a remote area (C), geographic isolation (C), socioeconomic status of parents (C), + perceived food value (M) = parents' decision to buy non-perishable highly processed foods, sugary drinks, and snacks.</td>
</tr>
</tbody>
</table>
If parents perceive that fruits and vegetables are healthy (M), although they are costly (C), they may be interested in buying fruits and vegetables and avoid non-perishable processed foods, sugary drinks and snacks (O).

If parents give preferences to their children’s choices for sugary drinks and snacks (C) as a way to express love, then parents may perceive higher food value for those items, which can cause them to buy those sugary drinks and snacks (O).

If parents live in a remote area (C) where they need to drive a long distance to buy food, then they may perceive higher food value (M) towards non-perishable processed foods, sugary drinks and snacks instead of easily perishable fruits and vegetables, which can cause them to buy those non-perishable processed foods, sugary drinks and snacks (O).
If there is poor drinking water quality and quantity in remote areas (C), then children may perceive higher food value (M) for sugary drinks instead of community tap water, which can force parents to buy sugary drinks (O). If parents have a low income (C), they might perceive healthy food as costly and insufficient in satisfying their children’s hunger (M), which may cause them to buy low-cost stomach-filling food and snacks (O).

<table>
<thead>
<tr>
<th>2. Self-efficacy (perceived ability to harvest, hunt and cook) (Indigenous-specific) (Cidro, Robin Martens, Zahayko, &amp; Lawrence, 2018; Lampow, 2022; Skinner et al., 2013)</th>
<th>Geographic isolation (C), socioeconomic status of parents (C), parents' busy schedule (C), loss of traditional diet (C), + self-efficacy (M) = parents' decision to buy non-perishable processed foods, sugary drinks and snacks. (O). If parents perceive that they are not being able to harvest, hunt and cook (M) traditional food because of their busy</th>
</tr>
</thead>
</table>

| Schedule (C), colonization (C), or government policy (C), or not having enough money to buy harvesting and hunting tools (C) which can cause them to buy ready-made highly processed foods, sugary drinks and snacks (O). |
| Colonization (C) + effects of colonialism in their belief (Indigenous-specific) (Assembly of First Nations Environmental Stewardship Unit, 2008; Cidro et al., 2018; Halseth, 2015) = parents' decision to buy non-perishable highly processed foods, sugary drinks and snacks. (O). If parents have the belief brought by colonization that their traditional food isn’t ‘good enough’ (M) or western food is better, then they may show less interest in traditional foods and instead choose highly processed foods, sugary drinks and snacks (O). |
**Figure 6.7.** Key mechanisms identified for parents' low breastfeeding tendency.

Table 6.7

*Key Mechanisms and Detailed CMO Related to Parents' Low Breastfeeding Tendency*

<table>
<thead>
<tr>
<th>Key mechanisms identified for parents' low breastfeeding tendency.</th>
<th>Detailed CMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Parents perceived breastfeeding value (Cidro et al., 2015; Romano, Cooke, &amp; Wilk, 2019; Schroth et al., 2005; Schroth et al., 2013)</td>
<td>Parents’ education and nutrition knowledge (C), young age of mother (C), socioeconomic status (C), parents' oral health knowledge and instructions (C), + parents perceived breastfeeding value (M) = ↑↓ breastfeeding tendency (O). If parents have education and nutrition knowledge (C), then they may perceive higher food value for breastfeeding (M) which can motivate them to breastfeed their children instead relying on bottle feeding (nighttime bottle feeding and feeding with sugar-laden juice) (O).</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>2. Stigma and fear of being judged (Cidro et al., 2015; Health Council of Canada, 2011)</td>
<td>Young age of mother (C), + stigma and fear of being judged (M) = breastfeeding tendency (O). If a mother of young age (C) fears the stigma or embarrassment of being a teen mom (M) or has a fear of being judged for becoming a mother at an early age (M), then she may be demotivated to continue breastfeeding her child (O).</td>
</tr>
<tr>
<td></td>
<td>Socioeconomic status (C), mother's busy schedule (C), cultural knowledge and skill (C), history of birth alert (C), + self-efficacy (perceived ability to breastfeed) (M) = breastfeeding tendency (O). If mothers have cultural knowledge and skills (C) about breastfeeding, then they may have a perception of being able to continue breastfeeding (M), which can motivate them to avoid bottle feeding (O). If a mother has a busy schedule, she may perceive not being able to continue</td>
</tr>
</tbody>
</table>
4. **Confidence and empowerment**  
(Cidro et al., 2015; Cidro et al., 2018; Moffitt, Lakhani, & Cruz, 2018)  

| Family member's support (C), presence of supportive women (C), + confidence and empowerment (M) = ↑↓ breastfeeding tendency (O).  
If a mother gets family members' support (C) and is surrounded by a circle of supportive women who play an important role in passing knowledge about breastfeeding to new moms (C), then she may feel confident and empowered (M), which can motivate her to continue breastfeeding (O). |

---

**6.1.3c: Colonization of bacteria.** A significant relationship exists between early childhood caries and the early colonization of bacteria on the tooth surface. Early colonization of
bacteria in the child's mouth occurs through the early transmission of bacteria from the mother or caregiver to the child's mouth, from family members and other children’s to the child's mouth, and by having developmental dental defects (anomalies that occur during the tooth formation stage) (Tinanoff et al., 2010; Manchanda et al., 2021). In this realist synthesis, I hypothesized some potential mechanisms based on available data that influence the early colonization of bacteria in the child's mouth. Those mechanisms are given in the figures 6.8 and 6.9, along with explanations in the table 6.8, 6.9, and 6.10.
Figure 6.8. Key mechanisms identified for the early colonization of bacteria.

Table 6.8
### Key Mechanisms and Detailed CMO Related to Regular Prenatal Dental Visit

<table>
<thead>
<tr>
<th>Key mechanisms identified for a regular prenatal dental visit.</th>
<th>Detailed CMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Perceived belief, prioritization and need for maintaining good oral hygiene (Jessani, 2014; Lawrence et al., 2016)</td>
<td>Education (C), previous dental experiences (C), community tradition and culture (C), oral health knowledge and instructions (C), + perceived belief, prioritization and need for maintaining good oral hygiene (M) = ▲▼ regular prenatal dental visit (O). If parents have a belief that the mother's poor oral health doesn’t affect children's dental health or that having tooth problems during pregnancy is normal (M), then they may show less interest in dental visits during pregnancy (O). If a pregnant mother lacks oral healthcare knowledge (C), then she may not give priority or may not feel the need to maintain good oral hygiene (M) during</td>
</tr>
</tbody>
</table>
pregnancy, which can demotivate her to visit prenatal dental care (O).

If a pregnant mother has the belief that visiting a dental clinic during pregnancy is not safe as it may harm her child by exposing them to dental chemicals and dental clinic atmosphere (M), etc., then she may avoid visiting the dentist during pregnancy (O).

| 2. Trust and rapport (Kyon-Achan et al., 2021; National Collaborating Centre for Indigenous Health, 2011) | Education (C), previous dental experiences (C), community tradition and culture (C), parents' oral health knowledge and instructions (C), power imbalance between dentist and pregnant mother (C), Indigenous inequity through colonization (C), + trust and rapport (M) = \( \uparrow \) regular prenatal dental visit (O).

If there is a power imbalance between dentists and pregnant mothers (C), it may hinder trust and rapport (M) between dental care practitioners and parents, thus creating an unfavourable atmosphere that |
can lead to avoiding prenatal dental treatment (O).

If pregnant mothers feel mistrust (M) toward dentists, it may be due to historical traumatic experiences (C), or a power imbalance between dentists and mothers (C), then they may be less likely to visit the dentist during pregnancy (O).

If pregnant mothers do not have trust in dentists (M), although they have oral health knowledge and instructions (C), then they may be less likely to visit the dentist during pregnancy (O).

| 3. Fear of being judged, isolated and fear of losing their child to social service (Health Council of Canada, 2011; Latimer, 2021; Lawrence et al., 2016; Sterritt & Woodward, 2019; Vescera, 2021) | Indigenous inequity through colonization (C), young age of mother (C), availability of dental professionals in a remote area (C), geographic isolation (C), difficulty travelling in city hospitals or community dental clinics (C), + fear of being judged, isolated and fear of losing their child to |
social service (M) = regular prenatal dental visit (O).

If there is a lack of dental professionals in a remote area (C), and parents need to travel to city hospitals or community dental clinics (C) for prenatal dental treatments, where they may have the feeling of being isolated and separated from their family (M), which can influence parents’ decision to disregard and defer prenatal dental care (O).

If the generational trauma of residential school and colonization (C) triggers Indigenous parents’ fear of losing their unborn child to social service (M), then they may want to protect their children and avoid visiting prenatal dental care (O).

If a young age pregnant mother (C) has a fear of being judged for becoming pregnant at an early age (M) or fear of revealing something which may cause losing her child to child welfare authorities (M), then
she may want to protect her child and avoid visiting prenatal dental care (O).
If parents need to travel to city hospitals or community dental clinics (C) for prenatal dental treatments, then they may have a fear of being judged (M) by healthcare professionals or fear of being treated differently, which can influence parents' decisions to wait until care can be provided in their home environment resulting in deferred prenatal dental care (O).

<table>
<thead>
<tr>
<th>4. Anxiety and frustration (Desmarais, 2021; Indigenous Services Canada, n.d.; Lemchuk-Favel, 2010; National Collaborating Centre for Indigenous Health, 2011)</th>
<th>Availability of dental professionals in a remote area (C), geographic isolation (C), difficulty travelling in city hospitals or community dental clinics (C), socioeconomic status (C), ability to pay dental treatment fees (C), + anxiety and frustration M) = regular prenatal dental visit (O). If there is a lack of dental professionals in a remote area (C) and pregnant mothers need to travel to city hospitals or community dental clinics (C) for their prenatal dental care (O), they may want to protect their child and avoid visiting prenatal dental care (O).</th>
</tr>
</thead>
</table>

| treatments, then they may feel anxiety (M), which can influence their decision to disregard and defer prenatal dental care (O). If there is a shortage of dentists in remote communities (C), which leads to a long waiting list for a dentist appointment, then pregnant mothers may feel frustrated (M), resulting in avoiding prenatal dental care (O). If parents don't have the ability to pay dental treatment fees, they may become frustrated (M), which can demotivate them from visiting prenatal dental care (O). If a pregnant mother has previous poor dental experience (C), needle phobia (C), and hearing other people describe a painful dental procedure, then it may trigger anxiety in her (M), leading to avoiding dental appointments (O). |
| 5. Confidence and empowerment (Indigenous-specific) (Ashworth, 2018; Smylie et al., 2016) | Availability of culturally competent dental care (C), Indigenous Elder and family members support (C) + confidence and empowerment (M) = regular dental visit (O).

If pregnant mothers find culturally competent dental care available (C), they may have a sense of being respected (validation of traditional culture that was lost previously), empowered and confident (M), which ultimately can motivate them to seek prenatal dental treatment (O).

If pregnant mothers have support from family members and community Elders (C) regarding maintaining good oral hygiene during pregnancy, then they may feel confident (M), which can motivate them to seek prenatal dental treatment (O). |

|  |

Again, from Figure 6.8, we can see how overcrowded housing conditions and regular prenatal dental visits trigger mechanisms to influence the early colonization of bacteria in
children’s mouths. Those key mechanisms and detailed CMO related to the early colonization of bacteria are given in the table 6.9.

Table 6.9

*Key Mechanisms and Detailed CMO Related to the Early Colonization of Bacteria*

<table>
<thead>
<tr>
<th>Key mechanisms related to the early colonization of bacteria</th>
<th>Detailed CMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Transfer of <em>S. mutans</em> from mother to child (Damle et al., 2016).</td>
<td>Regular prenatal dental visit (C) + transfer of <em>S. mutans</em> from mother to child (M) = ( \downarrow \uparrow ) early colonization of bacteria (O). If a pregnant mother avoids prenatal dental visits and has untreated dental caries (C), then <em>S. mutans</em> can transfer early from mother to child through saliva during food and spoon-sharing (M), which can cause early colonization of bacteria resulting early childhood caries (O).</td>
</tr>
<tr>
<td>2. Transfer of <em>S. mutans</em> from family members to a child (Assembly of</td>
<td>Overcrowded housing condition (C) + transfer of <em>S. mutans</em> from family members</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\text{to the child (M)} = \downarrow \uparrow$ early colonization of bacteria (O).</th>
</tr>
</thead>
<tbody>
<tr>
<td>If a child lives in an overcrowded house (a suitable environment for the spread of cariogenic bacteria <em>S. mutans</em>) (C), then <em>S. mutans</em> can easily transfer to a child from other siblings and family members through food and toy sharing (M), which can cause early colonization of bacteria resulting early childhood caries (O).</td>
</tr>
</tbody>
</table>
Figure 6.9. Key mechanisms related to developmental dental defects.

Table 6.10

**Key Mechanisms and Detailed CMO Related to Developmental Dental Defects**

<table>
<thead>
<tr>
<th>Key mechanisms related to developmental dental defects which can lead to the early colonization of bacteria</th>
<th>Detailed CMO</th>
</tr>
</thead>
</table>

134
1. The intrauterine hyperglycemic condition may interfere with the metabolic process of enamel formation (Chen et al., 2017; Shen et al., 2016).

   **Gestational diabetes (C) + the intrauterine hyperglycemic condition may interfere with the metabolic process of enamel formation (M) = up down early colonization of bacteria (O).**

   If a mother has diabetes during pregnancy (C), then the intrauterine hyperglycemic condition may interfere with the metabolic process of enamel formation (M) and can cause a developmental defect of enamel (present as pits, grooves, thin enamel, and soft enamel), which can create a suitable environment for the early colonization of bacteria (O).

2. Nicotine may accumulate in fetal tissue, which can interfere with the mineralization of deciduous teeth (Maritz, 2008; Schroth et al., 2013; Zhong, Tang, Tan, & Huang, 2021).

   **Smoking during pregnancy (C) + nicotine may accumulate in fetal tissue, which can interfere with the mineralization of deciduous teeth (M) = up down early colonization of bacteria (O).**

   If a mother smokes during pregnancy (C), the growing fetus may be exposed to nicotine through its direct metabolite (cotinine can pass through the placenta).
and may interfere with the mineralization of deciduous teeth (M), which can cause developmental dental defect and make infant teeth more vulnerable to dental caries after the eruption (O).

<table>
<thead>
<tr>
<th>3.</th>
<th>A low level of fetus serum Vit D may cause low concentrations of calcium and phosphate ions in tooth cells which can affect the mineralization process (Foster, Nociti Jr, &amp; Somerman, 2014; Lehotay, Smith, Krahn, Etter, &amp; Eichhorst, 2013; Schroth et al., 2014; Swapna &amp; Abdulsalam, 2021).</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1.4: Identification of Substantive Theory</td>
<td>Vit D deficiency during pregnancy (C) + a low level of fetus serum Vit D may cause low concentrations of calcium and phosphate ions in tooth cells which can affect the mineralization process (M) = early colonization of bacteria (O). If a mother has Vit D deficiency during pregnancy (C), then it can cause a low level of fetus serum Vit D resulting in low concentrations of calcium and phosphate ions in tooth cells (M), which can affect the mineralization process and can cause developmental dental defects (O).</td>
</tr>
</tbody>
</table>
Substantive theories can assist researchers in comprehending the context-mechanism-outcome (CMO) patterns that are identified in a realist synthesis. They can provide a framework to understand how different contexts and mechanisms interact with each other to produce the observed outcomes (Wong, Westhorp, et al., 2013). At the beginning of this synthesis, no established substantive theory had been applied. During the identification of potential key mechanisms, I tried to find and incorporate any possible salient substantive theory by following RAMESES realist synthesis guidelines (Wong, Westhorp, et al., 2013). Settler colonial theory and Theory of Planned Behavior (TPB) were subsequently identified as salient substantive theories (Ajzen, 1991; Barker, 2021; Brookes, n.d.; Gakobo & Jere, 2016; Macoun & Strakosch, 2013; “The Theory of Planned Behavior”, n.d.; Veracini, 2010; Wolfe, 2006).

Settler colonialism is an ongoing process where colonizing societies displace and replace Indigenous Peoples and their ways of life. This process is done by imposing laws, institutions, and cultures that can lead to the marginalization and disempowerment of Indigenous Peoples (Veracini, 2010; Wolfe, 2006). Indigenous scholars and community leaders have played a significant role in developing settler colonial theory through their insights and critiques (Barker, 2021). Settler colonial theory aims to identify and bring attention to the dominant structures and processes of settler colonialism, providing valuable insights into the ongoing effects of colonialism (Macoun & Strakosch, 2013). By recognizing these ongoing effects, we can gain a better understanding of how colonialism contributes to health disparities among Indigenous Peoples and shapes their perceptions and choices around healthcare access.

Theory of Planned Behavior (TPB) - focuses on anticipating a person's intention to engage in a behavior at a particular time and location (Ajzen, 1991; “The Theory of Planned Behavior”, n.d.). According to this theory, there are three major constructs that drive behavior—
to explain (Gakobo & Jere, 2016). They are namely perceived attitude, subjective norms, and perceived behavioral control (Ajzen, 1991; Brookes, n.d.). When we think about an action, all of our knowledge, attitudes, prejudices, and thoughts come together to form the perceived attitude. The second construct is subjective norms, often known as perceived social pressure from family, friends, or close relationships to act in a certain way or our perception of other people's attitudes. The third construct is perceived behavioral control, which depends on the availability of resources and opportunities to support the performance of the behavior (Ajzen, 1991; Brookes, n.d.; Gakobo & Jere, 2016).

I tried to look at the effects of these substantive theories at the program theory level. The table below explains the identified substantive theory and the examples of substantive theory effects at the program theory level.

Table 6.11

*Identified Substantive Theories*

<table>
<thead>
<tr>
<th>Identified substantive theory</th>
<th>Specific aspects of a program theory supported by substantive theory.</th>
<th>Effects of substantive theory at the program theory level</th>
</tr>
</thead>
</table>
| 1. Settler colonial theory | Trust, self-efficacy (perceived ability to harvest, hunt and cook), effects of colonialism in their beliefs, anxiety, and fear of being judged and fear of losing their children to social service. | • If parents perceive that they are unable to harvest, hunt and cook (M) traditional food due to their busy schedule (C), or as a result of settler colonial policies and practices that have historically disrupted Indigenous ways of life and food habits (C), this can lead them to buy ready-made highly processed foods, sugary drinks and snacks (O).

• If the generational trauma of residential school and colonization (C) triggers parents' fear of losing their child to social service (M), then they may want to protect their children and avoid visiting dental care (O). |

| 2. Theory of Planned Behavior (TPB) | Parents' perceived values, prioritization and beliefs, self-efficacy, trust, stress and depression, | • If parents/caregivers have a belief about the inevitability of childhood dental caries, then they may show less interest in preventive dental visits |
confidence, and empowerment and only use dental care for emergencies.

- If parents feel mistrust toward dentists, which may be due to historical traumatic experiences or power imbalance between dentists and parents, then they are less likely to take their children to the dentist.

- If there is a lack of dental professionals in a remote area, and parents need to travel to city hospitals or surgical centers for their children's dental treatments, then parents may feel anxiety, which can influence their decision to disregard and defer dental care.

### 6.2: Chapter Summary

This chapter summarizes the findings of my realist synthesis. It provides a detailed explanation of the potential mechanisms that influence the phenomenon of early childhood caries.
in rural and remote children in Northern Saskatchewan. In addition, it discusses the identified substantive theories and examines their relation to my developed program theory. The next chapter considers the impact of these findings on future research, their implications, and the limitations of this realist synthesis.
CHAPTER SEVEN

7.1: Discussion

The main goal of this dissertation was to understand the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan in all of its complexity to assist future researchers and policymakers in improving children's oral health in that area. This realist synthesis aimed to answer the following two research questions.

1. What are the contexts and mechanisms at the individual and community levels that influence early childhood caries in rural and remote children in Northern Saskatchewan?

In this realist synthesis, I hypothesized some mechanisms at the individual and community levels that influence early childhood caries in rural and remote children in Northern Saskatchewan based on my readings of the literature that can form the basis of future research with these communities that will refine or refute these hypothesize mechanisms. The hypothesized mechanisms are parents' perceived values, prioritization and beliefs, self-efficacy (the perceived ability to maintain children's good hygiene, harvest, hunt and cook), stress and depression, trust, anxiety, fear of being judged, fear of losing their child to social service, parents perceived food value, effects of colonialism in their beliefs, perception of feasibility, confidence, and empowerment. Among these mechanisms, some are Indigenous-specific while most are not. As a non-Indigenous individual, I've identified those Indigenous-specific mechanisms based on
my analysis of secondary data only. It's essential to acknowledge that I can't speak for the complexity of important mechanisms that only Indigenous parents know. So, the Indigenous-specific mechanisms that are drawn from my interpretation of existing secondary literature need to be verified through engagement with the communities of Northern Saskatchewan. However, all the identified mechanisms can help to understand the complexity of this phenomenon. All the different level contexts and the mechanisms are explained with figures in the result section under three main headings Oral Hygiene, Diet, and Colonization of Bacteria.

2. What causal initial mid-range theories can be developed?

In a realist synthesis, a midrange theory can be developed by continuously refining the context-mechanism-outcome configuration. This theory can help policymakers understand how certain mechanisms operate in a particular context to create a specific outcome (Pawson, 2013). While developing my program theory, I realized that it is challenging to fully address the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan, because there is a hierarchy of mechanisms; one level of mechanisms is linked and nested with another, and these mechanisms manifest at multiple levels. Instead of expressing the findings through mid-range theory, I expressed them through figures (see Figure 6.3-6.9). These figures show how mechanisms are interconnected and how a context at one level can become an outcome at another level and, ultimately, shape the final result. To illustrate this, here are two examples that discuss multilevel CMO configurations, and show how one level of mechanisms impacts others and how they interact with one another to generate the phenomenon of early childhood caries.
Figure 7.1. Connection of mechanisms for regular teeth brushing.

In Figure 6.3 (chapter six), we can see that regular tooth brushing, the first step in maintaining good oral hygiene, is linked with 5 key mechanisms (parents' perceived values, prioritization and beliefs about tooth decay, self-efficacy, stress and depression, trust in authority, and empowerment). One of the key mechanisms for maintaining regular teeth brushing in children is the parents' perceived values and beliefs about tooth decay. In this realist synthesis, the contexts that influence this mechanism are the parents' education, parents’ and family members' dental experiences, community tradition and culture, and parents' oral health knowledge and instructions. When parents do not have adequate oral health knowledge and instructions or when they believe that most children develop caries despite precautions, they do not feel motivated to engage in preventive dental measures (such as maintaining regular teeth-
brushing, flossing and visiting dentists). Again, we see that parents' oral health knowledge and instructions are connected with 3 mechanisms (feeling of being able to understand and utilize the information, trust toward the source and feeling of being empowered or valued). These three mechanisms are also influenced by some other contexts, such as parents' education, language barrier, the availability of educational materials in their language, the availability of educational materials in remote areas, Indigenous community involvement, and colonization.

From Figure 7.1, we can see that due to the complexity of program theory at multiple levels, a context (oral health knowledge and instructions) at one level becomes an outcome at another level and, ultimately, shapes the final outcome. For example: policymakers might think that educating parents about oral health can inspire them to maintain their children's good oral hygiene. In turn, they may design interventions based on this thought. However, these interventions may not always work. Parents who mistrust the source of information or mistrust authority may not have an interest in learning those instructions. As a result, they may be less likely to monitor or maintain their children's regular tooth-brushing routines, which will eventually lead to early childhood caries.

Regular prenatal dental visits are crucial for preventing the early colonization of bacteria in children's mouths. This realist synthesis identified 5 key mechanisms related to regular prenatal dental visits of parents living in Northern Saskatchewan. Among them, is the fear of being judged and losing their child to social services. Contexts that influence this mechanism are young age of mothers, the availability of dental professionals in a remote area, geographic
isolation, Indigenous inequity through colonization, and difficulty travelling to the nearest city, which may be hundreds of kilometres away.

![Diagram of mechanisms for a regular prenatal dental visit]

**Figure 7.2.** Connection of mechanisms for a regular prenatal dental visit.

From Figure 7.2, we see that one of these contexts (the availability of dental professionals in rural areas) is also an intermediate outcome at another level, and it is also related to the mechanism of health professionals' feeling of being challenged. If there is transportation difficulty, a heavy workload, low manpower and resources in a remote area, a lack of educational opportunities and modern amenities for children in a remote area, or few career opportunities for partners in a remote area, then health professionals – including dentists, hygienists, dental therapists, nurses, registered dietitians, physicians and others – may feel frustrated, or feel
professionally challenged, which can lead them to leave. When there is a lack of dental professionals in a remote area, parents need to travel to city hospitals or community dental clinics for prenatal dental treatments; there, it is unlikely that the staff speaks their language or understands them culturally. Fear of being judged and treated differently by healthcare professionals, or fear of losing their child to social service for revealing something can influence parents’ decisions to wait until dental care is provided in their home community. Deferring or avoiding prenatal dental care can lead to poor maternal oral health. This may increase the chance of early childhood caries through the early transmission of \textit{S. mutans} from mother to infant (Lapirattanakul & Nakano, 2014). We should not blame parents for not being attentive to prenatal dental care. Instead, before designing interventions, we need to think about the dynamics as a whole and how the phenomenon of early childhood caries operates at multiple levels in the rural and remote children in Northern Saskatchewan.

\textbf{7.1.1: Significance}

This realist synthesis applied systems thinking approach to shed light on the complex nature of the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan. While addressing this phenomenon, I also realized that there is a hierarchy of mechanisms, and each level of mechanisms impacts others to generate the outcome. For example, one of the individual-level mechanisms related to regular dental visits is anxiety and frustration. When parents do not have the funds to pay their children’s dental treatment fees, they may become anxious or frustrated. This situation can demotivate them from visiting the dentist, which can lead to early childhood caries. However, one must consider that there are also mechanisms that shape parents' ability to pay dental treatment fees. Those mechanisms may be
related to inequalities in dental care financing, employment, and difficulties accessing dental insurance. Being an Indigenous individual in Northern Saskatchewan adds an additional layer of complexity when it comes to the ability of parents to afford dental treatment costs. This complexity is linked to the accessibility of the Non-Insured Health Benefits (NIHB) program, which primarily serves First Nations and Inuit communities, thereby excluding Métis and non-status First Nations individuals from dental and other healthcare services (Allan & Smylie, 2015; Indigenous Services Canada, n.d.). It's important to note that merely meeting the eligibility criteria for NIHB doesn't guarantee easy access, as there are various administrative and bureaucratic hurdles to navigate in order to access the benefits (Allan & Smylie, 2015; Lemchuk-Favel, 2010). In this case the mechanisms may be operating at the policy, economic, societal, or political levels.

Moreover, another Indigenous-specific mechanism related to Indigenous children's diet is the parents perceived ability to harvest, hunt and cook traditional foods. When parents perceive that they are not able to harvest, hunt, and cook traditional foods, they may be left with the option to buy ready-made highly processed foods, sugary drinks, and unhealthy snacks for their children. The context that influences this mechanism is the loss of the traditional diet. But when we explore the mechanisms that are related to the loss of the traditional diet, we may find it has connections with colonization, government policies and laws (Saskatchewan trespass law). Again, this mechanism that I hypothesized from secondary data might not be true for all Indigenous parents. Because the historical political relationships, differing government policies and assimilation strategies have played a crucial role in shaping distinct social experiences among Indigenous groups (Reading & Wien, 2009; Tri-Council Panel on Research Ethics, 2005).
When formulating strategies to improve the oral health status of children living in rural and remote areas in Northern Saskatchewan, policy makers need to consider the diversity and complexities that exist across different Indigenous communities living there (Tri-Council Panel on Research Ethics, 2023b; Voyageur & Calliou, 2000). This complexity arises from the unique cultures, traditions, policies and historical backgrounds of Indigenous groups, which have led to differences in social circumstances across the different Indigenous Peoples (Voyageur & Calliou, 2000). As a non-Indigenous individual, I am fully aware that, I cannot speak for the complexity of important mechanisms that only Indigenous Peoples know. The Indigenous-specific mechanisms that I hypothesized related to early childhood caries came from my understanding of what I found in the literature. These mechanisms need to be further developed with community consultation because the existing literature may not adequately incorporate the perspectives and experiences of Indigenous Peoples. However, the available existing data from the literature helped me to present and highlight the complex picture and the systemic nature of the phenomenon.

Another community-level mechanism to maintain good oral hygiene in remote areas is the parents' prioritization of maintaining their children’s regular teeth brushing. One of the contexts that influences this mechanism is the availability of clean drinking water in remote areas. If we explore further, we may find some other mechanisms operating at the environmental, policy, economic, and political levels that influence the availability of clean drinking water in remote areas in Northern Saskatchewan. Since I am unable to explore every possible level of
mechanisms in this realist synthesis, I invite future researchers who are knowledgeable in those fields to investigate further to uncover those mechanisms. This realist synthesis encourages multidisciplinary approaches to be used in the future to improve the oral health in rural and remote children in Northern Saskatchewan.

In this synthesis, I aimed to make hypotheses based on the available and existing data and developed a multilayer map showing a hierarchy of different-level mechanisms and their interactions with each other that influence the existence of early childhood caries in rural and remote children in Northern Saskatchewan. By looking at the multilayer map, we can understand the big complex picture and the systemic nature of this phenomenon.

7.1.2: Limitations

In Northern Saskatchewan, around 85% of the population are Indigenous Peoples, each with their distinct cultures, traditions, policies, and historical backgrounds (Irvine & Quinn, 2016; Statistics Canada, 2017; Tait, Butt, Henry, & Bland, 2017). To present the complexity of the phenomenon of early childhood caries that exist in rural and remote children in Northern Saskatchewan, I hypothesized some Indigenous-specific mechanisms along with other mechanisms at the individual and community levels that influence the phenomenon based on available secondary data. However, I acknowledge that, as a non-Indigenous individual, I am limited in my capacity to grasp and fully comprehend the unique challenges faced by Indigenous Peoples. Unfortunately, while developing my Initial program theory I was unable to visit Northern Saskatchewan and directly engage with the community due to the COVID-19 pandemic and the resulting travel restrictions. Furthermore, I recognize that, I cannot speak for the complexity of important mechanisms that only Indigenous Peoples know. The Indigenous-
specific mechanisms that I hypothesized related to early childhood caries are coming from my understanding of secondary literature and need to be further developed with community consultation.

To eradicate early childhood caries in rural and remote children in Northern Saskatchewan, we first need to understand and find the hierarchy of the different mechanisms that are playing out at multiple levels, such as the individual, community, economic, policy, societal, political, and environmental levels. Because of the time constraints I faced in completing my master's degree, I had to focus on understanding the complexity of the phenomenon at multiple system levels rather than capturing all of the mechanisms. In addition, it would be impossible for me to explore all the different level mechanisms with my expertise and limited time. Due to the complex nature of the studied phenomenon, finding and incorporating substantive theories at the program theory level was difficult. I was able to identify two substantive theories. I hope this limitation will be overcome in future work that will further refine the program theory. Another limitation of this realist synthesis is that it only included documents that were written in English.

7.1.3: Future Directions

This initial work sets the stage for proper engagement with Indigenous Peoples living in Northern Saskatchewan. Future research can refine and/or refute this program theory by visiting and consulting with Indigenous Peoples in Northern Saskatchewan to engage and seek their input. This future research should be guided by a deep respect for Indigenous knowledge, traditions, and ways of understanding the world. It should prioritize collaboration, cultural sensitivity, and community involvement at every stage, aiming to uphold Indigenous values and
their right to control research related to their culture. A suggestion as to how this could unfold is presented below.

The first step will need to involve engaging with the Indigenous community and establishing meaningful relationships. Permissions should be sought from community leaders and elders to enter into a research partnership with them that is respectful of the communities. Recognizing that building trust is crucial, the researcher will invest the necessary time required and take direction from the community. Activities may include attending community events, participating in cultural activities, and actively listening to community members' concerns and aspirations. It is recommended that community research advisory committee (RAC) with representatives from the Indigenous community be formed so that their insights and cultural protocols can guide the research. Regular meetings and open communication with this committee will be maintained throughout the research process, ensuring community participation in decision-making. Cultural protocols should be respected throughout the research. A research methodology that aligns with Indigenous paradigms should be carefully chosen in consultation with the RAC so that community members can share their experiences, strengths, and perspectives in a culturally relevant and respectful manner. Throughout the research, community members should be actively involved in the research process, from data collection to analysis and dissemination of findings as guided by the RAC. This involvement will ensure that the research benefits the community and respects their right to be in control of research that pertains to their culture.

7.1.4: Comparisons with Current Literature
No other publications have developed program theory to address the phenomenon of early childhood caries in rural and remote children in Northern Saskatchewan. However, the identified potential key mechanisms align with the findings of other research that focused on the barriers and facilitators of early childhood caries in other provinces in Canada (Irvine, Holve, Krol, & Schroth, 2011; Kyoon-Achan et al., 2021; Pierce et al., 2019). Research has demonstrated that parents’ attitudes and beliefs can impact the occurrence of early childhood caries (ECC) in preschool-aged children (Pierce et al., 2019). This realist synthesis supports this finding, and it suggests that parents’ perceived value, prioritization and beliefs about the normalization of dental caries in the community are the mechanisms that influences whether parents seek preventive dental care for their children or only seek dental treatment in emergencies. If parents hold the belief that dental caries is a natural part of childhood or that dental caries in children is ingrained in their culture and something that all children experience, then they may show less interest in seeking dental care for their children. Numerous studies have indicated that when expecting mothers receive dental care during pregnancy, it can help prevent or delay early childhood caries in their infants (Irvine, Holve, Krol, & Schroth, 2011; Kumar & Samelson, 2006). This realist synthesis found multiple mechanisms (parents’ perceived value, prioritization and need for maintaining good oral hygiene, trust and rapport, fear of being judged, fear of being isolated, fear of losing their child to social service, anxiety, confidence, and empowerment) that can influence parents’ willingness or hesitancy to visit oral health professionals during pregnancy. A study by Smylie et al. (2016) developed a mid-range theory of Indigenous community investment-ownership-activation for successful Indigenous children’s health promotion programs (Smylie et al., 2016). This realist synthesis also discussed how the
support of Indigenous community members and Elders' could motivate parents in engaging in good oral hygiene behavior and maintaining their children's healthy diets.

7.2: Chapter Summary

Although the Government of Canada and non-governmental groups have launched numerous measures aimed at reducing early childhood caries in rural and remote children in Northern Saskatchewan, the situation is still a major public health concern. This realist synthesis used system thinking approach to enquire further about reasons this situation still exists. Even though the mechanisms I identified and hypothesized related to the existence of early childhood caries in rural and remote children in Northern Saskatchewan, are based on the secondary data and need to be further developed with community consultation, serve as the first step towards unpacking the complexities of this phenomenon. This realist synthesis portrayed a multilayer map showing a hierarchy of different-level mechanisms and their interactions with each other that influence the existence of early childhood caries in rural and remote children in Northern Saskatchewan. By looking at the multilayer map, we can understand the complex systemic nature of this phenomenon and can realize the need for a holistic approach to tackle this issue. This realist synthesis also demonstrates the value of the system thinking approach and realist paradigm in understanding complex phenomena.
REFERENCES


Color theory. (n.d.). Retrieved May 4, 2023, from Massachusetts Institute of Technology website:
https://web.mit.edu/search/?q=Color+Theory#gsc.tab=0&gsc.q=Color%20Theory&gsc.page=1


Danermark, B. (2002). Interdisciplinary research and critical realism - The example of disability research. Alethia, 5(1), 56-64. doi:https://doi.org/10.1558/aleth.v5i1.56


Dhuria, P., Lawrence, W., Crozier, S., Cooper, C., Baird, J., & Vogel, C. (2021). Women’s perceptions of factors influencing their food shopping choices and how supermarkets can support them to make healthier choices. *BMC Public Health, 21*(1), 1-12. doi:https://doi.org/10.1186/s12889-021-11112-0


doi:https://doi.org/10.1186/s13643-015-0025-3


Prevention is better than cure. (n.d.). In The Idioms. Retrieved March 2, 2023, from https://www.theidioms.com/prevention-is-better-than-cure/#:~:text=Prevention%20is%20the%20act%20of,health%20issues%20or%20damage%20later.


doi:10.3402/ijch.v72i0.21167

doi:10.1542/peds.2013-2215


186


Socha, T., Zahaf, M., Chambers, L., Abraham, R., & Fiddler, T. (2012). Food insecurity in a Northern First Nations community: An exploratory study on food availability and


The Canadian Dental Hygienists Association. (2009, August 14). *Improving cost effectiveness and program efficiencies in First Nations and Inuit health branch, Non Insured Health*
Benefits program. Ottawa, ON: The Canadian Dental Hygienists Association. Retrieved from
https://www.cdha.ca/cdha/The_Profession/Policy_Advocacy/Tagged_Content/SubGov_Improving_Cost.aspx

The Northern Saskatchewan Administration District (NSAD). (n.d.). Retrieved September 1, 2023, from Northern Municipal Services website:
https://www.planningforgrowthnorthsk.com/about-the-northern-saskatchewan-administration-district.html

The risks of poor nutrition. (n.d.). Retrieved February 9, 2022, from Government of South Australia website:


University of Guelph; Dalhousie University; University of British Columbia; University of Saskatchewan. (2023, March 25). *Canada’s food price report 2023*. Retrieved from


*USask collaboration establishes first dental therapy degree program in Canada.* (2022, May 17). Retrieved from University of Saskatchewan:


Willy, C., Neugebauer, E. A., & Gerngroß, H. (2003). The concept of nonlinearity in complex systems: An additional approach to understand the pathophysiology of severe trauma and


194


APPENDICES

APPENDIX A

Table A.1

Final Included Documents

<table>
<thead>
<tr>
<th>Final Included Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Title</th>
<th>Journal/Source</th>
<th>DOI</th>
</tr>
</thead>
</table>
APPENDIX B

Initial Program Theory

Figure A.1. Initial Program Theory